

美國促進康復和圍手術期品質協會聯合共識：腦電圖神經監測在圍手術期中的作用

American Society for Enhanced Recovery and Perioperative Quality Initiative Joint Consensus Statement on the Role of Neuromonitoring in Perioperative Outcomes: Electroencephalography

Chan, Matthew T. V. MB, BS, PhD, FHKCA, FANZCA, FHKAM^{*}; Hedrick, Traci L. MD, MS[†]; Egan, Talmage D. MD[‡]; García, Paul S. MD, PhD[§]; Koch, Susanne MD^{||}; Purdon, Patrick L. PhD^{¶#}; Ramsay, Michael A. MD, FRCA^{**}; Miller, Timothy E. MB, ChB^{††}; McEvoy, Matthew D. MD^{‡‡}; Gan, Tong J. MD, MBA, MHS, FRCA^{§§}; ; on behalf of the Perioperative Quality Initiative (POQI) 6 Workgroup
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腦電圖（EEG）監測可提示麻醉期間的大腦狀態，目前已被廣泛使用。但腦電圖導向麻醉是否會影響圍手術期結局尚不清楚。第六屆圍手術期品質計畫（POQI-6）召集了一支由麻醉學，生物醫學工程，神經病學和外科手術等多學科專家組成的國際團隊，以回顧當前的文獻，並就麻醉期間腦電圖監測的實用性提出共識。我們總共檢索了 1023 篇文章，涉及麻醉期間使用 EEG 監測，並從 15 項試驗中進行了薈萃分析，以確定 EEG 導向麻醉對無意識，術後譫妄，神經認知障礙和長期死亡率的發生率的影響。在評估了當前證據後，工作組建議應將 EEG 監測作為重要器官監測器的一部分，以指導麻醉管理。並且鼓勵麻醉醫師熟悉 EEG 的基本內容，例如原始波形，頻譜圖和處理後的指標。現有證據表明，EEG 導向的麻醉降低了全憑靜脈麻醉期間的術中知曉，且在預防術中知曉的層面上，與潮氣末麻醉氣體監測效果相似。但是，沒有足夠的證據推薦使用 EEG 監測來預防術後譫妄，神經認知障礙或術後死亡率。

（許芳霞譯 李金寶校）

Electroencephalographic (EEG) monitoring to indicate brain state during anesthesia has become widely available. It remains unclear whether EEG-guided anesthesia influences perioperative outcomes. The sixth Perioperative Quality Initiative (POQI-6)

brought together an international team of multidisciplinary experts from anesthesiology, biomedical engineering, neurology, and surgery to review the current literature and to develop consensus recommendations on the utility of EEG monitoring during anesthesia. We retrieved a total of 1023 articles addressing the use of EEG monitoring during anesthesia and conducted meta-analyses from 15 trials to determine the effect of EEG-guided anesthesia on the rate of unintentional awareness, postoperative delirium, neurocognitive disorder, and long-term mortality after surgery. After considering current evidence, the working group recommends that EEG monitoring should be considered as part of the vital organ monitors to guide anesthetic management. In addition, we encourage anesthesiologists to be knowledgeable in basic EEG interpretation, such as raw waveform, spectrogram, and processed indices, when using these devices. Current evidence suggests that EEG-guided anesthesia reduces the rate of awareness during total intravenous anesthesia and has similar efficacy in preventing awareness as compared with end-tidal anesthetic gas monitoring. There is, however, insufficient evidence to recommend the use of EEG monitoring for preventing postoperative delirium, neurocognitive disorder, or postoperative mortality.

使用超級學習機器-學習演算法預測 ICU 住院期間的急性低血壓發作

Prediction of an Acute Hypotensive Episode During an ICU Hospitalization With a Super Learner Machine-Learning Algorithm

Cherifa, Ményssa MSc^{*,†,‡}; Blet, Alice MD, PhD^{§,§,||}; Chambaz, Antoine PhD^{†,‡,||};

Gayat, Etienne MD, PhD^{§,||}; Resche-Rigon, Matthieu MD, PhD^{*,†,‡}; Pirracchio,

Romain MD, PhD^{†,‡,#}

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背景：急性降血壓發作（AHE）定義為平均動脈壓（MAP）下降至<65 mm Hg 持續至少 5 分鐘，是重症監護病房（ICU）中最嚴重的事件之一。與危重症患者的不良結局有關。因而預測 AHE 的發生至關重要，以此可通過調整治療方案來預測或縮短 AHE。

方法：超級學習器（SL）演算法是一種集成的機器學習演算法，經過專門訓練用以提前 10 分鐘預測 AHE。潛在的預測因素包括年齡，性別，護理類型，嚴重程度評分和隨時間變化的特徵（例如機械通氣，血管加壓藥或鎮靜藥物）以及生命體征：心率，脈搏血氧飽和度和動脈血壓。該演算法在重症監護醫學資訊集資

料集 (MIMIC II) 資料庫上進行了訓練。內部驗證基於接收器工作特性曲線下面積 (AUROC) 和 Brier 分數 (BS)。外部驗證來自法國巴黎 Lariboisière 醫院的對外資料庫。

結果：在納入研究的 1151 例患者，826 例 (72%) 患者在 ICU 期間至少有 1 次 AHE。每位患者的 1 個隨機週期內，採用 Haar 小波變換預處理的 SL 演算法的 AUROC 為 0.929 (95% 置信區間 [CI], 0.899-0.958)，BS 為 0.08。每位患者的所有可用時間段內，採用 Haar 小波變換預處理的 SL 的 AUROC 為 0.890 (95% CI, 0.886-0.895)，BS 為 0.11。在外部驗證佇列中，每位元患者 1 個隨機週期內的 AUROC 為 0.884 (95% CI, 0.775-0.993)，所有可用週期為 0.889 (0.768-1)，並且 BSs < 0.1。

結論：SL 演算法可以很好地提前 10 分鐘預測 AHE 發生。它可以對低血壓風險進行有效，健全和快速的評估，從而為常規使用開闢了道路。

(許芳霞譯 李金寶校)

BACKGROUND: Acute hypotensive episodes (AHE), defined as a drop in the mean arterial pressure (MAP) <65 mm Hg lasting at least 5 consecutive minutes, are among the most critical events in the intensive care unit (ICU). They are known to be associated with adverse outcome in critically ill patients. AHE prediction is of prime interest because it could allow for treatment adjustment to predict or shorten AHE.

METHODS: The Super Learner (SL) algorithm is an ensemble machine-learning algorithm that we specifically trained to predict an AHE 10 minutes in advance. Potential predictors included age, sex, type of care unit, severity scores, and time-evolving characteristics such as mechanical ventilation, vasopressors, or sedation medication as well as features extracted from physiological signals: heart rate, pulse oximetry, and arterial blood pressure. The algorithm was trained on the Medical Information Mart for Intensive Care dataset (MIMIC II) database. Internal validation was based on the area under the receiver operating characteristic curve (AUROC) and the Brier score (BS). External validation was performed using an external dataset from Lariboisière hospital, Paris, France.

RESULTS: Among 1151 patients included, 826 (72%) patients had at least 1 AHE during their ICU stay. Using 1 single random period per patient, the SL algorithm with Haar wavelets transform preprocessing was associated with an AUROC of 0.929

(95% confidence interval [CI], 0.899-0.958) and a BS of 0.08. Using all available periods for each patient, SL with Haar wavelets transform preprocessing was associated with an AUROC of 0.890 (95% CI, 0.886-0.895) and a BS of 0.11. In the external validation cohort, the AUROC reached 0.884 (95% CI, 0.775-0.993) with 1 random period per patient and 0.889 (0.768-1) with all available periods and BSs <0.1.

CONCLUSIONS: The SL algorithm exhibits good performance for the prediction of an AHE 10 minutes ahead of time. It allows an efficient, robust, and rapid evaluation of the risk of hypotension that opens the way to routine use.

