

Table of Contents

December, 2013

Anesthetic Pharmacology

[脂肪乳剂对细胞内布比卡因的影响为脂质复苏的机制：使用电压门控质子通道的电生理研究](#)

(陈实玉译 薛张纲校)

The Effect of Lipid Emulsion on Intracellular Bupivacaine as a Mechanism of Lipid Resuscitation: An Electrophysiological Study Using Voltage-Gated Proton Channels

- Hori, Kotaro;
- Matsuura, Tadashi;
- Mori, Takashi;
- Kuno, Miyuki;
- Sawada, Makoto;
- and Nishikawa, Kiyonobu

Anesthesia & Analgesia. 117(6):1293-1301, December 2013.

Technology, Computing, and Simulation

Research Report

[在肝部分切除术中患者使用脉搏波传送时间测得的心输出量：对 esCCO 系统与热稀释法的比较](#)

(赵晓译 马皓琳 李世通校)

Pulse Wave Transit Time Measurements of Cardiac Output in Patients Undergoing Partial Hepatectomy: A Comparison of the esCCO System with Thermodilution

- Tsutsui, Masato;
- Araki, Yoshiyuki;
- Masui, Kenichi;
- Kazama, Tomiei;
- Sugo, Yoshihiro;
- Archer, Thomas L.;

- and Manecke, Gerard R. Jr

Anesthesia & Analgesia. 117(6):1307-1312, December 2013.

[在离体及麻醉猪在体实验中药物输注系统汇合管死腔对输注药物剂量改变时输注响应时间的影响](#)

(谈婧华 译 陈杰 校)

Drug Infusion System Manifold Dead-Volume Impacts the Delivery Response Time to Changes in Infused Medication Doses In Vitro and Also In Vivo in Anesthetized Swine

- Lovich, Mark A.;
- Wakim, Matthew G.;
- Wei, Abraham;
- Parker, Michael J.;
- Maslov, Mikhail Y.;
- Pezone, Matthew J.;
- Tsukada, Hisashi;
- and Peterfreund, Robert A.

Anesthesia & Analgesia. 117(6):1313-1318, December 2013.

[麻醉设备与表观死腔容积，一个临床以及实验室研究](#)

(陈婉南译 薛张纲校)

Apparent Dead Space with the Anesthetic Conserving Device, AnaConDa® : A Clinical and Laboratory Investigation

- Stureson, Louise W.;
- Bodelsson, Mikael;
- Johansson, Anders;
- Jonson, Björn;
- and Malmkvist, Gunnar

Anesthesia & Analgesia. 117(6):1319-1324, December 2013.

Brief Report

[使用 COOK 换管器时的换管失败和并发症：对 1177 名患者的单中心队列研究](#)

(盛嘉君 译，马皓琳、李士通 审校)

Airway Exchange Failure and Complications with the Use of the Cook Airway Exchange Catheter® : A Single Center Cohort Study of 1177 Patients

- McLean, Sheron;

- Lanam, Carolyn R.;
- Benedict, Wendy;
- Kirkpatrick, Nathan;
- Kheterpal, Sachin;
- and Ramachandran, Satya Krishna

Anesthesia & Analgesia. 117(6):1325-1327, December 2013.

Patient Safety

Research Report

[使用依托咪酯而非异丙酚进行麻醉诱导可增加非心脏手术后 30 天内死亡及心血管发病率](#)

(边文玉 译 陈杰 校)

Anesthetic Induction with Etomidate, Rather than Propofol, Is Associated with Increased 30-Day Mortality and Cardiovascular Morbidity After Noncardiac Surgery

- Komatsu, Ryu;
- You, Jing;
- Mascha, Edward J.;
- Sessler, Daniel I.;
- Kasuya, Yusuke;
- and Turan, Alparslan

Anesthesia & Analgesia. 117(6):1329-1337, December 2013.

[如何改进围手术期风险评估模型:通过生命体征使用外科 Apgar 评分系统一例](#)

(李春译 薛张纲校)

How to Improve the Performance of Intraoperative Risk Models: An Example with Vital Signs Using the Surgical Apgar Score

- Hyder, Joseph A.;
- Kor, Daryl J.;
- Cima, Robert R.;
- and Subramanian, Arun

Anesthesia & Analgesia. 117(6):1338-1346, December 2013.

[甲颏高度:预测喉镜检查困难的一项新的临床测试](#)

(邢怡安 译 马皓琳 李士通 校)

Thyromental Height: A New Clinical Test for Prediction of Difficult Laryngoscopy

- Etezadi, Farhad;
- Ahangari, Aylar;
- Shokri, Hajar;
- Najafi, Atabak;
- Khajavi, Mohammad Reza;
- Daghigh, Mahtab;
- and Moharari, Reza Shariat

Anesthesia & Analgesia. 117(6):1347-1351, December 2013.

Brief Report

[声门下狭窄患者的气道管理：一个学术机构的经验之谈](#)

(朱浩译 陈杰校)

Airway Management in Patients with Subglottic Stenosis: Experience at an Academic Institution

- Knights, Richard M.;
- Clements, Stephan;
- Jewell, Elizabeth;
- Tremper, Kevin;
- and Healy, David

Anesthesia & Analgesia. 117(6):1352-1354, December 2013.

Obstetric Anesthesiology

Review Article

[临床产科麻醉期间的过敏反应：文献综述](#)

(凌晓敏译 薛张纲校)

Anaphylaxis in the Clinical Setting of Obstetric Anesthesia: A Literature Review

- Hepner, David L.;
- Castells, Mariana;
- Mouton-Faivre, Claudie;
- and Dewachter, Pascale

Anesthesia & Analgesia. 117(6):1357-1367, December 2013.

Brief Report

[剖宫产后椎管内吗啡镇痛后呼吸抑制发生率的回顾性研究](#)

(董静译 马皓琳 李士通 校)

A Retrospective Assessment of the Incidence of Respiratory Depression After Neuraxial Morphine Administration for Postcesarean Delivery Analgesia

- Crowgey, Theresa R.;
- Dominguez, Jennifer E.;
- Peterson-Layne, Cathleen;
- Allen, Terrence K.;
- Muir, Holly A.;
- and Habib, Ashraf S.

Anesthesia & Analgesia. 117(6):1368-1370, December 2013.

Pediatric Anesthesiology

Research Report

[麻醉诱导时使用视频眼镜作为术前焦虑儿童管理的一项娱乐工具](#)

(李峰日 译 陈杰 校)

Anesthesia Induction Using Video Glasses as a Distraction Tool for the Management of Preoperative Anxiety in Children

- Kerimoglu, Beklen;
- Neuman, Avishai;
- Paul, Jonathan;
- Stefanov, Dimitre G.;
- and Twersky, Rebecca

Anesthesia & Analgesia. 117(6):1373-1379, December 2013.

[儿童输液反应预测：系统性综述](#)

(刘毅译 薛张纲校)

Predicting Fluid Responsiveness in Children: A Systematic Review

- Gan, Heng;
- Cannesson, Maxime;
- Chandler, John R.;
- and Ansermino, J. Mark

Anesthesia & Analgesia. 117(6):1380-1392, December 2013.

[顺阿曲库铵和罗库溴铵对麻醉儿童肺功能的影响](#)

(王晓莉译 马皓琳 李士通校)

The Effect of Cisatracurium and Rocuronium on Lung Function in Anesthetized Children

- Yang, Charles I.;
- Fine, Gavin F.;
- Jooste, Edmund H.;
- Mutich, Rebecca;
- Walczak, Stephen A.;
- and Motoyama, Etsuro K.

Anesthesia & Analgesia. 117(6):1393-1400, December 2013.

[儿童尿道下裂手术应用阴部神经阻滞和骶管阻滞麻醉的有效性对比研究](#)

(贺加贝 译 陈杰 校)

The Effectiveness of Pudendal Nerve Block Versus Caudal Block Anesthesia for Hypospadias in Children

- Naja, Zoher M.;
- Ziade, Fouad M.;
- Kamel, Raymond;
- El-Kayali, Sabah;
- Daoud, Nabil;
- and El-Rajab, Mariam A.

Anesthesia & Analgesia. 117(6):1401-1407, December 2013.

Review Article

[儿科麻醉的质量及安全性](#)

(徐升译 薛张纲校)

Quality and Safety in Pediatric Anesthesia

- Varughese, Anna M.;
- Rampersad, Sally E.;
- Whitney, Gina M.;
- Flick, Randall P.;
- Anton, Blair;

- and Heitmiller, Eugenie S.

Anesthesia & Analgesia. 117(6):1408-1418, December 2013.

Pediatric Neuroscience

Research Report

[婴儿期暴露于全身麻醉对 12 岁儿童学习成绩的影响](#)

(张怡译马皓琳李士通校)

The Effects of Exposure to General Anesthesia in Infancy on Academic Performance at Age 12

- Bong, Choon Looi;
- Allen, John Carson;
- and Kim, Josephine Tan Swee

Anesthesia & Analgesia. 117(6):1419-1428, December 2013.

[新生大鼠在出生后暴露在七氟烷下会导致海马长时程增强作用的明显抑制](#)

(林甲票 译 陈杰 校)

Neonatal Exposure to Sevoflurane Causes Significant Suppression of Hippocampal Long-Term Potentiation in Postgrowth Rats

- Kato, Rui;
- Tachibana, Kaori;
- Nishimoto, Naoki;
- Hashimoto, Toshikazu;
- Uchida, Yosuke;
- Ito, Ryoko;
- Tsuruga, Kenkichi;
- Takita, Koichi;
- and Morimoto, Yuji

Anesthesia & Analgesia. 117(6):1429-1435, December 2013.

Neuroscience in Anesthesiology and Perioperative Medicine

Research Report

[以沙滩椅位置进行的肩关节镜手术在全身麻醉状态下，精氨酸利尿剂能预防防止低血压，但同时会影响脑部供氧](#)

(徐峥译 薛张纲校)

Under General Anesthesia Arginine Vasopressin Prevents Hypotension but Impairs Cerebral Oxygenation During Arthroscopic Shoulder Surgery in the Beach Chair Position

- Cho, Soo Y.;
- Kim, Seok J.;
- Jeong, Cheol W.;
- Jeong, Chang Y.;
- Chung, Sung S.;
- Lee, JongUn;
- and Yoo, Kyung Y.

Anesthesia & Analgesia. 117(6):1436-1443, December 2013.

General Articles

Special Article

[Datta 短喉镜手柄的发展及历史背景](#)

(王赞译 马皓琳 李士通校)

The Development and Historical Context of the Datta Short Laryngoscope Handle

- Chang, Laura Y.;
- and Tsen, Lawrence C.

Anesthesia & Analgesia. 117(6):1480-1484, December 2013.

Pain Medicine

Research Report

[持续肌间沟神经阻滞在门诊肩袖修复手术患者中的应用：一项前瞻随机试验](#)

(陆秉玮 译 陈杰 校)

Continuous Interscalene Block in Patients Having Outpatient Rotator Cuff Repair Surgery: A Prospective Randomized Trial

- Salviz, Emine Aysu;
- Xu, Daquan;
- Frulla, Ashton;

- Kwofie, Kwesi;
- Shastri, Uma;
- Chen, Junping;
- Shariat, Ali Nima;
- Littwin, Sanford;
- Lin, Emily;
- Choi, Jason;
- Hobeika, Paul;
- Hadzic, Admir

Anesthesia & Analgesia. 117(6):1485-1492, December 2013.

Pain and Analgesic Mechanisms

Research Report

[坐骨神经部分离断术大鼠鞘内给予超低剂量纳洛酮可增强吗啡的抗痛觉过敏作用，并下调脊髓背角 TNF- \$\alpha\$ 和 TNFR1 表达](#)

(朱怡琦译 薛张纲校)

Intrathecal Ultra-Low Dose Naloxone Enhances the Antihyperalgesic Effects of Morphine and Attenuates Tumor Necrosis Factor- α and Tumor Necrosis Factor- α Receptor 1 Expression in the Dorsal Horn of Rats with Partial Sciatic Nerve Transection

- Yang, Chih-Ping;
- Cherng, Chen-Hwan;
- Wu, Ching-Tang;
- Huang, Hui-Yi;
- Tao, Pao-Luh;
- Lee, Sing-Ong;
- and Wong, Chih-Shung

Anesthesia & Analgesia. 117(6):1493-1502, December 2013.

[在离体及麻醉猪在体实验中药物输注系统汇合管死腔对输注药物剂量改变时输注响应时间的影响](#)

Drug Infusion System Manifold Dead-Volume Impacts the Delivery Response Time to Changes in Infused Medication Doses In Vitro and Also In Vivo in Anesthetized Swine

Lovich, Mark A. MD, PhD*; Wakim, Matthew G. BS*; Wei, Abraham BS*; Parker, Michael J. MD†; Maslov, Mikhail Y. MD, PhD*; Pezone, Matthew J. BA*; Tsukada, Hisashi MD‡; Peterfreund, Robert A. MD, PhD§

Anesthesia & Analgesia: 2013 117 1313–1318

背景：静脉输注系统可被认作是将多种药物输液线与经皮导管相连接的汇合管。既往离体研究表明，药物输送存在显著延时，无法反映泵设置输注率的即刻改变，特别是药物和载体液流量较低，以及输液系统死腔流量较高时。药用汇合管允许多个输注连接到一个单一导管端口，但增加了死腔量。本研究推测，在体药物输注的生理反应时间过程反映了死腔量对药物输送的影响。

方法：分别比较离体和在体实验中高低死腔量对开始及停止肾上腺素输注（以 3ml/h 速度溶于 10ml/h 载体液进行恒速输注）的动力学反应，对比体内和体外实验中大死腔量和低死腔量的 T 管的影响。药物从最上游端口进入的四个相邻旋塞组成的汇合管与一种在导管下游接头处并联若干共轴通道的新型管道进行比较，后者的结构基本上消除了由汇合管本身造成的死腔。计算初始和停止药物输注时离体实验中增加或减少 50% 和 90% 药物输送的时间（T50 和 T90），以及猪模型活体实验中的药物收缩效应。

结果：在离体或在体实验中，共轴低死腔量汇合管组开始和停止药物输注达到稳态的时间比高死腔量设计组更短。低死腔量汇合管和高死腔量汇合管组在离体实验中药物输送达到 50% 和 90% 稳态时间分别为 $1.4 \pm 0.12\text{min}$ 和 $2.2 \pm 0.42\text{min}$ ，以及 $7.1 \pm 0.58\text{min}$ 和 $9.8 \pm 1.6\text{min}$ 。在体实验中，两组收缩效应在药物使用后达到完全反应 50% 和 90% 的时间分别为 $4.3 \pm 1.3\text{min}$ 和 $9.9 \pm 3.9\text{min}$ ，以及 $11 \pm 1.2\text{min}$ 和 $17 \pm 2.6\text{min}$ 。在离体实验中，两组在停止输注后药物输送下降 50% 和 90% 的时间分别为 $1.9 \pm 0.17\text{min}$ 和 $3.5 \pm 0.61\text{min}$ ，以及 $10.0 \pm 1.0\text{min}$ 和 $17.0 \pm 2.8\text{min}$ 。在体实验中，两组在停止输注后收缩效应下降 50% 和 90% 的时间分别为 $4.1 \pm 1.1\text{min}$ 和 $14 \pm 5.2\text{min}$ ，以及 $12 \pm 2.7\text{min}$ 和 $23 \pm 5.6\text{min}$ 。

结论：汇合管的结构影响泵设置的药物输注速率改变后的在体生物学反应和药物输送速率。

（谈婧华 译 陈杰 校）

BACKGROUND: IV infusion systems can be configured with manifolds connecting multiple drug infusion lines to transcutaneous catheters. Prior in vitro studies suggest that there may be significant lag times for drug delivery to reflect changes in infusion rates set at the pump, especially with low drug and carrier flows and larger infusion system dead-volumes. Drug manifolds allow multiple infusions to connect to a single catheter port but add dead-volume. We hypothesized that the time course of physiological responses to drug infusion in vivo reflects the impact of dead-volume on drug delivery.

METHODS: The kinetic response to starting and stopping epinephrine infusion ([3 mL/h] with constant carrier flow [10 mL/h]) was compared for high- and low-dead-volume manifolds in vitro and in vivo. A manifold consisting of 4 sequential stopcocks with drug entering at the most upstream port was contrasted with a novel design comprising a tube with separate coaxial channels meeting at the downstream connector to the catheter, which virtually eliminates the manifold contribution to the dead-volume. The time to 50% (T50) and 90% (T90) increase or decrease in drug delivery in vitro or contractile response in a swine model in vivo were calculated for initiation and cessation of drug infusion.

RESULTS: The time to steady state after initiation and cessation of drug infusion both in vitro and in vivo was much less with the coaxial low-dead-volume manifold than with the high-volume design. Drug delivery after initiation in vitro reached 50% and 90% of steady state in 1.4 ± 0.12 and 2.2 ± 0.42 minutes with the low-dead-volume manifold and in 7.1 ± 0.58 and 9.8 ± 1.6 minutes with the high-dead-volume manifold, respectively. The contractility in vivo reached 50% and 90% of the full response after drug initiation in 4.3 ± 1.3 and 9.9 ± 3.9 minutes with the low-dead-volume manifold and 11 ± 1.2 and 17 ± 2.6 minutes with the high-dead-volume manifold, respectively. Drug delivery in vitro decreased by 50% and 90% after drug cessation in 1.9 ± 0.17 and 3.5 ± 0.61 minutes with the low-dead-volume manifold and 10.0 ± 1.0 and 17.0 ± 2.8 minutes with the high-dead-volume manifold, respectively. The contractility in vivo decreased by 50% and 90% with drug cessation in 4.1 ± 1.1 and 14 ± 5.2 with the low-dead-volume manifold and 12 ± 2.7 and 23 ± 5.6 minutes with the high-dead-volume manifold, respectively.

CONCLUSIONS: The architecture of the manifold impacts the in vivo biologic response, and the drug delivery rate, to changes in drug infusion rate set at the pump.

使用依托咪酯而非异丙酚进行麻醉诱导可增加非心脏手术后 30 天内死亡及心血管发病率

Anesthetic Induction with Etomidate, Rather than Propofol, Is Associated with Increased 30-Day Mortality and Cardiovascular Morbidity After Noncardiac Surgery

Komatsu, Ryu MD*; You, Jing MS†‡; Mascha, Edward J. PhD†‡; Sessler, Daniel I. MD‡; Kasuya, Yusuke MD§; Turan, Alparslan MD‡

Anesthesia & Analgesia: 2013 117 1329–1337

背景：由于依托咪酯损害肾上腺功能并且弱化手术刺激相关的皮质醇释放，本研究假设接受依托咪酯诱导的患者比接受异丙酚诱导的患者有更高的死亡率和发病率。

方法：本研究评估了克利夫兰医学中心电子病历中 31148 名 ASAIII~IV 级接受非心脏手术的患者。在这些患者中，2616 名接受了依托咪酯诱导，挥发性麻醉剂维持的麻醉方式，而 28532 名接受了异丙酚诱导，挥发性麻醉药维持。将 2144 名接受依托咪酯诱导的患者与 5233 名接受异丙酚诱导的患者进行倾向性配对，比较两组术后 30 天死亡率、住院天数、心血管和感染疾病发病率、升压药需求量和术中血流动力学参数。

结果：接受依托咪酯诱导的患者比接受异丙酚诱导的患者死亡概率高 2.5 倍（98% 可信区间，1.9-3.4）。前者心血管疾病发病率也显著高于后者（比值比的 98% 可信区间为：1.5[1.2-2.0]），并且住院天数明显延长（风险比的 95% 可信区间为：0.82[0.78-0.87]）。然而，两者之间的感染疾病发病率（比值比的 98% 可信区间为：1.0[0.8-1.2]）和术中升压药的使用情况（比值比的 95% 可信区间为：0.92[0.82-1.0]）并没有差异。

结论：依托咪酯大幅增加术后 30 天死亡率、心血管疾病发病率和住院时间延长发生的风险。本研究结论中，特别是术后 30 天死亡率可经受一种明显不可预测的二元混淆参数的考量。虽然本研究只是揭示了依托咪酯的使用与患者不良预后之间的联系而非因果关系，但是鉴于诱导期稳定的血流动力学可能伴随着极其不利的长期预后，临床医生应该明智地使用依托咪酯。

（边文玉 译 陈杰 校）

BACKGROUND: Because etomidate impairs adrenal function and blunts the cortisol release associated with surgical stimulus, we hypothesized that patients induced with etomidate suffer greater mortality and morbidity than comparable patients induced with propofol.

METHODS: We evaluated the electronic records of 31,148 ASA physical status III and IV patients who had noncardiac surgery at the Cleveland Clinic. Among these, anesthesia was induced with etomidate and maintained with volatile anesthetics in 2616 patients whereas 28,532 were given propofol for induction and maintained with volatile anesthetics. Two thousand one hundred forty-four patients given etomidate were propensity matched with 5233 patients given propofol and the groups compared on 30-day postoperative mortality, length of hospital stay, cardiovascular and infectious morbidities, vasopressor requirement, and intraoperative hemodynamics.

RESULTS: Patients given etomidate had 2.5 (98% confidence interval [CI], 1.9–3.4) times the odds of dying than those given propofol. Etomidate patients also had significantly greater odds of having cardiovascular morbidity (odds ratio [OR] [98% CI]: 1.5 [1.2–2.0]), and significantly longer hospital stay (hazard ratio [95% CI]: 0.82 [0.78–0.87]). However, infectious morbidity (OR [98% CI]: 1.0 [0.8–1.2]) and intraoperative vasopressor use (OR [95% CI] 0.92: [0.82–1.0]) did not differ between the agents.

CONCLUSION: Etomidate was associated with a substantially increased risk for 30-day mortality, cardiovascular morbidity, and prolonged hospital stay. Our conclusions, especially on 30-day mortality, are robust to a strong unmeasured binary confounding variable. Although our

study showed only an association between etomidate use and worse patients' outcomes but not causal relationship, clinicians should use etomidate judiciously, considering that improved hemodynamic stability at induction may be accompanied by substantially worse longer-term outcomes.