預測危機：機器學習模型可預測術中心動過緩伴低血壓的發生

Forecasting a Crisis: Machine-Learning Models Predict Occurrence of Intraoperative Bradycardia Associated With Hypotension

Solomon, Stuart C. MD* ; Saxena, Rajeev C. MD, MBA* ; Neradilek, Moni B. MS† ; Hau, Vickie MD* ; Fong, Christine T. MS* ; Lang, John D. MD* ; Posner, Karen L. PhD* ; Nair, Bala G. PhD*

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背景：預測分析系統可以通過增強對高風險臨床事件的準備，識別和回應來改善圍手術期護理。心動過緩是一種相當普遍且影響因素眾多而難以預測的臨床事件。它可能是良性的，也可能與需要積極治療的低血壓有關。我們的目的是通過術前電子病歷和術中麻醉資訊管理系統資料來構建模型，預測術中 3 個時間點的術中嚴重心動過緩的發生。

方法：資料來源於華盛頓大學醫學中心 2012 年至 2017 年所開展的 62,182 例擇期非心臟手術。臨床事件定義為嚴重心動過緩（心率<50 次/分鐘），且在 10 分鐘視窗期內出現低血壓（平均動脈壓<55 mmHg）。我們開發了模型來預測以下 3 個時間點至少有 1 次事件的存在：麻醉誘導（TP1），手術開始（TP2）和手術開始後 30 分鐘（TP3）。預測變數基於每個時間點之前的可用資料，包括術前患者和手術資料（TP1），然後是基於術中每分鐘的監護儀資料，呼吸機參數，靜脈輸液，輸液和推注藥物資料（TP2 和 TP3）。建立機器學習和邏輯回歸模型，通過 ROC 曲線下的面積（AUC）評估其預測能力。

結果：TP1、TP2、TP3 時刻後的臨床事件分別為 3498 (5.6%)、2404 (3.9%)、1066 (1.7%)。心率是 TP1 之後事件的最強預測因數。TP2 時刻前的臨床事件、平均心率和平均脈搏率是 TP2 時刻之後臨床事件的最強預測因數。TP2 時刻前的臨床事件、平均心率和平均脈搏率（及其相互作用）以及心率和血壓連續 15 分鐘下降是 TP3 時刻後臨床事件的最強預測因數。最佳的機器學習模型 AUC 分別為 0.81 (TP1)，0.87 (TP2) 和 0.89 (TP3)，在 95%特異性下的陽性預測值分別為 0.30、0.29 和 0.15。

結論：我們研發了可利用術前和術中即時資料預測不穩定的心動過緩的模型。我們的研究提示了如何利用模型來預測多個時間間隔內的臨床事件，希望未來能研發即時、術中、可幫助決策的工具。

（許芳霞譯 李金寶校）

BACKGROUND: Predictive analytics systems may improve perioperative care by enhancing preparation for, recognition of, and response to high-risk clinical events. Bradycardia is a fairly common and unpredictable clinical event with many causes; it may be benign or become associated with hypotension requiring aggressive treatment. Our aim was to build models to predict the occurrence of clinically significant intraoperative bradycardia at 3 time points during an operative course by utilizing available preoperative electronic medical record and intraoperative anesthesia information management system data.

METHODS: The analyzed data include 62,182 scheduled noncardiac procedures performed at the University of Washington Medical Center between 2012 and 2017. The clinical event was defined as severe bradycardia (heart rate <50 beats per minute) followed by hypotension (mean arterial pressure <55 mm Hg) within a 10-minute window. We developed models to predict the presence of at least 1 event following 3 time points: induction of anesthesia (TP1), start of the procedure (TP2), and 30 minutes after the start of the procedure (TP3). Predictor variables were based on data available before each time point and included preoperative patient and procedure data (TP1), followed by intraoperative minute-to-minute patient monitor, ventilator, intravenous fluid, infusion, and bolus medication data (TP2 and TP3). Machine-learning and logistic regression models were developed, and their predictive abilities were evaluated using the area under the ROC curve (AUC). The contribution of the input variables to the models were evaluated.

RESULTS: The number of events was 3498 (5.6%) after TP1, 2404 (3.9%) after TP2, and 1066 (1.7%) after TP3. Heart rate was the strongest predictor for events after TP1. Occurrence of a previous event, mean heart rate, and mean pulse rates before TP2 were the strongest predictor for events after TP2. Occurrence of a previous event, mean heart rate, mean pulse rates before TP2 (and their interaction), and 15-minute slopes in heart rate and blood pressure before TP2 were the strongest predictors for events after TP3. The best performing machine-learning models including all cases produced an AUC of 0.81 (TP1), 0.87 (TP2), and 0.89 (TP3) with positive predictive values of 0.30, 0.29, and 0.15 at 95% specificity, respectively.

CONCLUSIONS: We developed models to predict unstable bradycardia leveraging preoperative and real-time intraoperative data. Our study demonstrates how predictive models may be utilized to predict clinical events across multiple time intervals, with a future goal of developing real-time, intraoperative, decision support.

新型成像通過無監督的流形學習揭示心血管波形分析的內部動態性

Novel Imaging Revealing Inner Dynamics for Cardiovascular Waveform Analysis via Unsupervised Manifold Learning

Wang, Shen-Chih MD, PhD^{*,†}; Wu, Hau-Tieng MD, PhD^{‡,§,||}; Huang, Po-Hsun MD, PhD^{||,#}; Chang, Cheng-Hsi MD^{**,††}; Ting, Chien-Kun MD, PhD^{*,†}; Lin, Yu-Ting MD, PhD^{*}

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背景：心血管波形包含用於臨床診斷的資訊。通過從大量原始波形資料中學習的波形形態的細微變化，無監督流形學習有助於描繪高維結構並將其顯示為新穎的3D 圖像。我們假設這種結構的形狀傳達了臨床相關的內部動態資訊。

方法：為了驗證該假設，我們研究了缺血性心臟病的心電圖（ECG）波形和動態血管活性改變時動脈血壓（ABP）波形。我們將每次心跳或脈搏建模為位於流形上的點，並使用彌撒圖（DMap）建立這些脈衝之間的關係。DMap 的輸出結果轉換為可視的3D 圖像。對於 ECG 資料集，首先我們分析了3D 圖像中從不穩定型心絞痛患者到健康對照的非 ST 段升高型的 ECG 波形分佈，並研究了術中 ST 段升高型 ECG 波形，以顯示動態 ECG 波形變化。對於 ABP 資料集，我們分析了在氣管插管和使用血管擴張劑時收集的波形。為了量化動態分離，我們應用了

支持向量機 (SVM) 分析，並報告了總精度和宏觀 F1 評分。我們進一步進行了軌跡分析，並得出了連續跳動 (或脈衝) 的運動方向作為高維空間中的向量。

結果：對於非 ST 段抬高型心電圖，三維圖像呈現由不穩定型心絞痛到健康對照的連續 ECG 波形構成的分層樹結構 (準確度=97.6%，macro-f1=96.1%)。DMap 有助於量化和視覺化術中 1 小時內 ST 段抬高心肌事件的發展 (準確度=97.58%，宏-F1=96.06%)。尼卡地平給藥後的 ABP 波形分析顯示個體間的差異 (準確度為 95.01%，macro-f1=96.9%) 及其與個體內運動軌跡的共同方向。氣管插管過程中 ABP 波形的動態變化呈環形軌跡結構，利用尼卡地平的學習知識可以進一步對其進行劃分。

結論：DMap 和生成的 ECG 或 ABP 波形的三維圖像提供了臨床相關的內部動態資訊。可為急性冠狀動脈綜合征的診斷提供線索，顯示心肌缺血發作的臨床過程，揭示應激或血管擴張狀態下的生理機制。

(許芳霞譯 李金寶校)

BACKGROUND: Cardiovascular waveforms contain information for clinical diagnosis. By learning and organizing the subtle change of waveform morphology from large amounts of raw waveform data, unsupervised manifold learning helps delineate a high-dimensional structure and display it as a novel 3-dimensional (3D) image. We hypothesize that the shape of this structure conveys clinically relevant inner dynamics information.