声门下狭窄患者的气道管理：一个学术机构的经验之谈

Airway Management in Patients with Subglottic Stenosis: Experience at an Academic Institution

Knights, Richard M. MB, ChB, MRCP, FRCA; Clements, Stephan BM, BSc, MRCS, FRCA; Jewell, Elizabeth MS; Tremper, Kevin MD, PhD; Healy, David MD

Anesthesia & Analgesia: 2013 117 1352–1354

本文描述一个关于调查气道技术的初步研究，这些技术被应用于声门下狭窄患者的麻醉管理中。收集密西根大学健康系统中经历手术的声门下狭窄患者的电子临床信息数据。通过159例患者信息分析人口统计学、气道技术、低氧血症的发生率以及操作失败等。结果显示使用4种最普通技术和使用不常见的技术间具有较低的低氧血症发生率；个人操作技术间的结果没有差异。此研究表明需要一个更大的前瞻性多中心研究进一步探讨声门下狭窄的患者上述调查结果。

（朱浩 译 陈杰 校）

We describe a pilot study investigating the airway techniques used in the anesthetic management of subglottic stenosis. We searched the electronic clinical information database of the University of Michigan Health System for cases of subglottic stenosis in patients undergoing surgery. Demographics, airway techniques, incidence of hypoxemia, and technique failure were extracted from 159 records. A lower incidence of hypoxemia was found between the 4 most commonly used techniques and the less common techniques. We detected no difference in outcome between individual techniques. This study suggests a larger prospective multicenter study is required to further investigate these outcomes in patients with subglottic stenosis.

麻醉诱导时使用视频眼镜作为术前焦虑儿童管理的一项娱乐工具

Anesthesia Induction Using Video Glasses as a Distraction Tool for the Management of Preoperative Anxiety in Children

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Anesthesia & Analgesia: 2013 117 1373–1379

背景： 适合围术期的娱乐技术唾手可得，但是目前缺乏与术前口服咪达唑仑缓解焦虑进行比较的临床证据。视频眼镜可以让儿童接受电影和动画片的视听信息，在其帮助下可完成患儿的麻醉吸入诱导。本研究比较口服咪达唑仑和使用视频眼镜分散患儿注意力在术前儿童焦虑管理方面的有效性。

方法： 在此项前瞻、随机的研究中，96名年龄在4-9岁之间的门诊手术患儿入选，分为三组，分别接受口服咪达唑仑，使用视频眼镜及复合应用。使用改良 YALE 术前焦虑量表作为评估术前基线时、20分钟后送至手术室时和面罩诱导时焦虑状态的主要判断方法。

结果： 在基线和手术室转运期间，三组的焦虑评分均无显著增加（P值分别为0.21、0.42、0.57），观察到在基线至麻醉诱导期间，咪达唑仑组（P=0.02）和复合组（P=0.03）而非视频眼镜组（P=0.38）的焦虑值有所增加，但无临床意义。三组间改良 YALE 术前焦虑量表变化的两两比较的可信区间都无临床显著差异（以15个单位为临界值）。

结论：单独应用视频眼镜、口服咪达唑仑或联合使用都能在患儿进入手术室时保持其基线水平的镇静状态。并可预防患儿在麻醉诱导期间焦虑的增加。视频眼镜是一种安全、无创、非药物性和令人愉快的缓解术前焦虑的手段，其效果不亚于咪达唑仑。

（李峰日 译 陈杰 校）

BACKGROUND: Distraction technology suitable for the perioperative setting is readily available, but there is little evidence to show how it compares with oral midazolam in managing anxiety. Video glasses, which enable children to view and listen to cartoons and movies, may be used through the completion of inhaled induction. We compared the efficacy of oral midazolam and behavioral distraction with video glasses in managing preoperative anxiety in children.

METHODS: In this prospective, randomized study, 96 children aged 4 to 9 years undergoing outpatient surgery were recruited to one of 3 intervention groups receiving midazolam, video glasses, or both. The Modified Yale Preoperative Anxiety Scale was the primary dependent measure used to assess anxiety at baseline before intervention, 20 minutes later at transport to the operating room (OR), and during mask induction.

RESULTS: There was no significant increase in anxiety score within any group between baseline and OR transport ($P = 0.21, 0.42,$ and 0.57 for midazolam, video glasses, and combined groups, respectively). An increase in anxiety, though not large enough to be clinically significant, was observed from baseline to induction in the midazolam and combined groups ($P = 0.02$ and 0.03) but not in the video glasses group ($P = 0.38$). Confidence intervals for pairwise comparisons in Modified Yale Preoperative Anxiety Scale changes among groups were all within a clinically significant difference of 15 units.

CONCLUSIONS: The use of video glasses and midazolam alone or in combination maintains baseline levels of anxiety at time of transport to the OR and prevents significantly increased anxiety during induction of anesthesia in children. Video glasses are not inferior to midazolam for preoperative anxiolysis and provide a safe, noninvasive, nonpharmacologic, and pleasant alternative.

儿童尿道下裂手术应用阴部神经阻滞和骶管阻滞麻醉的有效性对比研究

The Effectiveness of Pudendal Nerve Block Versus Caudal Block Anesthesia for Hypospadias in Children

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Anesthesia & Analgesia: 2013 117 1401–1407

背景：骶管阻滞（CB）有诸多不利之处，其中之一即其单次注射后作用持续时间较短。阴部神经阻滞（PNB）由于其在包皮环切术上的麻醉成功应用，对于尿道下裂修复术亦可能成为一种合适的替代方法。本研究通过测量术后 24h 镇痛药物使用量以比较 PNB 和 CB 的效果。

方法：本次前瞻性双盲实验研究中，病人随机分为 2 组：接受 CB 或神经刺激仪引导的 PNB。在 PNB 组，为患儿注射 0.25% 布比卡因（0.3ml/kg）以及可乐定（1ug/kg）。在 CB 组，为患儿注射 0.25% 布比卡因（1ml/kg）以及可乐定（1ug/kg）。记录患儿在手术后 24h 内的镇痛药物用量。使用 Hannalah 和 Broadman 提出的“客观疼痛分级”方法来评估患儿术后疼痛。

结果：80 名患儿参与了本项研究，两组各 40 人。PNB 组的平均年龄为 3.1（1.1）岁，CB 组平均年龄为 3.2（1.1）岁。PNB 组和 CB 组的平均体重分别为 15.3（2.8）kg 和 15.3（2.2）kg。CB 组在术后首个 24h 内使用镇痛药物的比例（70%）显著高于 PNB 组（20%， $P < 0.0001$ ）。CB 组中每名患儿的平均镇痛药物使用量更多（扑热息痛 $P < 0.0001$ ，曲马多 $P = 0.003$ ）。

结论：相较于 CB，使用 PNB 能显著减少患儿在术后首个 24h 所使用的镇痛药物用量。

（贺加贝 译 陈杰 校）

BACKGROUND: Caudal block (CB) has some disadvantages, one of which is its short duration of action after a single injection. For hypospadias repair, pudendal nerve block (PNB) might be a suitable alternative since it has been successfully used for analgesia for circumcision. We evaluated PNB compared with CB as measured by total analgesic consumption 24 hours postoperatively.

METHODS: In this prospective, double-blinded study, patients were randomized into 2 groups, either receiving CB or nerve stimulator-guided PNB. In the PNB group, patients were injected with 0.3 mL/kg 0.25% bupivacaine and 1 µg/kg clonidine. In the CB group, patients were injected with 1 mL/kg 0.25% bupivacaine and 1 µg/kg clonidine. Analgesic consumption was assessed during the first 24 hours postoperatively. The “objective pain scale” developed by Hannalah and Broadman¹⁷ was used to assess postoperative pain.

RESULTS: Eighty patients participated in the study, 40 in each group. The mean age in the PNB group was 3.1 (1.1) years and in the CB group was 3.2 (1.1) years. The mean weights in the PNB and CB groups were 15.3 (2.8) kg and 15.3 (2.2) kg, respectively. The percentage of patients who received analgesics during the first 24 hours were significantly higher in the CB (70%) compared with the PNB group (20%, $P < 0.0001$). The average amount of analgesics consumed per patient within 24 hours postoperatively was higher in the CB group (paracetamol $P < 0.0001$, Tramal $P = 0.003$).

CONCLUSION: Patients who received PNB had reduced analgesic consumption and pain within the first 24 hours postoperatively compared with CB.

新生大鼠在出生后暴露在七氟烷下会导致海马长时程增强作用的明显抑制

Neonatal Exposure to Sevoflurane Causes Significant Suppression of Hippocampal Long-Term Potentiation in Postgrowth Rats

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Anesthesia & Analgesia: 2013 117 1429–1435

背景：吸入麻醉药七氟醚在临床上用于新生儿是非常普遍的。最近研究表明，新生啮齿动物暴露于七氟醚可引起急性广泛神经退行性疾病和持久的神经认知功能障碍。虽然七氟醚对海马细胞活性的急性毒性作用在一些研究中已有报道，但新生儿的七氟醚暴露对长期海马突触可塑性的作用知之甚少，后者被认为与学习和记忆形成过程相关。本研究首次检验暴露于有临床意义相关浓度七氟醚中的新生大鼠其长期电生理影响。

方法：在出生后第 7 天，将大鼠暴露于与氧气混合的七氟醚中（1%或 2%浓度 2 小时）。为了消除七氟烷诱导后呼吸抑制所造成的血气异常的影响，一组大鼠暴露于高浓度的二氧化碳（8%浓度）2 小时来模拟暴露于 2%七氟醚所引起呼吸障碍。

结果：新生大鼠在出生后暴露在 2%七氟醚 2 小时能引起长时程增强（LTP）诱导作用的显著抑制。对照组和二氧化碳暴露组在长时程增强（LTP）诱导作用方面无显著差异，这表明七氟醚介导的长时程增强（LTP）作用的抑制不是由血气异常引起的。

结论：本研究结果表明：新生大鼠接触较高浓度七氟烷能改变海马突触可塑性，并且持续到成年。

（林甲票 译 陈杰 校）

BACKGROUND: The inhaled anesthetic sevoflurane is commonly used for neonates in the clinical setting. Recent studies have indicated that exposure of neonatal rodents to sevoflurane

causes acute widespread neurodegeneration and long-lasting neurocognitive dysfunction. Although acute toxic effects of sevoflurane on cellular viability in the hippocampus have been reported in some studies, little is known about the effects of neonatal sevoflurane exposure on long-term hippocampal synaptic plasticity, which has been implicated in the processes of learning and memory formation. Our study is the first to examine the long-term electrophysiological impact of neonatal exposure to a clinically relevant concentration of sevoflurane.

METHODS: On postnatal day 7, rats were exposed to sevoflurane (1% or 2% for 2 hours) with oxygen. To eliminate the influence of blood gas abnormalities caused by sevoflurane-induced respiratory suppression, a group of rats were exposed to a high concentration of carbon dioxide (8% for 2 hours) to duplicate respiratory disturbances caused by 2% sevoflurane exposure.

RESULTS: Exposure of neonatal rats to 2% sevoflurane for 2 hours caused significant suppression of long-term potentiation (LTP) induction in the postgrowth period. There was no significant difference between the control group and the CO₂-exposed group in LTP induction, indicating that sevoflurane-induced LTP suppression was not caused by blood gas abnormalities.

CONCLUSION: Our present findings indicate that neonatal exposure to sevoflurane at a higher concentration can cause alterations in the hippocampal synaptic plasticity that persists into adulthood.