METHODS: To validate this hypothesis, we investigate the electrocardiography (ECG) waveform for ischemic heart disease and arterial blood pressure (ABP) waveform in dynamic vasoactive episodes. We model each beat or pulse to be a point lying on a manifold-like a surface-and use the diffusion map (DMap) to establish the relationship among those pulses. The output of the DMap is converted to a 3D image for visualization. For ECG datasets, first we analyzed the non-ST-elevation ECG waveform distribution from unstable angina to healthy control in the 3D image, and we investigated intraoperative ST-elevation ECG waveforms to show the dynamic ECG waveform changes. For ABP datasets, we analyzed waveforms collected under endotracheal intubation and administration of vasodilator. To quantify the dynamic separation, we applied the support vector machine (SVM) analysis and reported the total accuracy and macro-F1 score. We further performed the trajectory analysis and

derived the moving direction of successive beats (or pulses) as vectors in the high-dimensional space.

RESULTS: For the non-ST-elevation ECG, a hierarchical tree structure comprising consecutive ECG waveforms spanning from unstable angina to healthy control is presented in the 3D image (accuracy = 97.6%, macro-F1 = 96.1%). The DMap helps quantify and visualize the evolving direction of intraoperative ST-elevation myocardial episode in a 1-hour period (accuracy = 97.58%, macro-F1 = 96.06%). The ABP waveform analysis of Nicardipine administration shows interindividual difference (accuracy = 95.01%, macro-F1 = 96.9%) and their common directions from intraindividual moving trajectories. The dynamic change of the ABP waveform during endotracheal intubation shows a loop-like trajectory structure, which can be further divided using the manifold learning knowledge obtained from Nicardipine.

CONCLUSIONS: The DMap and the generated 3D image of ECG or ABP waveforms provides clinically relevant inner dynamics information. It provides clues of acute coronary syndrome diagnosis, shows clinical course in myocardial ischemic episode, and reveals underneath physiological mechanism under stress or vasodilators.

失血性休克對靜脈麻醉藥物的分佈及效應的影響：敘述性綜述

The Influence of Hemorrhagic Shock on the Disposition and Effects of Intravenous Anesthetics: A Narrative Review

Egan, Ezekiel D. BA; Johnson, Ken B. MD

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在失血性休克的情況下，減少靜脈麻醉劑的劑量是一個公認的臨床教條。總體來說，從動物和人類資料中獲取的有關失血性休克期間靜脈麻醉劑用量的資訊，證實了該臨床教條，並為失血性休克背景下靜脈麻醉劑的合理選擇和使用提供了依據。失血性休克時的生理變化可改變靜脈麻醉藥的藥動學和藥效學。休克生理學引起的中央室和中央間隙減小導致劑量-濃度關係改變。對於大多數藥劑和輔藥來說，休克導致了更高的濃度和更強的效應。值得注意的例外是依託咪酯，它在休克期間的藥動學相對不變。濃度的增加不僅導致主要效應的增加，也導致副作用的增加，特別是心血管效應。所有藥物的藥代動力學改變基本上都是通過液體復蘇來逆轉的。異丙酚在這些藥物中比較特殊，除了有藥代動力學變化外，它在休克期間表現出更強的藥效。並且即使在液體復蘇後，仍有藥效變化。休克期間

這些藥效持續性變化的原因不太可能是內源性阿片類藥物的增加，而很大可能是由於未結合的異丙酚的比例增加。休克的不同階段也可能會影響藥物的變化。隨著休克生理學進展到無補償階段，這種變化更加迅速和明顯。儘管資料不多，但人類的資料證實了動物研究的結果。在失血性休克的情況下，動物和人類的資料都為靜脈麻醉劑的合理選擇和使用提供了依據。依託咪酯是出血性休克患者首選誘導劑這一根深蒂固的臨床教條得到了有力的證據支持。丙泊酚是嚴重出血患者麻醉誘導或維持的較差選擇，即使是在復蘇的情況下；且包括緊急創傷病例或常規有輕度或中度失血的病例。

（許芳霞譯 李金寶校）

The need to reduce the dose of intravenous anesthetic in the setting of hemorrhagic shock is a well-established clinical dogma. Considered collectively, the body of information concerning the behavior of intravenous anesthetics during hemorrhagic shock, drawn from animal and human data, confirms that clinical dogma and informs the rational selection and administration of intravenous anesthetics in the setting of hemorrhagic shock. The physiologic changes during hemorrhagic shock can alter pharmacokinetics and pharmacodynamics of intravenous anesthetics. Decreased size of the central compartment and central clearance caused by shock physiology lead to an altered dose-concentration relationship. For most agents and adjuncts, shock leads to substantially higher concentrations and increased effect. The notable exception is etomidate, which has relatively unchanged pharmacokinetics during shock. Increased concentrations lead to increased primary effect as well as increased side effects, notably cardiovascular effects. Pharmacokinetic changes are essentially reversed for all agents by fluid resuscitation. Propofol is unique among agents in that, in addition to the pharmacokinetic changes, it exhibits increased potency during shock. The pharmacodynamic changes of propofol persist despite fluid resuscitation. The persistence of these pharmacodynamic changes during shock is unlikely to be due to increased endogenous opiates, but is most likely due to increased fraction of unbound propofol. The stage of shock also appears to influence the pharmacologic changes. The changes are more rapid and pronounced as shock physiology progresses to the uncompensated stage. Although scant, human data corroborate the findings of animal studies. Both the animal and human data inform the rational selection and administration of intravenous anesthetics in the setting of hemorrhagic shock. The well-entrenched clinical dogma that etomidate is a preferred induction agent in patients experiencing hemorrhagic shock is firmly supported by the evidence. Propofol is a poor choice for induction or maintenance of anesthesia in severely

bleeding patients, even with resuscitation; this can include emergent trauma cases or scheduled cases that routinely have mild or moderate blood loss.

關於兒童眼科手術局麻的文獻綜述

Regional Anesthesia for Pediatric Ophthalmic Surgery: A Review of the Literature

Jean, Yuel-Kai DO^{*}; Kam, David MD^{*}; Gayer, Steven MD[†]; Palte, Howard D. MD[†]; Stein, Alecia L. S. MD[†]

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兒童眼科局部麻醉已被廣泛報導，但很少使用。本文綜述了支援傳導麻醉在小兒眼科手術中應用的現有證據。兒童和成人在軸長、眼壓和有效眼眶空間方面的關鍵解剖差異影響了眼科區域麻醉的實施。眼睛在出生時接近成人大小，並且在眼眶還沒怎麼變化時迅速完成生長。這導致局部麻醉時眼外眶容積明顯減小。基於針的局部阻滯根據針與眼外肌束的關係進行（即眼內或眼外），基於套管的局部阻滯根據對腱膜深部潛在空間進行。在兒童中，由兒科麻醉師或眼科醫師進行麻醉誘導，通過解剖標誌物或超聲檢查進行阻滯。眼部傳導麻醉為眼科手術提供了一些優勢，包括鎮痛、致盲、阻斷眼心反射、減少術後噁心和嘔吐。短（16 毫米）鈍的針頭是首選，因為兒童的眼球與眼框的比例是不一樣的。不同長度的軟套管在亞肌腱阻滯中是安全的。超聲技術有助於直觀、即時地顯示針頭位置和局部麻醉劑擴散，並減少針意外放入眼肌束內。發育中的眼睛容易受到熱損傷和機械損傷，因此必須使用眼睛額定的感測器。輔助性透明質酸酶可改善眼部致盲，降低局部麻醉劑量要求，提高初始阻滯成功率；同時，右美托咪定可增加局麻藥的藥效，延長鎮痛時間，但不增加不良事件。在新生兒和嬰兒，視網膜母細胞瘤手術，以及後葡萄腫和眼眶炎中，眼肌束內阻滯是一種相對禁忌症。對於兒科眼科手術，綜合征患兒的阻滯位置，以及與每種技術的潛在不良反應，均需要特殊考慮。以上是基於我們在繁忙的學術眼科三級轉診中心的經驗所提供的建議。