持续肌间沟神经阻滞在门诊肩袖修复手术患者中的应用：一项前瞻随机试验

Continuous Interscalene Block in Patients Having Outpatient Rotator Cuff Repair Surgery: A Prospective Randomized Trial

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Anesthesia & Analgesia: 2013 117 1485–1492

背景：本随机研究对比了接受单次肌间沟注射（SISB）和持续肌间沟臂丛阻滞（CISB）或全身麻醉（GA）行肩关节镜肩袖修复手术的患者持续至术后一周的恢复情况。主要预期结果是在研究结束时，接受 CISB 患者的最高疼痛数字分级（NRS），即最痛评分低于接受 SISB 或者全麻的患者。

方法：71 例患者接受了门诊择期肩关节镜肩袖修复术。CISB 组患者通过导管行单次 0.5% 罗哌卡因 20ml 注射，SISB 组患者通过穿刺针也进行相同配方剂量的单次注射。CISB 组患者同时还在 48 小时内接受了 0.2% 罗哌卡因 5ml/h 的持续输注和每小时患者自控的单次 5ml 药物注射。全麻组患者仅进行标准全麻。分别在术后第 1,2,3,7 天在麻醉恢复室和家中记录术后一周内最高疼痛数字评分、首次疼痛时间、镇痛药物用量、快速转出麻醉恢复室率、麻醉恢复室停留时间、出院时间、总睡眠时间以及相关副反应。

结果：CISB 和 SISB 组患者的 NRS 评分均未 ≥ 1 ，在麻醉恢复室也未要求镇痛。多数 CISB 和 SISB 患者都快速转出 PACU，而全麻患者均未快速转出恢复室 ($X^2P = 0.003$)。CISB 组和 SISB 组麻醉恢复室停留时间显著短于全麻组 (分别为 20 ± 31 , 30 ± 42 , 165 ± 118 min, (CISB vs GA, $P < 0.001$; SISB vs GA, $P < 0.001$)。出院时间 CISB、SISB 组也显著快于全麻组。CISB 组首次疼痛出现时间较晚。术后第 1、2 天 CISB 组平均 NRS 分数和麻醉药用量（剂量 ≥ 1 ）低于 SISB 组和全麻组直到术后第 3 天。术后 48 小时内 CISB 组睡眠时间显著长于 SISB 组和全麻组 ($P < 0.01$)。研究结束时，CISB 组有 26% 的患者，SISB 组有 83% 的患者，全麻组有 58% 的患者 $NRS \geq 4$ (P 均 ≤ 0.05)

结论：CISB 带来的镇痛优势体现在麻醉恢复室，且延续至出院后的恢复中期，终止于术后第 7 天。

（陆秉玮 译 陈杰 校）

BACKGROUND: We performed this randomized trial to compare the recovery profile of patients receiving single injection (SISB) and continuous interscalene brachial plexus block (CISB) or general anesthesia (GA) for arthroscopic rotator cuff repair surgery through the first postoperative week. Our primary hypothesis was that the highest pain numeric rating scale (NRS) (worst pain score) at the end of the study week would be lower for patients in the CISB group than for patients in the SISB or GA groups.

METHODS: Seventy-one patients scheduled for elective outpatient arthroscopic rotator cuff repair were enrolled. CISB patients received 20 mL of 0.5% ropivacaine as a bolus through a catheter, whereas SISB patients received the same injection volume through a needle. CISB patients received an infusion of 0.2% ropivacaine at 5 mL/h with a patient-controlled bolus of 5 mL hourly for 48 hours. GA-only patients received a standardized general anesthetic. Postoperative highest NRS pain scores through the first postoperative week, time-to-first pain, analgesic consumption, fast-tracked postoperative anesthesia care unit (PACU) bypass rate, length of PACU stay, time-to-discharge home, total hours of sleep, and related adverse effects were recorded in the PACU and at home on postoperative days 1, 2, 3, and 7.

RESULTS: No patient in the CISB or SISB groups reported a NRS ≥ 1 or required analgesics while in the PACU. While most patients in the CISB and SISB groups were fast-tracked to PACU discharge, no patient in the GA group was fast-tracked ($X^2P = 0.003$). Length of stay in the PACU was significantly shorter for the CISB and SISB groups than for the GA group (20 ± 31 , 30 ± 42 , and 165 ± 118 minutes, respectively (CISB vs GA, $P < 0.001$; SISB vs GA, $P < 0.001$), and time-to-discharge home was significantly shorter when compared with the GA group. Time to first pain report was longer in the CISB group. Mean NRS scores were lower for patients in the CISB group than in the SISB and GA groups on postoperative days 1 and 2, and use of narcotics (doses ≥ 1) was lower until postoperative day 3. Patients who received CISB slept significantly longer than patients who received SISB or GA ($P < 0.01$) during the first 48 hours postoperatively. By the end of the study week, 26% of patients in the CISB group, 83% in the SISB group, and 58% of GA patients reported NRS ≥ 4 (both P-values).

CONCLUSION: The analgesic benefits of CISB found in the PACU and immediately after discharge extend through the intermediate recovery period ending on postoperative day 7.

在肝部分切除术中患者使用脉搏波传送时间测得的心输出量：对 esCCO 系统与热稀释法的比较

Pulse Wave Transit Time Measurements of Cardiac Output in Patients Undergoing Partial Hepatectomy: A Comparison of the esCCO System with Thermodilution

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Anesthesia & Analgesia 2013 117 1307–1312

背景：在麻醉状态下精确地测量心输出量有助于安全控制血流动力学。一些微创的测量心输出量的方式逐步发展，以替代通过肺动脉导管置入术的热稀释法。在进行肝部分切除术的患者中，我们评估了一项新的通过脉搏波传送时间测量心输出量的方法针对通过热稀释法所测得的心输出量变化趋势的可靠性。

方法：对 31 例全麻下行肝部分切除术的患者（ASA 评级 II 或 III 级）进行了评估。在麻醉诱导后、体位变为头高位 20°后、体位变为头低位 20°后、用 6% 羟乙基淀粉 10 mL·kg⁻¹ 扩容后、在肝门阻断时以及肝门阻断后开放后的瞬间，记录通过脉搏波传送时间法和通过热稀释法测得的心输出量测量值。使用 Bland-Altman 分析和一致性分析对这一趋势进行评估。

结果：在使用连续脉冲波传送时间测量值和相应的热稀释测量值之间的变化方向显示了96.0%的一致率（95%的置信区间下限=64%），一致限为-1.51 到 1.61 L•min⁻¹。

结论：虽然脉搏波传送时间测量法有很好的一致性，但是它在前负荷和外周血管阻力有变化的患者中的趋势有相当宽的一致限。当升压药用于治疗与外周血管阻力降低相关的低血压时存在潜在的误差。该研究的局限性是心输出量数据是以非盲方式收集的，并且用了已经存在的动脉内导管，尽管这个系统只需要常规的无创心血管监测。这是一项有前途的技术，不过目前仍有其局限性，它将需要进一步的改进和临床评估。

（赵晓 译 马皓琳 李世通 校）

BACKGROUND: Measuring cardiac output accurately during anesthesia is thought to be helpful for safely controlling hemodynamics. Several minimally invasive methods to measure cardiac output have been developed as alternatives to thermodilution with pulmonary artery catheterization. We evaluated the reliability of a novel pulse wave transit time method of cardiac output assessment to trend with thermodilution cardiac output in patients undergoing partial hepatectomy.

METHODS: Thirty-one patients (ASA physical status II or III) undergoing partial hepatectomy under general anesthesia were evaluated. Cardiac output measurements by pulse wave transit time method and by thermodilution were recorded after induction of anesthesia, after a change in body positioning to 20° head up, after a change to 20° head down, after volume challenge with 10 mL•kg⁻¹ hydroxyethyl starch 6%, during the Pringle maneuver, and immediately after Pringle maneuver release. Trending was assessed using Bland-Altman analysis and concordance analysis.

RESULTS: The direction of change between consecutive pulse wave transit time measurements and the corresponding thermodilution measurements showed a concordance rate of 96.0% (lower 95% confidence interval = 64%), with limits of agreement -1.51 and 1.61 L•min⁻¹.

CONCLUSIONS: The pulse wave transit time method had good concordance but fairly wide limits of agreement with regard to trending in patients with changes in preload and systemic vascular resistance. There are potential inaccuracies when vasopressors are used to treat hypotension associated with decreased systemic vascular resistance. The study limitations are that the cardiac output data were collected in a nonblinded fashion, and an existing intraarterial catheter was used, although the system requires only routine, noninvasive cardiovascular monitors. This is a promising technique that currently has limitations and will require further improvements and clinical assessment.

使用 COOK 换管器时的换管失败和并发症：对 1177 名患者的单中心队列研究

Airway Exchange Failure and Complications with the Use of the Cook Airway Exchange Catheter® : A Single Center Cohort Study of 1177 Patients

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Anesthesia & Analgesia 2013 117 1325-1327

关于使用换管器时失败和气道损伤概率的数据有限。我们进行了一项使用换管器的单中心回顾性分析以确定换管失败和气道损伤发生率和相关因素。在 1177 个案例中，尝试换管过程中插管失败的发生率是 73/527(13.8%)。在换管器用于双腔管插管的过程中和手术后尝试在导管上方插管时的换管失败发生率最高。气胸在尝试换管后的发生率是 1.5%。8 名气胸患者中有 6 名遭遇了困难换管。

（盛嘉君 译，马皓琳、李士通 审校）

There are limited data on rates of failure and airway injury with the use of airway exchange catheters. We performed a single-center retrospective analysis of airway exchange catheters to determine the incidence and associated factors for tube exchange failure and airway injury. Among 1177 cases, failed intubation during attempted tube exchange was noted in 73/527 (13.8%). Airway exchange failure rates were greatest during exchange catheter use for double-lumen tube insertion and when intubation was attempted over the catheter postoperatively. Pneumothorax was noted after 1.5% of attempted tube exchanges. Difficult tube exchange was encountered in 6 of 8 patients with pneumothorax.

甲颏高度:预测喉镜检查困难的一项新的临床测试

Thyromental Height: A New Clinical Test for Prediction of Difficult Laryngoscopy

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Anesthesia & Analgesia 2013 117 1347-1351

背景: 据报道喉镜检查困难的发生率为 1.5% 至 20%。我们假设喉镜检查困难的发生与当患者仰卧口唇闭合时下颏前缘至甲状软骨的高度密切相关。我们称之为甲颏高度测试 (TMHT)。此项研究目的在于确定其预测喉镜检查困难的实用性。

方法: 314 例大于等于 16 岁计划接受全身麻醉的连续的男女患者被邀请入组。在术前门诊使用改良 Mallampati 分级、甲颏距离和胸颏距离及甲颏高度进行气道评估。之后,在气管插管时评价喉镜检查视野的 Cormack 和 Lehane 分级。喉镜检查者不知道气道评估结果。分别计算出甲颏高度的有效性和预测指数作为主要观察指标。对其他三种气道评估方法的有效性进行计算是本研究的次要观察指标。

结果: 最佳灵敏度和特异性值的范围为 47.46 至 51.02 毫米。为了便于临床应用,选用 50mm 作为临界值。甲颏高度比其他测试更准确 (所有 $P < 0.0001$)。

结论: 甲颏高度测试比现有解剖学测量更能准确预测喉镜检查困难。

(邢怡安 译 马皓琳 李士通 校)

BACKGROUND: The incidence of difficult laryngoscopy is reported in the range of 1.5% to 20%. We hypothesized that there is a close association between the occurrence of difficult laryngoscopy and the height between the anterior borders of the mentum and thyroid cartilage, while the patient lies supine with her/his mouth closed. We have termed this the “thyromental height test” (TMHT). Our aim in this study was to determine its utility in predicting difficult laryngoscopy.

METHODS: Three hundred fourteen consecutive male and female patients aged ≥ 16 years scheduled to undergo general anesthesia were invited to participate. Airway assessments were performed with the modified Mallampati test, thyromental distance and sternomental distance, and TMHT in the preoperative clinic. Afterward, Cormack and Lehane grade of laryngoscopy views was assessed during intubation. The laryngoscopist was unaware of airway assessments. As a primary end point, the validity and prediction indexes for the TMHT were calculated. Calculation of validity indexes for the 3 other methods of airway assessment was a secondary objective of this study.

RESULTS: The optimal sensitivity and specificity values were in the range of 47.46 to 51.02 mm. To facilitate clinical application, a cutoff value equal to 50 mm was chosen. TMHT was more accurate than the other tests (all $P < 0.0001$).

CONCLUSIONS: The TMHT appears to be a more accurate predictor of difficult laryngoscopy than the existing anatomical measurements.

剖宫产后椎管内吗啡镇痛后呼吸抑制发生率的回顾性研究

A Retrospective Assessment of the Incidence of Respiratory Depression After Neuraxial Morphine Administration for Postcesarean Delivery Analgesia

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Anesthesia & Analgesia 2013 117 1368–1370

呼吸抑制可以发生在椎管内给予吗啡后。在产科人群中，对剖宫产妇女椎管内给予吗啡后呼吸抑制的相关数据很少。在这个单中心回顾性研究的 5036 名产科患者（平均体重指数 = 34 kg/m²）均进行了剖宫产术并接受了椎管内吗啡给药，我们没有发现需要给予纳洛酮或快速反应小组参与的呼吸抑制病例。因此，在我们的研究中发生呼吸抑制的 95% 可信区间的上限为 0.07%（每 1429 案例发生 1 例事件）。

(董静译 马皓琳 李士通 校)

Respiratory depression can occur after neuraxial morphine administration. In the obstetric population, there are little data on respiratory depression after neuraxial morphine administration in women undergoing cesarean delivery. In this single-center, retrospective study in 5036 obstetric patients (mean body mass index = 34 kg/m²) who underwent cesarean delivery and received neuraxial morphine, we did not identify any instances of respiratory depression requiring naloxone administration or rapid response team involvement. Therefore, the upper 95% confidence limit for respiratory depression in our study is 0.07% (1 event per 1429 cases).

顺阿曲库铵和罗库溴铵对麻醉儿童肺功能的影响

The Effect of Cisatracurium and Rocuronium on Lung Function in Anesthetized Children

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Anesthesia & Analgesia 2013 117 1393–1400

背景：肌松药和术中支气管痉挛有密切关系。我们检测了临床相关剂量的顺阿曲库铵和罗库溴铵对小儿的呼吸力学的效应。我们假设顺阿曲库铵和罗库溴铵有支气管收缩效应。

方法：我们研究了 ASA 评分 I-II 级、需要用顺阿曲库铵或罗库溴铵进行全麻气管内插管进行择期牙科或泌尿科手术的小儿。在用肌松药之前、之后及用沙丁胺醇后再次进行肺功能测试。通过用力放气和被动放气方法，获得用力肺活量（FVC）和在 FVC 的 10% 时的最大呼气流速（MEF10）。用相对于基线的分数变化来比较受试者。MEF10 的变化 >30% 被认为有临床差异。用 t 检验和威尔科克森秩和检验来分析数据。

结果：研究了 25 个受试者（中位年龄 5.25 岁；范围为 9 个月到 9.9 岁）；12 个接受顺阿曲库铵和 13 个接受罗库溴铵。数据表示成变化比例 ± 标准差或者在非正太分布的案例里为变化比例的中位数（第一，第三四分位数）及 P 值。在顺阿曲库铵组，FVC 相对于基线的分数变化在用肌松药之后与基线之间没有差异 (1.00 ± 0.04 , $P = 0.5$)，但 MEF10 显著降低 (0.80 ± 0.18 , $P = 0.002$)。在罗库溴铵组，FVC 有小的但显著的减少 (0.99 [第一个四分位数 0.97, 第三个四分位数 1], $P = 0.02$)，MEF10 显著降低 (0.78 ± 0.26 , $P = 0.008$)。在顺阿曲

库铵组给予沙丁胺醇后，FVC 与基础值比较略增加但有显著意义(1.02 ± 0.02 , $P = 0.005$)。MEF10 与基础值比较显著增加(1.24 ± 0.43 , $P = 0.04$)。在罗库溴铵组，FVC (1.02 ± 0.02 , $P = 0.004$) and MEF10 (1.23 ± 0.29 , $P = 0.01$)在给予沙丁胺醇后与基线比较也有显著差异。

结论：用临床相关剂量时，顺阿曲库铵和罗库溴铵都可引起肺功能改变，表明小气道有收缩。一般来说，这些改变是轻微的在临床不被观察到。然而，在罗库溴铵组，13 个病人中的 3 个在 MEF10 表现出明显的减少 ($\leq 50\%$)，证明了在敏感的病人有显著的支气管-细支气管收缩的潜在性。

(王晓莉译 马皓琳 李士通校)

BACKGROUND: Neuromuscular blocking drugs have been implicated in intraoperative bronchoconstrictive episodes. We examined the effects of clinically relevant doses of cisatracurium and rocuronium on the lung mechanics of pediatric subjects. We hypothesized that cisatracurium and rocuronium would have bronchoconstrictive effects.

METHODS: We studied ASA physical status I and II pediatric subjects having elective dental or urological procedures, requiring general anesthesia with endotracheal intubations with either cisatracurium or rocuronium. Pulmonary function tests were performed before and after neuromuscular blocking drug dosing and again after albuterol administration. Using forced deflation and passive deflation techniques, forced vital capacity (FVC) and maximum expiratory flow rate at 10% (MEF10) of FVC were obtained. Fractional changes from the baseline were used to compare subjects. Changes in MEF10 of $>30\%$ were considered clinically significant. A Shapiro-Wilk test, paired t test, and Wilcoxon rank sum test were used to analyze the data.

RESULTS: Twenty-five subjects (median age = 5.25 years; range = 9 months–9.9 years) were studied; 12 subjects received cisatracurium and 13 subjects received rocuronium. Data are shown as mean proportional change \pm SD or, in the case of not normally distributed, median proportional change (first, third quartile) with P values. In the cisatracurium group, there were no differences between baseline and postneuromuscular blocker administration in the fractional change from the baselines of FVC (1.00 ± 0.04 , $P = 0.5$), but there was a significant decrease in MEF10 (0.80 ± 0.18 , $P = 0.002$). In the rocuronium group, there were small yet significant decreases of FVC (0.99 [first quartile 0.97 , third quartile 1], $P = 0.02$) and significant decreases in MEF10 (0.78 ± 0.26 , $P = 0.008$). After administration of albuterol in the cisatracurium group, FVC increased slightly but significantly from baseline values (1.02 ± 0.02 , $P = 0.005$). MEF10 increased significantly beyond baseline values (1.24 ± 0.43 , $P = 0.04$). In the rocuronium group, there were also significant differences between baseline and postalbuterol administration from the baseline value of FVC (1.02 ± 0.02 , $P = 0.004$) and MEF10 (1.23 ± 0.29 , $P = 0.01$).

CONCLUSIONS: At clinically relevant doses, both cisatracurium and rocuronium caused changes in lung function, indicating constriction of smaller airways. In general, these changes were mild and not clinically detectable. However, in the rocuronium group, 3 of 13 patients showed more noticeable decreases in MEF10 ($\leq 50\%$), demonstrating the potential for significant broncho-bronchiolar constriction in susceptible patients.

婴儿期暴露于全身麻醉对 12 岁儿童学习成绩的影响

The Effects of Exposure to General Anesthesia in Infancy on Academic Performance at Age 12

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Anesthesia & Analgesia 2013 117 1419–1428

背景：最近来自于幼年动物模型的证据表明在神经生长期暴露于阈值剂量以上麻醉药物会导致广泛的神经元凋亡，造成不可逆的脑损伤和随后的学习困难。此项研究结果与因小手术暴露于全身麻醉的人类婴儿的相关性尚未得知。在这项试验性的观察队列研究中，我们试图确定婴儿期因小手术暴露于全身麻醉的 12 岁儿童与从未暴露于麻醉或镇静的儿童相比，在学习成绩上是否表现出不同，其证据为(1)在新加坡标准小学毕业考试(PSLE)中较低的总分和(2)正式诊断的学习功能障碍。

方法：我们比较了 100 个 1 岁前在我们机构因小手术暴露于全身麻醉的足月且表面上健康的 12 岁儿童与 106 名年龄匹配的从未暴露于麻醉或镇静的儿童。儿童的父母完成一个耗时 20 分钟的关于孩子的病史、学校环境和家庭环境的电话采访。

结果：平均 PSLE 总分(3.0; 95% 可信区间[CI], -8.3 至 14.3)在暴露组(197.0; 95% CI, 185.6–208.4)和对照组(194.0; 95% CI, 182.9–205.1)之间无统计学差异($P = 0.603$)。暴露组中学习功能障碍正式诊断率为 15% (100 人中有 15 人)，而对照组为 3.77% (106 人中有 4 人) ($P < 0.001$)。曾暴露于全身麻醉的儿童的学习功能障碍正式诊断相对于对照组的比值比为 4.5(95% CI, 1.44–14.1)。

结论：婴儿期曾因小手术暴露于全身麻醉的表面上健康的儿童在 12 岁时被正式诊断为学习功能障碍的概率比从未暴露于麻醉的同龄儿童大 4.5 倍。然而，研究精确性不足以发现 PSLE 分数的临床相关差异。

(张怡译马皓琳李士通校)

BACKGROUND: Recent evidence from juvenile animal models has shown that exposure to anesthetic drugs above threshold doses during a critical neurodevelopmental window causes widespread neuronal apoptosis, resulting in irreversible brain damage and subsequent learning difficulties. The relevance of this to human infants having general anesthesia for minor surgery is unknown. In this pilot observational cohort study, we sought to determine whether children exposed to general anesthesia for minor surgery during infancy exhibited differences in academic achievement at age 12 years, as evidenced by (1) lower aggregate scores in the Singapore standardized Primary School Leaving Examination (PSLE) and (2) formally diagnosed learning disability, compared with children who were never exposed to anesthesia or sedation.

METHODS: We compared 100 full-term, apparently healthy children aged 12 years who were exposed to general anesthesia for minor surgery before age 1 at our institution with an age-matched cohort of 106 children who were never exposed to anesthesia or sedation. Parents of children completed a 20-minute telephone interview with questions regarding their children's medical history, school environment, and home environment.