(許芳霞譯 李金寶校)

Ophthalmic pediatric regional anesthesia has been widely described, but infrequently used. This review summarizes the available evidence supporting the use of conduction anesthesia in pediatric ophthalmic surgery. Key anatomic differences in axial length, intraocular pressure, and available orbital space between young children and adults impact conduct of ophthalmic regional anesthesia. The eye is near adult size at birth and completes its growth rapidly while the orbit does not. This results in significantly diminished extraocular orbital volumes for local anesthetic deposition. Needle-based blocks are categorized by relation of the needle to the extraocular muscle cone (ie, intraconal or extraconal) and in the cannula-based block, by description of the potential space deep to the Tenon capsule. In children, blocks are placed after induction of anesthesia by a pediatric anesthesiologist or ophthalmologist, via anatomic landmarks or under ultrasonography. Ocular conduction anesthesia confers several advantages for eye surgery including analgesia, akinesia, ablation of the oculocardiac reflex, and reduction of postoperative nausea and vomiting. Short (16 mm), blunt-tip needles are preferred because of altered globe-to-orbit ratios in children. Soft-tip cannulae of varying length have been demonstrated as safe in sub-Tenon blockade. Ultrasound technology facilitates direct, real-time visualization of needle position and local anesthetic spread and reduces inadvertent intraconal needle placement. The developing eye is vulnerable to thermal and mechanical insults, so ocular-rated transducers are mandated. The adjuvant hyaluronidase improves ocular akinesia, decreases local anesthetic dosage requirements, and improves initial block success; meanwhile, dexmedetomidine increases local anesthetic potency and prolongs duration of analgesia without an increase in adverse events. Intraconal blockade is a relative contraindication in neonates and infants, retinoblastoma surgery, and in the presence of posterior staphylomas and buphthalmos. Specific considerations include pertinent pediatric ophthalmologic topics, block placement in the syndromic child, and potential adverse effects associated with each technique. Recommendations based on our experience at a busy academic ophthalmologic tertiary referral center are provided.

心臟手術患者低潮氣量與其氧合輕度改善相關：佇列研究

Low Tidal Volumes Are Associated With Slightly Improved Oxygenation in Patients Having Cardiac Surgery: A Cohort Analysis

Jia, Yuan MD^{*}; Leung, Steve M. MD^{*}; Turan, Alparslan MD^{*}; Artis, Amanda S. MS[†];

Marciniak, Donn MD[‡]; Mick, Stephanie MD[§]; Devarajan, Jagan MD^{||}; Duncan,

Andra E. MD, MS[¶]

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背景：低潮氣量的機械通氣對非心臟手術患者似乎有好處，但對心臟手術患者是否有好處尚不清楚。

方法：回顧性分析 2010 年 1 月至 2016 年 8 月中旬接受單腔氣管插管機械通氣的需要體外迴圈的擇期心臟手術患者。對手術期間（不包括體外迴圈階段）時間加權平均潮氣量（毫升/千克預測體重[PBW]）。檢查潮氣量與術後氧合（通過動脈氧分壓(PaO₂)/吸入氧濃度[PaO₂/FiO₂]測量)、氧合受損(PaO₂/FiO₂<300)和臨床結局之間的關係。

結果：在 9359 例心臟外科患者中，較大的潮氣量與術後稍差的氧合相關。潮氣量每增加 1 ml/kg PBW，術後 PaO₂/FiO₂ 降低約 1.05%(97.5%置信區間[CI]，-1.74 至-0.37；P_{Bon}=0.0005)。術中潮氣量的增加也與氧合不良的比例增加（比值比[OR；97.5% CI:1.08 [1.02-1.14]每增加 1 ml/kg PBW 潮氣量；P_{BON}=0.0029），插管時間延長（每增加 1 ml/kg 潮氣量 5%（風險比; [98.33% CI]，0.95[0.93-0.98]每增加 1 ml/kg PBW；P_{Bon}<0.0001），死亡率增加（OR[98.33%可信區間]，潮氣量每增加 1 ml/kg PBW 死亡率增加 1.34[1.06-1.70]，P_{Holm}=0.0144）相關。術中潮氣量的增加也與術後急性呼吸衰竭相關（OR[98.33%可信區間]，潮氣量每增加 1 ml/kg PBW 1.16[1.03-1.32]；P_{Holm}=0.0146），但與其他肺部併發症無關。

結論：較低的时间加權平均術中潮氣量與心臟手術患者術後氧合狀況的輕微改善有關。

（許芳霞譯 李金寶校）

BACKGROUND: Mechanical ventilation with low tidal volumes appears to provide benefit in patients having noncardiac surgery; however, whether it is beneficial in patients having cardiac surgery is unclear.

METHODS: We retrospectively examined patients having elective cardiac surgery requiring cardiopulmonary bypass through a median sternotomy approach who received mechanical ventilation with a single lumen endotracheal tube from January

2010 to mid-August 2016. Time-weighted average tidal volume (milliliter per kilogram predicted body weight [PBW]) during the duration of surgery excluding cardiopulmonary bypass was analyzed. The association between tidal volumes and postoperative oxygenation (measured by arterial partial pressure of oxygen (PaO₂)/fraction of inspired oxygen ratio [PaO₂/FIO₂]), impaired oxygenation (PaO₂/FIO₂ <300), and clinical outcomes were examined.

RESULTS: Of 9359 cardiac surgical patients, larger tidal volumes were associated with slightly worse postoperative oxygenation. Postoperative PaO₂/FIO₂ decreased an estimated 1.05% per 1 mL/kg PBW increase in tidal volume (97.5% confidence interval [CI], -1.74 to -0.37; P_{Bon} = .0005). An increase in intraoperative tidal volumes was also associated with increased odds of impaired oxygenation (odds ratio [OR; 97.5% CI]: 1.08 [1.02-1.14] per 1 mL/kg PBW increase in tidal volume; P_{Bon} = .0029), slightly longer intubation time (5% per 1 mL/kg increase in tidal volume (hazard ratio [98.33% CI], 0.95 [0.93-0.98] per 1 mL/kg PBW; P_{Bon} < .0001), and increased mortality (OR [98.33% CI], 1.34 [1.06-1.70] per 1 mL/kg PBW increase in tidal volume; P_{Holm} = .0144). An increase in intraoperative tidal volumes was also associated with acute postoperative respiratory failure (OR [98.33% CI], 1.16 [1.03-1.32] per 1 mL/kg PBW increase in tidal volume; P_{Holm} = .0146), but not other pulmonary complications.

CONCLUSIONS: Lower time-weighted average intraoperative tidal volumes were associated with a very modest improvement in postoperative oxygenation in patients having cardiac surgery.

術前預防性使用萬古黴素在小兒神經外科和骨科患者的血漿和軟組織濃度

Preoperative Vancomycin Administration for Surgical Site Prophylaxis: Plasma and Soft-Tissue Concentrations in Pediatric Neurosurgical and Orthopedic Patients

Brooks Peterson, Melissa MD^{*}; Cohen, Mindy N. MD^{*}; O'Neill, Brent R. MD[†]; Garg, Sumeet MD[‡]; Child, Jason PharmD[§]; Henthorn, Thomas K. MD^{||}; Galinkin, Jeffrey G. MD^{*}

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背景：萬古黴素被用做兒科手術患者的預防性使用抗生素，但其在血漿和組織的藥代動力學尚不清楚。指南推薦在使用後 60 分鐘內劃皮；但組織中的萬古黴素濃度在早期可能尚未達到治療效果。我們開展了一個研究，檢測小兒神經外科和骨科患者的血漿及皮膚組織萬古黴素中的濃度，從而明確其在術中的藥代動力學。

方法：對 0.1~18.8 歲的脊柱後融合 (n=30) 或腦室-腹腔分流術 (n=30) 患者靜脈注射萬古黴素 15 mg/kg (最大 1000 mg) 1 小時以上。在切口和皮膚縫合處對皮膚進行活檢。在劃皮時、術中 2 小時和 4 小時以及縫合時採集血樣。人群藥代動力學分析用於估計藥代動力學參數，並建立術中血漿和皮膚萬古黴素濃度隨時間變化的模型。

結果：藥代動力學分析包括 59 名受試者、130 份血漿和 107 份皮膚樣本的資料。兩室模型，中央室體積 (vc) 和周邊室體積 (v2) 被證明是最合適的。逐步協變數選擇表明清除間隙和體表面積以及 V2 和體重有顯著相關性。手術期間皮膚萬古黴素濃度持續上升。模型預測皮膚和血漿萬古黴素濃度平衡需要 5 小時以上。

結論：與手術結束時的濃度相比，術前剛應用萬古黴素時的濃度相對較低。如果手術開始時需要更高的皮膚濃度，建議延長給藥和劃皮之間的時間。

(許芳霞譯 李金寶校)

BACKGROUND: Vancomycin is used for antibiotic prophylaxis in pediatric surgical patients without a complete understanding of plasma and soft-tissue pharmacokinetics. Guidelines recommend incision within 60 minutes after administration; however, tissue vancomycin concentrations at that early time may not be therapeutic. We conducted a study of plasma and skin concentrations in pediatric neurosurgical and orthopedic patients to characterize intraoperative vancomycin pharmacokinetics.

METHODS: Patients (0.1-18.8 years of age) undergoing posterior spinal fusion (n = 30) or ventriculoperitoneal shunt placement (n = 30) received intravenous vancomycin 15 mg/kg (maximum 1000 mg) over 1 hour. Skin was biopsied at incision and skin closure. Blood samples were collected at incision, at 2 and 4 hours intraoperatively, and at closure. Population pharmacokinetic analysis was performed to characterize pharmacokinetic parameter estimates and to develop a model of intraoperative plasma and skin vancomycin concentrations versus time.

RESULTS: Pharmacokinetic analysis included data from 59 subjects, 130 plasma samples, and 107 skin samples. A 2-compartment model, volume of the central (Vc) and volume of the peripheral compartment (V2), proved to have the best fit. Stepwise covariate selection yielded a significant relationship for body surface area on elimination clearance and body weight on V2. Skin vancomycin concentrations rose continuously during surgery. Modeling predicted that equilibration of skin and plasma vancomycin concentrations took ≥ 5 hours.

CONCLUSIONS: Skin vancomycin concentrations immediately after a preoperative dose are relatively low compared with concentrations at the end of surgery. It may be advisable to extend the time between dose and incision if higher skin concentrations are desired at the start of surgery.

一種結合 **Poincare** 分析的自動化演算法可以量化阿片類藥物引起共濟失調呼吸的嚴重程度

An Automated Algorithm Incorporating Poincaré Analysis Can Quantify the Severity of Opioid-Induced Ataxic Breath

Ermer, Sean C. BS^{*}; Farney, Robert J. MD[†]; Johnson, Ken B. MD, MS^{*}; Orr, Joseph A. PhD^{*}; Egan, Talmage D. MD^{*}; Brewer, Lara M. PhD^{*}

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背景：阿片類藥物引起的呼吸抑制（**OIRD**）傳統上是通過評估呼吸頻率、動脈血氧飽和度、呼氣末 **CO2** 和精神狀態來識別的。儘管人們普遍認為不規則或共濟失調的呼吸模式是阿片類藥物作用的表現，但尚無用於評估共濟失調呼吸嚴重程度的標準化方法。本研究旨在探討使用電腦學習演算法來量化阿片類藥物引起的共濟失調呼吸的嚴重程度。我們假設領域專家之間具有高度的一致性，電腦學習演算法與領域專家在評估共濟失調呼吸嚴重程度方面同樣具有很高的一致性。

方法：我們對 26 名健康志願者靶控輸注丙泊酚和瑞芬太尼，以模擬輕度睡眠和 **OIRD**。呼吸資料獲取自呼吸電感容積描記（**RIP**）帶和鼻內壓力感測器。三名領域專家根據視覺評分範本量化了共濟失調呼吸的嚴重程度。信度檢驗用於評估 3 名領域專家之間的一致性。利用多類支援向量機（**SVM**）訓練識別領域專家已標記的資料子集，然後分析剩餘資料量化共濟失調呼吸嚴重程度。採用卡方檢驗方法評估機器學習演算法與分組領域專家之間的一致性。卡方檢驗擴展了信度檢驗，在本例中，它分離了一個評分者，即機器學習演算法，並將其與一組評分者

進行了比較。兩項統計指標的接受標準均設定為 >0.8 。對 SVM 的識別訓練和測試主要使用 2 個感測器輸入的呼吸參數，即呼吸電感容積和鼻內壓力。

結果：3 名領域專家的卡方值為 0.93 (95% 置信區間[CI]=0.91-0.95)。與專家相比，RIP SVM 的卡方值為 0.98 (95% 置信區間[CI]=0.96-0.99)，鼻內壓力 SVM 卡方值為 0.96 (95% 置信區間=0.92-0.98)。

結論：我們得出結論，電腦學習演算法可以與領域專家小組一致的方式量化共濟失調呼吸嚴重程度。這種方法可能與傳統方法相結合，有助於識別 OIRD 患者。

(盧旭譯 潘豔、薛張綱校)

Background: Opioid-induced respiratory depression (OIRD) is traditionally recognized by assessment of respiratory rate, arterial oxygen saturation, end-tidal CO₂, and mental status. Although an irregular or ataxic breathing pattern is widely recognized as a manifestation of opioid effects, there is no standardized method for assessing ataxic breathing severity. The purpose of this study was to explore using a machine-learning algorithm for quantifying the severity of opioid-induced ataxic breathing. We hypothesized that domain experts would have high interrater agreement with each other and that a machine-learning algorithm would have high interrater agreement with the domain experts for ataxic breathing severity assessment.

Methods: We administered target-controlled infusions of propofol and remifentanyl to 26 healthy volunteers to simulate light sleep and OIRD. Respiration data were collected from respiratory inductance plethysmography (RIP) bands and an intranasal pressure transducer. Three domain experts quantified the severity of ataxic breathing in accordance with a visual scoring template. The Krippendorff alpha, which reports the extent of interrater agreement among N raters, was used to assess agreement among the 3 domain experts. A multiclass support vector machine (SVM) was trained on a subset of the domain expert-labeled data and then used to quantify ataxic breathing severity on the remaining data. The Vanbelle kappa was used to assess the interrater agreement of the machine-learning algorithm with the grouped domain experts. The Vanbelle kappa expands on the Krippendorff alpha by isolating a single rater-in this case, the machine-learning algorithm-and comparing it to a group of raters. Acceptance criteria for both statistical measures were set at >0.8 . The SVM was trained and tested using 2 sensor inputs for the breath marks: RIP and intranasal pressure.

Results: Krippendorff alpha was 0.93 (95% confidence interval [CI], 0.91-0.95) for the 3 domain experts. Vanbelle kappa was 0.98 (95% CI, 0.96-0.99) for the RIP SVM and 0.96 (0.92-0.98) for the intranasal pressure SVM compared to the domain experts.

Conclusions: We concluded it may be feasible for a machine-learning algorithm to quantify ataxic breathing severity in a manner consistent with a panel of domain experts. This methodology may be helpful in conjunction with traditional measures to identify patients experiencing OIRD.