RESULTS: The difference in mean PSLE aggregate scores (3.0; 95% confidence interval [CI], -8.3 to 14.3) between exposed (197.0; 95% CI, 185.6–208.4) and control groups (194.0; 95% CI, 182.9–205.1) was not statistically significant ($P = 0.603$). The presence of formally diagnosed learning disability was 15% (15 of 100) in the exposed group compared with 3.77% (4 of 106) in the control group ($P < 0.001$). The odds ratio for a formal diagnosis of learning disability in those exposed to general anesthesia relative to controls was 4.5 (95% CI, 1.44–14.1).

CONCLUSION: The odds of a formal diagnosis of learning disability by age 12 years in apparently healthy children exposed to general anesthesia for minor surgery during infancy were 4.5 times greater than their peers who had never been exposed to anesthesia. However, study precision was inadequate to detect a clinically relevant difference in PSLE scores.

Datta 短喉镜手柄的发展及历史背景

The Development and Historical Context of the Datta Short Laryngoscope Handle

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Anesthesia & Analgesia 2013 117 1480–1484

怀孕期间的激素、生理及解剖学的改变会对麻醉产生一系列的显著影响，其中包括气管插管困难或失败的可能性。美国麻醉医师协会总结了 1970 年代的索赔数据库，发现 30% 的所有产科索赔涉及产妇死亡，大部分源于插管或通气困难。在 1970 年代后期，布莱根妇产科医院 (马萨诸塞州，波士顿) 的一位产科麻醉医师 Sanjay Datta 医生 (医学学士学位)，发现在美国的产科麻醉实践与他以前在英国和加拿大的经历相比较有一些差异。Datta 医生认识到北美产妇的体重指数更高，同时观察到剖宫产率及全麻应用的比例较高。这些不同使他评估可以改变哪种喉镜本身来改善产妇插管的容易性；这导致了短喉镜柄的发展。本文将阐述 Datta 短喉镜手柄的起源及伴随的历史背景。

(王赞译 马皓琳 李士通校)

The hormonal, physiologic, and anatomic changes of pregnancy have a number of significant anesthetic implications, including the potential for difficulties and failures in tracheal intubation. The American Society of Anesthesiology closed claims database in the 1970s observed that maternal deaths were involved in 30% of all obstetrics claims, most stemming from difficulty with intubation or ventilation. In the late 1970s, Dr. Sanjay Datta, MBBS, an obstetric anesthesiologist at Brigham and Women's Hospital (Boston, MA), observed a number of differences in the practice of obstetric anesthesia in the United States when compared with his prior experiences in the United Kingdom and Canada. Dr. Datta perceived that parturients within North America had a higher body mass index. In addition, he observed an increased rate of cesarean delivery and general anesthesia use. These differences led him to evaluate ways in which the laryngoscope itself could be altered to improve the ease of intubation of parturients; this led to the development of the short laryngoscope handle. The genesis of the Datta short laryngoscope handle, and the accompanying historical context, will be explored.

脂肪乳剂对细胞内布比卡因的影响为脂质复苏的机制：使用电压门控质子通道的电生理研究

The effect of lipid emulsion on intracellular bupivacaine as a mechanism of lipid resuscitation: an electrophysiological study using voltage-gated proton channels.

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Anesthesia & Analgesia 2013 117 1293-1301

背景：脂质复苏局麻药的全身毒性反应已成为标准化的治疗方案，但是其中的机制仍不甚明了。虽然分隔作用是机制之一，但难以从其他机制中独立评价，或者说难以测定胞内局麻药的浓度。胞内局麻药的浓度才是造成局麻药中毒的主要原因。我们近期报道过局麻药带弱碱基，增加了细胞内 pH 值，从而减小了电压门控质子电流。电压门控质子电流能用电通道可逆电位来估算。基于这种特性，我们更详细地分析了脂质体的分隔作用及复苏机制。

方法：用全细胞电压钳夹技术记录大鼠小胶质细胞株 (GMI-R1) 的质子通道电流，又用 Intralipid® 20% 作为脂肪乳剂。通过测量电流幅值和通道的可逆电位来评估脂肪乳剂对胞内局麻药浓度的影响。胞内局麻药的浓度用 Henderson-Hasselbalch 公式代入估测的胞内 pH 值计算得出。为了确认分隔作用的重要性，我们离心分离脂质。数据都用平均值±标准差表示，除非另有说明。

结果：布比卡因(1 mM)减少对照组质子电流到 $43\% \pm 10\%$ ，使可逆电位上升(从 -88.0 ± 4.1 到 -76.0 ± 5.5 mV, 每组 $n = 5$, $P = 0.02$)。另一组浓度的结果是恢复质子电流到 $79\% \pm 2\%$ ，可逆电位恢复接近于对照值 (-86.0 ± 7.1 mV, $n = 5$, $P = 0.03$)。4% 脂质浓度中质子电流和可逆电位的测定结果和离心水提物中的结果大致相同 (-85.6 ± 4.9 mV, $n = 5$, $P = 0.9$ ，

95% CI -9.3 to 8.6)。当在细胞外加入 1 mM 布比卡因，胞内的浓度估测为 18.1 ± 3.9 mM，而用了 4% 脂质体后胞内的浓度估测为 5.4 ± 1.8 mM。

结论：通过实时测定分析电压门控通道，第一次计量分析了脂质体对胞内脂质体的分割作用。我们的结果表明脂质体能显著减少胞内布比卡因浓度，这个特性主要是基于其分隔作用。这让我们能更好理解其复苏局麻药中毒的机制。

(陈实玉译 薛张纲校)

BACKGROUND: Lipid resuscitation has become a standard treatment for local anesthetic (LA) systemic toxicity, but its mechanisms remain to be fully elucidated. Although the partitioning effect is one of the proposed mechanisms, it is difficult to evaluate its impact independently from several other mechanisms or to examine the intracellular concentration of a LA, which is primarily responsible for LA systemic toxicity. We recently reported that LAs as weak bases reduced voltage-gated proton currents by increasing intracellular pH, which could be estimated from the reversal potentials of the channels (V_{rev}). Using this characteristic, we examined the partitioning effect in detail and showed its impact on lipid resuscitation.

METHODS: A whole-cell voltage clamp technique was used to record proton channel currents in a rat microglial cell line (GMI-R1). We used Intralipid® 20% as lipid emulsion. The effects of lipid emulsion on the intracellular concentrations of LAs were evaluated by measuring the current amplitude and the V_{rev} . The intracellular concentrations of LAs were calculated by the Henderson-Hasselbalch equation, using estimated intracellular pH. To confirm the importance of partitioning, we separated lipid by centrifugation. Data are means \pm SD unless otherwise stated.

RESULTS: Bupivacaine (1 mM) decreased proton currents to $43\% \pm 10\%$ of the control and shifted the V_{rev} to positive voltages (from -88.0 ± 4.1 to -76.0 ± 5.5 mV, $n = 5$ each, $P = 0.02$). An addition of the lipid emulsion recovered the currents to $79\% \pm 2\%$ of the control and returned the V_{rev} toward the control value (to -86.0 ± 7.1 mV, $n = 5$, $P = 0.03$). Both recoveries of the current and V_{rev} in the centrifuged aqueous extract were almost the same as in the 4% lipid solution (-85.6 ± 4.9 mV, $n = 5$, $P = 0.9$, 95% confidence interval for difference = -9.3 to 8.6). When 1 mM bupivacaine was applied extracellularly, the intracellular concentration of the charged form of bupivacaine was estimated to reach about 18.1 ± 3.9 mM but decreased to 5.4 ± 1.8 mM by the 4% lipid solution.

CONCLUSIONS: Here we quantitatively evaluated for the first time the partitioning effect of lipid emulsion therapy on the intracellular concentration of bupivacaine in real-time settings by analyzing behaviors of voltage-gated proton channels. Our results suggested that lipid emulsion markedly reduced the intracellular concentration of bupivacaine, which was mostly due to the partitioning effect. This could contribute to our understanding of the mechanisms underlying lipid resuscitation, especially the importance of the partitioning effect.

麻醉设备与表观死腔容积，一个临床以及实验室研究

Apparent Dead Space with the Anesthetic Conserving Device, AnaConDa® : A Clinical and Laboratory Investigation

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Anesthesia & Analgesia 2013 117 1319–1324

背景：麻醉药物节约设备（ACD）通过吸附呼出气中的药物以及在吸入时释放药物能够中等量的降低挥发性麻醉药的使用。尽管通过增加潮气量以弥补较大的设备死腔，在使用 ACD 的患者中仍能观察到二氧化碳分压的（ $PaCO_2$ ）升高。在一使用常温干燥气体测试试验肺的试验中证实这是由于 ACD 在呼出时吸收 CO_2 并在吸气时释放 CO_2 引起的。在

试验肺中这一现象现在比在患者中更显著。研究者测试了一假设，即较小的死腔在患者中达到的效果是通过较高的温度和/或湿度来减少 CO₂ 的再吸入。

方法：6 例心脏手术术后的患者的肺通过常规的湿热交换器(HME)或 ACD 通气。研究通过实验肺在不同的温度和湿度中测试了 ACD.使用红外光谱法通过二氧化碳单次呼吸测试以及二氧化碳重复吸入测量死腔量。

结果：在患者中，表观死腔容积的平均数为 136 mL（95%可信区间[CI]，120-167）与湿热交换器 HME 相比 ACD 大得多（校正后内部容积分别为 50ml 和 100ml）。ACD 呼出 CO₂ 重复吸入量平均数为 53%（范围为 48-58），HME 为 29%（范围为 27-32）。二氧化碳重复吸入平均差异为 23%（95%可信区间为 18-27）。在实验肺的测试中 ACD 的死腔不受身体的温度影响，在增加湿度后死腔量从 360ml 减少到 260ml.这将二氧化碳重吸收率从 62%下降至 48%。

结论：使用 ACD 所增加的表观死腔容积的程度可通过其内部容积解释。这是由于 ACD 在呼气时吸收 CO₂ 以及吸气时释放 CO₂ 导致的。CO₂ 的重吸收可以通过湿化来减少。由 ACD 造成的死腔在临床上可能与急性呼吸窘迫综合征和其他呼吸机相关疾病有关，但其临床重要性的证实需要更大量的样本研究。

（陈婉南译 薛张纲校）

BACKGROUND: The anesthetic conserving device (ACD) reduces consumption of volatile anesthetic drug by a conserving medium adsorbing exhaled drug during expiration and releasing it during inspiration. Elevated arterial CO₂ tension (PaCO₂) has been observed in patients using the ACD, despite tidal volume increase to compensate for larger apparatus dead space. In a test lung using room temperature dry gas, this was shown to be due to adsorption of CO₂ in the ACD during expiration and release of CO₂ during the following inspiration. The effect in the test lung was higher than in patients. We tested the hypothesis that a lesser dead space effect in patients is due to higher temperature and/or moisture attenuating rebreathing of CO₂.

METHODS: The lungs of 6 postoperative cardiac surgery patients were ventilated using a conventional heat and moisture exchanger (HME) or an ACD. The ACD was studied with a test lung at varying temperatures and moistures. Infrared spectrometry was used to measure apparent dead space by the single-breath test for CO₂ as well as rebreathing of CO₂.