圍手術期貧血：圍手術期護理的預防，診斷和管理

Perioperative Anemia: Prevention, Diagnosis, and Management Throughout the Spectrum of Perioperative Care

Warner, Matthew A. MD^{*,†}; Shore-Lesserson, Linda MD^{†,‡}; Shander, Aryeh MD^{†,§}; Patel, Sephalie Y. MD^{†,||}; Perelman, Seth I. MD^{†,¶}; Guinn, Nicole R. MD^{†,#}

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貧血在圍手術期很常見，並且與患者預後差有關。值得注意的是，貧血常常被忽略，直到血紅蛋白水準下降到有輸血指征的水準。不幸的是，這種簡單的基於輸血的方法已經轉移了臨床的關注點，不再關注通過直接控制潛在病因來充分預防、診斷和治療貧血的策略。儘管已經發表了有關擇期手術前糾正貧血的建議，但有關循證的貧血管理策略的設計和實施的資訊很少。此外，貧血不僅僅是術前要面對的問題。相反，必須在整個圍手術期護理中積極解決患者的貧血問題。本文提供有關整個圍手術期在外科手術患者中實施貧血管理策略的實用資訊。包括預防、診斷和治療貧血的循證醫學建議，也包括補鐵和補充促紅細胞生成素（ESA）的實用性。

(吳兆藝譯 潘豔、薛張綱校)

Anemia is common in the perioperative period and is associated with poor patient outcomes. Remarkably, anemia is frequently ignored until hemoglobin levels drop low enough to warrant a red blood cell transfusion. This simplified transfusion-based approach has unfortunately shifted clinical focus away from strategies to adequately prevent, diagnose, and treat anemia through direct management of the underlying cause(s). While recommendations have been published for the treatment of anemia before elective surgery, information regarding the design and implementation of evidence-based anemia management strategies is sparse. Moreover, anemia is not solely a concern of the preoperative encounter. Rather, anemia must be actively addressed throughout the perioperative spectrum of patient care. This article provides

practical information regarding the implementation of anemia management strategies in surgical patients throughout the perioperative period. This includes evidence-based recommendations for the prevention, diagnosis, and treatment of anemia, including the utility of iron supplementation and erythropoiesis-stimulating agents (ESAs).

吸入艾洛前列素對慢性阻塞性肺疾病合併肺氧合不良的患者單肺通氣期間肺力學和心肌功能的影響

Effects of Inhaled Iloprost on Lung Mechanics and Myocardial Function During One-Lung Ventilation in Chronic Obstructive Pulmonary Disease Patients Combined With Poor Lung Oxygenation

Kim, Namoo MD, PhD^{*}; Lee, Su Hyun MD[†]; Joe, Youngeun MD^{*}; Kim, Taelim MD^{*}; Shin, Heesoo MD^{*}; Oh, Young Jun MD, PhD^{*}

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背景：慢性阻塞性肺疾病（COPD）患者的通氣/灌注不匹配會加劇心臟功能以及肺氧合惡化。我們假設在慢性阻塞性肺病患者單肺通氣（OLV）期間吸入伊洛前列素可以改善肺功能和心肌功能，從而改善肺部氧合作用

方法：本研究共納入 40 例中度至重度 COPD 患者，在開始單肺通氣 OLV 30 分鐘後表現出動脈血氧分壓與吸入氧分數的比值（ $\text{PaO}_2 / \text{FIO}_2$ ） $<150 \text{ mm Hg}$ 。將患者隨機分為 ILO 組（ $n = 20$ ）或對照組（ $n = 20$ ），分別吸入伊洛前列素（ $20\mu\text{g}$ ）和生理鹽水。在開始 OLV 後 30 分鐘（Tx 前）和完成藥物吸入後 30 分鐘（Tx 後）評估 $\text{PaO}_2 / \text{FIO}_2$ 比，死腔，動態順應性和具有心肌性能指數（MPI）的組織多普勒成像。使用組間線性混合模型分析重複變數。

結果：在 Tx 前，兩組間的測量參數沒有差異。在 Tx 後，伊洛前列素組（ILO 組）的 $\text{PaO}_2 / \text{FIO}_2$ 比值（ $P < .001$ ）和動態順應性（ $P = .023$ ）顯著提高，死腔通氣（ $P = .001$ ）顯著降低，與對照組相比，ILO 組的左心室 MPI（ $P = .003$ ）和右心室 MPI（ $P < .001$ ）顯著降低。

結論：在肺氧合不良的 COPD 患者的 OLV 期間，吸入伊洛前列素可同時改善肺氧合，肺力學和心肌功能。

(王沛譯 潘豔、薛張綱校)

Background: The ventilation/perfusion mismatch in chronic obstructive pulmonary disease (COPD) patients can exacerbate cardiac function as well as pulmonary oxygenation. We hypothesized that inhaled iloprost can ameliorate pulmonary oxygenation with lung mechanics and myocardial function during one-lung ventilation (OLV) in COPD patients combined with poor lung oxygenation.

Methods: A total of 40 patients with moderate to severe COPD, who exhibited the ratio of partial pressure of arterial oxygen to the fraction of inspired oxygen (PaO₂/FIO₂) <150 mm Hg 30 minutes after initiating OLV, were enrolled in this study. Patients were randomly allocated into either ILO group (n = 20) or Control group (n = 20), in which iloprost (20 µg) and saline were inhaled, respectively. The PaO₂/FIO₂ ratio, dead space, dynamic compliance, and tissue Doppler imaging with myocardial performance index (MPI) were assessed 30 minutes after initiating OLV (pre-Tx) and 30 minutes after completion of drug inhalation (post-Tx). Repeated variables were analyzed using a linear mixed-model between the groups.

Results: At pre-Tx, no differences were observed in measured parameters between the groups. At post-Tx, PaO₂/FIO₂ ratio (P < .001) and dynamic compliance (P = .023) were significantly higher and dead space ventilation was significantly lower (P = .001) in iloprost group (ILO group) compared to Control group. Left (P = .003) and right ventricular MPIs (P < .001) significantly decreased in ILO group compared to Control group.

Conclusions: Inhaled iloprost improved pulmonary oxygenation, lung mechanics, and cardiac function simultaneously during OLV in COPD patients with poor lung oxygenation.

術中電子警報提高了對國家品質計畫措施中圍手術期溫度管理的依從性

Intraoperative Electronic Alerts Improve Compliance With National Quality Program Measure for Perioperative Temperature Management

Lakha, Sameer MD^{*}; Levin, Matthew A. MD^{*,†}; Leibowitz, Andrew B. MD^{*}; Lin, Hung-Mo DSc[‡]; Gal, Jonathan S. MD^{*}

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背景：麻醉服務的報銷已從按服務付費模式轉變為以價值為基礎的模式，該模式將支付與品質指標掛鉤。醫療保險和醫療補助服務中心（CMS）的基於價值的支付計畫包括圍手術期溫度管理的品質測量（措施 424，圍手術期溫度管理）。

該政策的實施可能會對臨床實踐、資料收集和報告中提出新的挑戰。因此我們調查了此新興標準中相關的電子決策支援工具所造成的影響。

方法：在這項回顧觀察性研究中，我們收集了能夠測量溫度並維持正常體溫的電子決策支援工具實施前後單個學術醫學中心的病例圍術期溫度資料，這些病例均符合向 CMS 上報的條件。本研究使用分段回歸分析評估了新措施依從性的比例，還評估了術中體溫測量的比例。並進行了多變數 logistic 回歸以評估患者和手術因素與測量依從性之間的關聯。

結果：評估了 2017 年符合條件的 24,755 例病例，並將 2016 年以後的 25,274 例也納入以擴展基線。分段時間序列回歸在度量依從性方面未顯示明顯的基線趨勢。引入電子警報與總體依從性從 84.4%（95% 置信區間[CI]，83.6%-85.2%）增加到 92.4%（91.4%-93.4%）相關，術中依從性從 26.8% 增加（25.8%-27.8%）至 71.0%（69.6%-72.4%）。警報與總體依從性之間的關聯也出現在多變數分析中。

結論：在符合向 CMS 報告的病例中，術中決策支持工具的實施與正常體溫維持的顯著改善相關。這可以提高措施 424 的依從性，也表明了電子警報可以說明醫務工作者提高其績效並且以此支付獎金。

（李瑋珊譯潘豔、薛張綱校）

BACKGROUND: Reimbursement for anesthesia services has been shifting from a fee-for-service model to a value-based model that ties payment to quality metrics. The Centers for Medicare & Medicaid Service's (CMS) value-based payment program includes a quality measure for perioperative temperature management (Measure #424, Perioperative Temperature Management). Compliance may impose new challenges in clinical practice, data collection, and reporting. We investigated the impact of an electronic decision-support tool on adherence to this emerging standard.

METHODS: In this retrospective observational study, perioperative temperature data were collected from cases eligible for reporting this measure to CMS from a single academic medical center before and after the implementation of an electronic

decision-support tool that prompted temperature measurement and maintenance of normothermia. Proportions of measure compliance were assessed using segmented regression analysis. Proportions of intraoperative temperature measurement were also assessed, and multivariable logistic regression was performed to assess the association between patient and surgical factors and measure compliance.

RESULTS: A total of 24,755 cases eligible for reporting in 2017 were assessed, and 25,274 cases from 2016 were included as an extended baseline. Segmented time-series regression did not show a significant baseline trend in measure compliance. Introduction of the alerts was associated with an increase in overall compliance from 84.4% (95% confidence interval [CI], 83.6%-85.2%) to 92.4% (91.4%-93.4%), and an increase in intraoperative compliance from 26.8% (25.8%-27.8%) to 71.0% (69.6%-72.4%). The association between the alerts and overall compliance was also present on multivariable analysis.

CONCLUSIONS: Implementation of an intraoperative decision-support tool was associated with statistically significant improvement in the maintenance of normothermia in cases eligible for reporting to CMS. This led to improved compliance with Measure #424 and suggests that electronic alerts can help practices improve their performance and payment bonus eligibility.

通過深度學習從睡眠腦節律預測深度催眠狀態:一種資料再利用的方法

Predicting Deep Hypnotic State From Sleep Brain Rhythms Using Deep Learning: A Data-Repurposing Approach

Sunil Belur Nagaraj, PhD, corresponding author* Sowmya M. Ramaswamy, Msc,†
Maud A. S. Weerink, MD,† and Michel M. R. F. Struys, MD, PhD, FRCA†‡
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背景:通過腦電圖(EEG)來追蹤定量大腦活動從而預測催眠水準的腦電監測器被認為是一種節省人力的方法。由於藥物存在特異性腦電圖模式，任何新開發的經過處理的腦電圖監測器都需要通過昂貴的臨床試驗來檢測每一種藥物和藥物組合的腦電圖反應，從而驗證其有效性和安全性。因此，我們需要一種可替代的、高效的、經濟的方法。

方法:利用深度學習法，我們開發了一種新的資料重組框架來預測睡眠腦節律的催眠水準。通過使用一個線上大型睡眠資料庫(由 5723 個臨床腦電圖組成)來訓練深度學習法和一個臨床試驗催眠資料庫(由 30 個腦電圖組成)來測試輸注右美

托咪定期間的睡眠水準。利用準確度和人工特性曲線下面積(AUC)對模型性能進行評估。

結果:使用右美托咪定為藥物模型，在睡眠水準上訓練的深度學習模型中，預測深度催眠水準的準確率(95% 置信區間 CI) = 81 (79.2-88.3)%，AUC (95% CI) = 0.89(0.82-0.94)。同時，我們還證明了右美托咪定誘導的深度催眠階段的腦電圖模式與非快動眼睡眠階段 3 的腦電圖睡眠是同源的。

結論:通過對大型睡眠腦電圖資料深入學習和再處理，我們提出了一種新的開發催眠水準監測器的方法，並通過優化這一系統，使得可以監測任何需要檢測的個人。我們提供了一個新的資料重組框架使用睡眠腦電圖預測催眠水準，從而無需開展新的臨床試驗用於開發睡眠水準監測器。

(石平 譯潘豔、薛張綱校)

BACKGROUND: Brain monitors tracking quantitative brain activities from electroencephalogram (EEG) to predict hypnotic levels have been proposed as a labor-saving alternative to behavioral assessments. Expensive clinical trials are required to validate any newly developed processed EEG monitor for every drug and combinations of drugs due to drug-specific EEG patterns. There is a need for an alternative, efficient, and economical method.

METHODS: Using deep learning algorithms, we developed a novel data-repurposing framework to predict hypnotic levels from sleep brain rhythms. We used an online large sleep data set (5723 clinical EEGs) for training the deep learning algorithm and a clinical trial hypnotic data set (30 EEGs) for testing during dexmedetomidine infusion. Model performance was evaluated using accuracy and the area under the receiver operator characteristic curve (AUC).

RESULTS: The deep learning model (a combination of a convolutional neural network and long short-term memory units) trained on sleep EEG predicted deep hypnotic level with an accuracy (95% confidence interval [CI]) = 81 (79.2–88.3)%, AUC (95% CI) = 0.89 (0.82–0.94) using dexmedetomidine as a prototype drug. We also demonstrate that EEG patterns during dexmedetomidine-induced deep hypnotic level are homologous to nonrapid eye movement stage 3 EEG sleep.

CONCLUSIONS: We propose a novel method to develop hypnotic level monitors using large sleep EEG data, deep learning, and a data-repurposing approach, and for optimizing such a system for monitoring any given individual. We provide a novel

data-repurposing framework to predict hypnosis levels using sleep EEG, eliminating the need for new clinical trials to develop hypnosis level monitors.

對於行心臟外科手術的患者，術中自體血回輸對凝血因數濃度的影響

.Impact of Intraoperative Cell Salvage on Blood Coagulation Factor Concentrations in Patients Undergoing Cardiac Surgery

Adam, Elisabeth H. MD^{*}; Funke, Moritz MD^{*}; Zacharowski, Kai MD, PhD, ML, FRCA^{*}; Meybohm, Patrick MD^{*}; Keller, Harald CCP[†]; Weber, Christian F. MD^{*,‡}
Anesthesia & Analgesia: 2020 130 1389-1395

背景：心胸外科手術常涉及大量失血和同種異體濃縮紅細胞的輸注。為了最大限度減少同種異體紅細胞的輸注，術中自體血回輸技術在臨床上已經被運用多年。這項研究的目的是評估自體血回輸對凝血因數的影響。

方法：我們在一家學術型醫院的一項前瞻性單中心觀察佇列研究中，招募了 30 位擇期行心臟手術的患者。從自體血回輸系統的儲存系統和處理過的紅細胞濃縮液中分別獲得了患者血液樣本。在患者血液經過自體血回輸系統處理之前和之後，我們分別評估了凝血因數、纖維蛋白原、抗凝血酶和 von Willebrand 因數生物活性以及濃度，並使用 Wilcoxon 配對符號秩檢驗進行統計分析。

結果：我們的結果顯示，與儲存系統中凝血因數的濃度/活性相比，處理過的紅細胞濃縮液中纖維蛋白原(P<.001)、凝血因數 II(P=.004)、凝血因數 VII、X、XIII(P<.001)和其他所有測量的凝血因數濃度/或活性均顯著降低。

結論：本研究的結果表明，自體血回輸系統洗滌處理使凝血因數濃度/活性顯著降低。因此，對於大量失血且有大量紅細胞輸注需要的患者，醫生需要考慮適當的凝血功能管理。

(王甲利譯 潘豔、薛張綱校)

BACKGROUND: Cardiothoracic surgery is associated with major blood loss and allogeneic transfusion of red blood cell concentrates. To minimize allogeneic red blood cell (RBC) transfusion, intraoperative cell salvage has been effectively used for

years. The objective of this study was to evaluate the impact of cell salvage on blood coagulation factors.

METHODS: We enrolled 30 patients scheduled for cardiac surgery in a prospective single-center observational cohort study at an academic hospital. Blood samples from the cell salvage system were obtained from both the reservoir and the processed red blood cell concentrate. Coagulation factors, fibrinogen, antithrombin and von Willebrand activity, and antigen were assessed before and after cell salvage. Statistical analysis was performed using Wilcoxon matched-pairs signed rank test.