RESULTS: In patients, the median apparent dead space was 136 mL (95% confidence interval [CI], 120-167) larger using the ACD compared with an HME (after correction for difference in internal volume 100 and 50 mL, respectively). Median rebreathing of CO₂ using the ACD was 53% (range 48-58) of exhaled CO₂ compared with 29% (range 27-32) with an HME. The median difference in CO₂ rebreathing was 23% (95% CI, 18-27). In the test lung apparent dead space using ACD was unaffected by body temperature but decreased from 360 to 260 mL when moisture was added. This decreased rebreathing of CO₂ from 62% to 48%.

CONCLUSIONS: The use of an ACD increases apparent dead space to a greater extent than can be explained by its internal volume. This is caused by adsorption of CO₂ in the ACD during expiration and release of CO₂ during inspiration. Rebreathing of CO₂ was attenuated by moisture. The dead space effect of the ACD could be clinically relevant in acute respiratory distress syndrome and other diseases associated with ventilation difficulties, but investigations with larger sample sizes would be needed to determine the clinical importance.

如何改进围手术期风险评估模型:通过生命体征使用外科 Apgar 评分系统一例

How to improve the performance of intraoperative risk models: an example with vital signs using the surgical apgar score.

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Anesthesia & Analgesia 2013 117 1338–1346

背景：通过计算机整合病人资料,早期准确地区分出风险病人和安全病人,可提高临床服务质量。病人生命体征资料抽样策略的重要性尚不明确。通过 SAS 评分系统实例,我们假设更大的抽样间隔可改进此项工具的特异性和总体预测能力。

方法：我们使用电子化围手术期资料,病人来源于美国外科医师协会质量改进计划纳入的单中心注册的普通外科和血管外科的病人。SAS 评分系统包括最低心律,最低平均动脉压,以及切皮与皮肤缝合期间评估的血液丢失量,并通过 5 种方法计算:即刻、5 分钟间隔伴或不伴间隔重叠、10 分钟间隔伴或不伴间隔重叠。包括死亡在内的主要并发症于术后 30 天评估。

结果：3000 例病人中,272 (9.1%) 例发生了主要并发症或死亡。随着抽样间隔由即时增加到 10 分钟不伴间隔重叠,灵敏度、阳性预测值和阴性预测值没有显著改变,然而特异度 (79.5%到 82.9%, $P < 0.001$) 和准确度 (76.0%到 79.3%, $P < 0.01$)。在多元模型中,通过 c-统计计算出 SAS 系统的预测效用几乎由最短抽样间隔的 $\Delta c = +0.012$ ($P = 0.038$) 增加到最长抽样间隔的 $\Delta c = +0.021$ ($P < 0.002$)。与术前风险评估模型相比,净改叙得以改善 0.01 ($P = 0.8$) vs 0.06 ($P = 0.02$),综合歧视同样得以改善 0.008 ($P < 0.01$) vs 0.015 ($P < 0.001$)。

结论：当生命体征资料按照 ASA 标准兼容方式记录时,抽样间隔显著影响 SAS 评分系统的实施。计算机整合病人资料受抽样方法的影响,具有优化安全有效临床策略的潜能。

(李春译 薛张纲校)

BACKGROUND: Computerized reviews of patient data promise to improve patient care through early and accurate identification of at-risk and well patients. The significance of sampling strategy for patient vital signs data is not known. In the instance of the surgical Apgar score (SAS), we hypothesized that larger sampling intervals would improve the specificity and overall predictive ability of this tool.

METHODS: We used electronic intraoperative data from general and vascular surgical patients in a single-institution registry of the American College of Surgeons National Surgical Quality Improvement Program. The SAS, consisting of lowest heart rate, lowest mean arterial blood pressure, and estimated blood loss between incision and skin closure, was calculated using 5 methods: instantaneously and using intervals of 5 and 10 minutes with and without interval overlap. Major complications including death were assessed at 30 days postoperatively.

RESULTS: Among 3000 patients, 272 (9.1%) experienced major complications or death. As the sampling interval increased from instantaneous (shortest) to 10 minutes without overlap (largest), the sensitivity, positive predictive value, and negative predictive value did not change significantly, but significant improvements were noted for specificity (79.5% to 82.9% across methods, P for trend < 0.001) and accuracy (76.0% to 79.3% across methods, P for trend < 0.01). In multivariate modeling, the predictive utility of the SAS as measured by the c-statistic nearly increased from $\Delta c = +0.012$ ($P = 0.038$) to $\Delta c = +0.021$ ($P < 0.002$) between the shortest and largest sampling intervals, respectively. Compared with a preoperative risk model, the net reclassification improvement and integrated discrimination improvement for the shortest versus largest sampling intervals of the SAS were net reclassification improvement 0.01 ($P = 0.8$) vs 0.06 ($P = 0.02$), and for integrated discrimination improvement, they were 0.008 ($P < 0.01$) vs 0.015 ($P < 0.001$).

CONCLUSIONS: When vital signs data are recorded in compliance with American Society of Anesthesiologists' standards, the sampling strategy for vital signs significantly influences performance of the SAS. Computerized reviews of patient data are subject to the choice of

sampling methods for vital signs and may have the potential to be optimized for safe, efficient patient care.

临床产科麻醉期间的过敏反应：文献综述

Anaphylaxis in the Clinical Setting of Obstetric Anesthesia: A Literature Review.

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Anesthesia & Analgesia 2013 117 1357–1367

妊娠期间过敏反应的发生率大约为 3/100000 例。由于存在主动脉、腔静脉压迫和过敏引起的心血管功能障碍这两方面的累加效应，妊娠末三个月内发生的过敏反应的临床处理极具挑战性。这篇综述总结了自然分娩和剖宫产手术期间发生过敏反应的临床表现，探讨了此期间造成过敏反应较为常见的过敏源，并制定合理的方法来鉴别诱发过敏反应的物质。我们还对妊娠晚期过敏反应的处理策略提出建议，包括在处理严重过敏性休克的患者时紧急应用肾上腺素和行急诊剖宫产。从个案报道、非致死性和致死病例，病理生理学的解释和共识意见获得的证据是有限的。

（凌晓敏译 薛张纲校）

The prevalence of anaphylaxis occurring during pregnancy is approximately 3 cases per 100,000 deliveries. The management of anaphylaxis occurring during the third trimester of pregnancy may be challenging because of the additive effects of aortocaval compression and cardiovascular disturbances of anaphylaxis. In this review, we identify the clinical signs of anaphylaxis occurring during labor and cesarean delivery, discuss the more common allergens that cause anaphylaxis during this clinical setting, and develop a rational approach to the identification of the offending allergen. We also suggest strategies for the management of anaphylaxis occurring during the third trimester of pregnancy, including the prompt administration of epinephrine and emergency cesarean delivery in cases of severe reactions. Evidence is limited to case reports and extrapolation from nonfatal and fatal cases, interpretation of pathophysiology, and consensus opinion.

儿童输液反应预测：系统性综述

Predicting Fluid Responsiveness in Children: A Systematic Review

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Anesthesia & Analgesia 2013 117 1380–1392

背景：血流动力复苏的主要方法是通过输液来提高心排血量。但输液并不是对所有患者都起作用，而且过多地输液是有害的。预测输液的反应具有挑战性，特别是对于儿童。大量血液动力变量被当作液体反应的预测指标而提出。基于心肺相互反应的动态变量似乎可以作为预测成年人液体反应的良好指标，但是其对患儿的液体反应却没有预测作用。

方法：我们系统地回顾了患儿液体反应预测指标的现有证据。使用文献服务检索系统（PubMed（1947-2013））和荷兰医学文摘数据库（EMBASE（1974-2013））进行了一个系统的搜索。搜索术语包括液体，体积，反应，回应，挑战，推注，负荷，预测和指

引。涉及儿科（婴儿，小孩，青少年）这一课题的研究结果是有限的。数据的抽取是由两位作者使用预定义的数据域独立完成的，包括研究质量指标。任何变量在接受者操作特征曲线这一区间，即明显大于 0.5 时，均被认为是可以预测的。

结果：涉及在 438 位儿科患者中使用（年龄范围 1 天-17.8 岁）的 501 种口服液的 12 项研究包括在内。对 24 个变量进行了调查。许多研究显示的唯一可预测的变量是主动脉血流量峰值流速的呼吸变量（5 个研究）。发现被动抬腿试验产生的心搏量指数，心搏距离变量以及心脏指数（心搏量）变化只有在单独的研究中才可以被预测。基于心率，动脉收缩压，预负荷（中央静脉压，肺动脉闭塞压），热稀释（整体舒张末期容量指数），超声波稀释（活跃循环血容量，中心血容量，总舒张末期容量，总射血分数），超声心动图（左心室末端舒张区）和多普勒（心搏量指数，校正流动时间）的静态变量无法预测孩子身上的血流动力学反应。基于动脉血压的动态变量法（动脉收缩压变化、脉压变化、每搏量变异度、动脉收缩压最大值与最小值的差值以及呼气末暂停时的收缩压）和体积描记法（脉搏血氧计体积描记幅度变化）也是不可预测的。体积描记器的变量指标和下腔静脉直径变量之间存在矛盾的结果。

结论：主动脉血流量峰值流速的呼吸变量是所显示的唯一可以预测患儿输液反应的变量。静态变量不能预测患儿的输液反应，该反应与成年人所表现的迹象一致。基于动脉血压的动态变量无法预测患儿输液反应，而且基于体积描记法的动态变量的证据不够充分。

(刘毅译 薛张纲校)

BACKGROUND: Administration of fluid to improve cardiac output is the mainstay of hemodynamic resuscitation. Not all patients respond to fluid therapy, and excessive fluid administration is harmful. Predicting fluid responsiveness can be challenging, particularly in children. Numerous hemodynamic variables have been proposed as predictors of fluid responsiveness. Dynamic variables based on the heart-lung interaction appear to be excellent predictors of fluid responsiveness in adults, but there is no consensus on their usefulness in children.

METHODS: We systematically reviewed the current evidence for predictors of fluid responsiveness in children. A systematic search was performed using PubMed (1947-2013) and EMBASE (1974-2013). Search terms included fluid, volume, response, respond, challenge, bolus, load, predict, and guide. Results were limited to studies involving pediatric subjects (infant, child, and adolescent). Extraction of data was performed independently by 2 authors using predefined data fields, including study quality indicators. Any variable with an area under the receiver operating characteristic curve that was significantly above 0.5 was considered predictive.

RESULTS: Twelve studies involving 501 fluid boluses in 438 pediatric patients (age range 1 day to 17.8 years) were included. Twenty-four variables were investigated. The only variable shown in multiple studies to be predictive was respiratory variation in aortic blood flow peak velocity (5 studies). Stroke volume index, stroke distance variation, and change in cardiac index (and stroke volume) induced by passive leg raising were found to be predictive in single studies only. Static variables based on heart rate, systolic arterial blood pressure, preload (central venous pressure, pulmonary artery occlusion pressure), thermodilution (global end diastolic volume index), ultrasound dilution (active circulation volume, central blood volume, total end diastolic volume, total ejection fraction), echocardiography (left ventricular end diastolic area), and Doppler (stroke volume index, corrected flow time) did not predict fluid responsiveness in children. Dynamic variables based on arterial blood pressure (systolic pressure variation, pulse pressure variation and stroke volume variation, difference between maximal or minimal systolic arterial blood pressure and systolic pressure at end-expiratory pause) and plethysmography (pulse oximeter plethysmograph amplitude variation) were also not predictive. There were contradicting results for plethysmograph variation index and inferior vena cava diameter variation.

CONCLUSIONS: Respiratory variation in aortic blood flow peak velocity was the only variable shown to predict fluid responsiveness in children. Static variables did not predict fluid responsiveness in children, which was consistent with evidence in adults. Dynamic variables

based on arterial blood pressure did not predict fluid responsiveness in children, but the evidence for dynamic variables based on plethysmography was inconclusive.

儿科麻醉的质量及安全性

Quality and Safety in Pediatric Anesthesia

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Anesthesia & Analgesia 2013 117 1408–1418

当今，医疗保健专业人士和政策制定者最为关心的问题是患者的医疗质量和价值。结局、安全以及服务是评估医疗质量的要素，以此来评估成本。医疗保健机构和专业人员都面临着提高医疗质量，同时减少相关成本和提高价值的挑战。什么是有效且必要的质量测量、什么不是，是评估提高产品质量和价值的工作的方式。然而目前只有很少的手段用于评估医疗质量，临床医生往往缺乏进行相关质量改进工作所需的资源和技能。在这篇文章中，我们简要回顾了儿科麻醉在质量改进方面的努力。

（徐升译 薛张纲校）

Health care quality and value are leading issues in medicine today for patients, health care professionals, and policy makers. Outcome, safety, and service—the components of quality—have been used to define value when placed in the context of cost. Health care organizations and professionals are faced with the challenge of improving quality while reducing health care related costs to improve value. Measurement of quality is essential for assessing what is effective and what is not when working toward improving quality and value. However, there are few tools currently for assessing quality of care, and clinicians often lack the resources and skills required to conduct quality improvement work. In this article, we provide a brief review of quality improvement as a discipline and describe these efforts within pediatric anesthesiology.

以沙滩椅位置进行的肩关节镜手术在全身麻醉状态下，精氨酸利尿剂能预防防止低血压，但同时会影响脑部供氧

Under general anesthesia arginine vasopressin prevents hypotension but impairs cerebral oxygenation during arthroscopic shoulder surgery in the beach chair position.

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Anesthesia & Analgesia 2013 117 1436–1443

背景：以沙滩椅位置进行手术的患者存在脑缺血的危险。我们评估了精氨酸利尿剂在手术期间对血流动力学以及脑部氧供的影响，

方法：三十例接受肩部手术的患者在异丙酚和瑞芬太尼静脉麻醉下被随机分为两组，分别在接受 BCP 前 2 分钟静注精氨酸升压素 0.07 U/kg（精氨酸升压素组，N = 15）或等体积的生理盐水（对照组，N = 15）。麻醉诱导前后及接受 BCP 后测定患者的平均动脉压，心率，颈静脉血氧饱和度，和局部脑组织氧饱和度。

结果：AVP 本身在给药后能增加平均动脉压，降低 S_{jo}O₂ 和 S_{cto}O₂ (P < 0.0001)，同时不影响心率。虽然在 BCP 过程的两组中 MAP 都会下降，但是它在精氨酸加压素组降得更多 (P < 0.0001)。而在 BCP 过程中，HR 在对照组保持不变，在 AVP 组降低。颈静脉血氧饱和度在 BCP 过程中的两组没有显著差异。S_{cto}O₂ 在 BCP 过程中两组都下降，在 AVP 组直到研究结束更显著。低血压的发生率 (13% 比 67%；P = 0.003) 不常见，而脑部氧供减少 (>20% presitting S_{cto}O₂ 下降值) (80% 比 13%；P = 0.0003) 明显高于 AVP 组。颈静脉氧饱和度 (S_{jo}O₂ < 50%) 组与组之间可比较。

结论：预防性注射精氨酸加压素可以对全麻状态下的肩部手术因为 BCP 引起的低血压有预防作用。然而，它与局部脑组织而不是颈静脉氧饱和度降低的垂直位置。

(徐峥译 薛张纲校)

BACKGROUND: Patients undergoing surgery in the beach chair position (BCP) are at a risk of cerebral ischemia. We evaluated the effect of arginine vasopressin (AVP) on hemodynamics and cerebral oxygenation during surgery in the BCP.

METHODS: Thirty patients undergoing shoulder surgery in BCP under propofol-remifentanyl anesthesia were randomly allocated either to receive IV AVP (AVP group,) or an equal volume of saline (control group,) 2 minutes before taking BCP. Mean arterial blood pressure (MAP), heart rate (HR), jugular venous bulb oxygen saturation (S_{jo}O₂), and regional cerebral tissue oxygen saturation (S_{cto}O₂) were measured after induction of anesthesia and before (presitting in supine position) and after patients took BCP.

RESULTS: AVP itself given before the positioning increased MAP and decreased S_{jo}O₂ and S_{cto}O₂ (P < 0.0001), with HR unaffected. Although MAP was decreased by BCP in both groups, it was higher in the AVP group (P < 0.0001). While in BCP, HR remained unaltered in the control and decreased in the AVP group. S_{jo}O₂ in BCP did not differ between the groups. S_{cto}O₂ was decreased by BCP in both groups, which was more pronounced in the AVP group until the end of study. The incidence of hypotension (13% vs 67%; P = 0.003) was less frequent, and that of cerebral desaturation (>20% S_{cto}O₂ decrease from presitting value) (80% vs 13%; P = 0.0003) was higher in the AVP group. The incidence of jugular desaturation (S_{jo}O₂ < 50%) was comparable between the groups.

CONCLUSIONS: A prophylactic bolus administration of AVP prevents hypotension associated with BCP in patients undergoing shoulder surgery under general anesthesia. However, it was associated with regional cerebral but not jugular venous oxygen desaturation on upright positioning.

坐骨神经部分离断术大鼠鞘内给予超低剂量纳洛酮可增强吗啡的抗痛觉过敏作用，并下调脊髓背角 TNF- α 和 TNFR1 表达

Intrathecal Ultra-Low Dose Naloxone Enhances the Antihyperalgesic Effects of Morphine and Attenuates Tumor Necrosis Factor- α and Tumor Necrosis Factor- α Receptor 1 Expression in the Dorsal Horn of Rats with Partial Sciatic Nerve Transection

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Anesthesia & Analgesia 2013 117 1493–1502

背景：谷氨酸盐稳态和小胶质细胞激活在神经病理性疼痛形成及持续过程中起到了重要的作用。我们设计本实验旨在研究超低剂量纳洛酮单独给药或复合给予吗啡是否能够改变经行坐骨神经部分离断术 (PST) 的大鼠兴奋性氨基酸 (EAAs) 谷氨酸和天冬氨酸的浓度，以及脊髓背角 TNF- α 及其受体 TNFR1 和 TNFR2 的表达。

方法：选取雄性 Wistar 大鼠，行鞘内导管置入并根据不同的手术给药方案分为 7 组：假手术+生理盐水 (sham)，PST+生理盐水 (S)，PST+15 ng 纳洛酮 (n)，PST+15 μ g 纳洛酮 (N)，PST+10 μ g 吗啡 (M)，PST+15 ng 纳洛酮+10 μ g 吗啡 (Mn)，PST+15 μ g 纳洛酮+10 μ g 吗啡 (MN)。观察指标包括有：热退缩潜伏期和机械退缩阈值，TNF- α 和 TNFR 在脊髓和背根神经节的表达，脑渗析液中兴奋性氨基酸谷氨酸和天冬氨酸浓度的浓度。

结果：PST 术后 10 天大鼠出现痛觉过敏 ($P < 0.0001$) 和痛觉异常 ($P < 0.0001$)，且同侧脊髓背角 TNF- α ($P < 0.0001$) 和 TNFR1 ($P = 0.0009$) 表达上调。大剂量的纳洛酮 (15 μ g; $P = 0.0031$) 抑制了啡 (10 μ g) 的抗痛觉过敏和抗痛觉异常作用，而超低剂量的纳洛酮 (15 ng; $P = 0.0015$) 使其作用增强，并同时下调脊髓背角 TNF- α ($P < 0.0001$)、TNFR1 ($P = 0.0009$) 的表达和降低脑渗析液中兴奋性氨基酸浓度 (谷氨酸 $P = 0.0001$ ；天冬氨酸 $P = 0.004$)。采用方差分析或 Bonferroni 校正的 T 检验进行统计学分析。

结论：PST 大鼠给予超低剂量纳洛酮后，可能通过下调脊髓背角的 TNF- α 和 TNFR1 表达及降低兴奋性氨基酸浓度，从而增强啡的抗痛觉过敏作用及抗痛觉异常作用。在治疗神经病理性疼痛时，给予超低剂量纳洛酮也许可作为增强啡抗痛觉过敏作用的有效佐剂。

(朱怡琦译 薛张纲校)

BACKGROUND: Glutamate homeostasis and microglia activation play an important role in the development and maintenance of neuropathic pain. We designed this investigation to examine whether ultra-low dose naloxone administered alone or in combination with morphine could alter the concentration of the excitatory amino acids (EAAs) glutamate and aspartate, as well as the expression of tumor necrosis factor- α (TNF- α) and its receptors (TNFR1 and TNFR2) in the spinal cord dorsal horn of rats with partial sciatic nerve transection (PST).

METHODS: Male Wistar rats underwent intrathecal catheter implantation for drug delivery and were divided in 7 groups: sham-operated + saline (sham), PST + saline (S), PST + 15 ng naloxone (n), PST + 15 μ g naloxone (N), PST + 10 μ g morphine (M), PST + 15 ng naloxone + 10 μ g morphine (Mn), PST + 15 μ g naloxone + 10 μ g morphine (MN). Thermal withdrawal latency and mechanical withdrawal threshold, TNF- α and TNFR expression in the spinal cord and dorsal root ganglia, and EAAs glutamate and aspartate concentration in cerebrospinal fluid dialysates were measured.

RESULTS: Ten days after PST, rats developed hyperalgesia ($P < 0.0001$) and allodynia ($P < 0.0001$), and increased TNF- α ($P < 0.0001$) and TNFR1 expression ($P = 0.0009$) were measured in the ipsilateral spinal cord dorsal horn. The antihyperalgesic and antiallodynic effects of morphine (10 μ g) were abolished by high-dose naloxone (15 μ g; $P = 0.0031$) but enhanced by ultra-low dose naloxone (15 ng; $P = 0.0015$), and this was associated with a reduction of TNF- α ($P < 0.0001$) and TNFR1 ($P = 0.0009$) expression in the spinal cord dorsal horn and EAAs concentration (glutamate: $P = 0.0001$; aspartate: $P = 0.004$) in cerebrospinal fluid dialysate. Analysis of variance (ANOVA) or Student t test with Bonferroni correction were used for statistical analysis.

CONCLUSIONS: Ultra-low dose naloxone enhances the antihyperalgesia and antiallodynia effects of morphine in PST rats, possibly by reducing TNF- α and TNFR1 expression, and EAAs concentrations in the spinal dorsal horn. Ultra-low dose naloxone may be a useful adjuvant for increasing the analgesic effect of morphine in neuropathic pain conditions.