RESULTS: Our results revealed a significant decrease of fibrinogen ($P < .001$), coagulation factors II ($P = .004$), factors VII, X, and XIII ($P < .001$), and all other measured coagulation factor concentrations/activities in the processed red blood cell concentrate, when compared to the concentrations/activities of the reservoir.

CONCLUSIONS: The results of the present study revealed a significant reduction of coagulation factor concentrations/activities by the washing process. Therefore, physicians need to consider adequate management of coagulation in patients with major blood loss and the need of large volumes of RBC transfusion.

POEM 手術患者的麻醉：文獻綜述

Anesthesia for Patients Undergoing Peroral Endoscopic Myotomy Procedures: A Review of the Literature

Löser, Benjamin MD^{*}; Recio Ariza, Olga[†]; Saugel, Bernd MD[†]; Reuter, Daniel A. MD^{*}; Zöllner, Christian MD[†]; Werner, Yuki B. MD[‡]; Rösch, Thomas MD[‡]; Petzoldt, Martin MD[†]

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特發性賁門失弛緩症是食管的一種運動障礙，對麻醉和圍手術期處理具有重要意義。隨著新的和更複雜的治療方式的發展，麻醉醫生越來越多地參與到這些患者的治療中。賁門失弛緩症的主要症狀如下：吞嚥困難，反流，胸痛和體重減輕。賁門失弛緩也與吸入風險增加有關。賁門失弛緩的病人經常通過內鏡下肉毒桿菌毒素注射，食管下括約肌的氣動擴張，腹腔鏡 Heller 肌切開術或經口內鏡肌切開術（POEM）來治療患者。POEM 手術基於“自然腔內腔鏡手術”的概念。由於在 POEM 手術中破壞了食道壁的完整性，可能會暴露出縱隔或腹膜腔。因此，吹入的二氧化碳經常引起高碳酸血症，張力性腹膜炎，縱隔氣腫或氣胸。一個多學科團隊，必須擅長病人情況的診斷和緊急處理，例如過度換氣，經皮腹部針減

壓或胸膜腔引流，因此成功進行 POEM 圍手術期管理至關重要。POEM 是一種需要全身麻醉的內窺鏡檢查手術。但是，目前尚無針對這些患者的麻醉專用管理或循證醫學推薦。由於全球各地的機構經驗差異很大，因此，本綜述基於 7 個回顧性病例，1 項前瞻性研究和我們的個人經驗，得出了麻醉建議和 POEM 手術的圍手術期管理策略。

（王碩譯 潘豔、薛張綱校）

Idiopathic achalasia is a motility disorder of the esophagus with important implications on anesthesia and perioperative management. As new and more complex treatment options develop, anesthesiologists are increasingly involved with these patients. The cardinal symptoms of achalasia are as follows: dysphagia, regurgitation, chest pain, and weight loss. Achalasia is also associated with an increased risk of aspiration. Patients are frequently treated by endoscopic botulinum toxin injections, pneumatic dilation of the lower esophageal sphincter, laparoscopic Heller myotomy, or peroral endoscopic myotomy (POEM). The POEM procedure is based on the concept of “natural orifice transluminal endoscopic surgery.” Because the integrity of the esophageal wall is deliberately interrupted during POEM, the mediastinum and the peritoneal cavity may be exposed. Thus, the insufflated carbon dioxide frequently causes hypercapnia, tension capnoperitoneum, capnomediastinum, or pneumothoraces. An interdisciplinary team, skilled in diagnostics and emergency measures such as therapeutic hyperventilation, percutaneous abdominal needle decompression, or pleural drainage, is essential for the successful perioperative management of POEM. POEM is one endoscopic procedure that requires general anesthesia. But neither anesthesia-specific care algorithms nor evidence-based recommendations are currently available for these patients. Because institutional experience varies broadly across the globe, this review examines anesthesia recommendations and perioperative management of POEM procedures based on 7 retrospective case series, 1 prospective study, and our personal experience.

全麻期間通過 3 種鎮痛監測指標指導使用阿片類藥物改變術中舒芬太尼用量及

應激激素釋放：一項隨機對照的初步研究

Guiding Opioid Administration by 3 Different Analgesia Nociception Monitoring Indices During General Anesthesia Alters Intraoperative Sufentanil Consumption and Stress Hormone Release: A Randomized Controlled Pilot Study

Funcke, Sandra MD*; Pinnschmidt, Hans O. PhD†; Wesseler, Stefan*; Brinkmann, Charlotte*; Beyer, Burkhard MD‡; Jazbutyte, Virginija PhD§; Behem, Christoph R. MD*; Trepte, Constantin MD*; Nitzschke, Rainer MD*

Author Information

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背景：該項初步研究探討了在全身麻醉過程中，3種不同的鎮痛監測裝置或臨床體征對舒芬太尼滴定的影響。

方法：將48例接受七氟醚/舒芬太尼麻醉行恥骨後前列腺癌根治術的患者隨機分為4組，分別在3種鎮痛監測裝置（手術指數（SPI）、瞳孔疼痛指數（PPI）、痛覺水準（NoL））中的1種或臨床判斷（對照組）的指導下使用舒芬太尼。主要終點是術中舒芬太尼的用量。在手術當天的4個時間點測定促腎上腺皮質激素（ACTH）和皮質醇（cortisol）。資料通過Kruskal-Wallis和Mann-Whitney U檢驗、混合模型和面積下曲線（AUC）進行分析和組間比較，並對應激激素的時間效應進行分析。

結果：舒芬太尼給藥總量($\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}\cdot 10^{-3}$)各組間的差異(中位數[四分位數]：對照組=5.6[4.4-6.4]，SPI=7.2[4.8-8.4]，PPI=2.0[1.8-2.9]，NoL=3.8[3.3-5.1]；PPI對SPI，-5.1[-6.6至-1.3]， $P < .001$ ；NoL對SPI，-3.0[-5.2至0.2]， $P = .024$ ；對照組對比SPI，-1.6[-3.7至1.7]， $P = .128$ ；NoL對比PPI，1.7[0.6-3.4]， $P < .001$ ；對照組對比PPI，3.4[2.0-4.6]， $P < .001$ ；對照組對比NoL，1.6[-0.2至3.3]， $P = .017$)(Hodges-Lehmann估計量[99%置信區間{CI}]，P值)。AUC分析顯示各組間NoL對PPI(-1.079[-1.950至-0.208]， $P = .001$)、PPI對SPI(1.192[0.317-2.068]， $P = .001$)和PPI對SPI(1.192[0.317-2.068]， $P = .001$)累積ACTH水準($\text{ng}\cdot\text{liter}^{-1}\cdot\text{min}$)存在差異，PPI對SPI(46,710[21,145-72,274]， $P < .001$)、NoL對SPI(27,645[3163-52,126]， $P = .003$)、以及對照組對SPI(31,824[6974-56,675]， P

= .001)的皮質醇水準 ($\mu\text{g}\cdot\text{l}^{-1}\cdot\text{min}$) 也存在差異。次要終點 (術後恢復、疼痛程度和鎮痛藥物) 無差異。

結論：鎮痛-痛覺監測的類型影響舒芬太尼的總用量。PPI 組較低的舒芬太尼劑量與內分泌應激反應增加有關。與對照組相比，SPI 滴定法不會引起阿片類藥物減少，但與內分泌應激反應降低有關。

(魏婉婷譯 潘豔、薛張綱校)

BACKGROUND: This pilot study investigated the effect of sufentanil titration by 3 different analgesia monitoring devices or clinical signs during general anesthesia.

METHODS: Forty-eight patients undergoing radical retropubic prostatectomy with sevoflurane/sufentanil anesthesia were randomly assigned into 4 groups and received sufentanil guided either by 1 of 3 analgesia monitoring devices (Surgical Pleth Index [SPI], Pupillary Pain Index [PPI], Nociception Level [NoL]) or by clinical judgment (control). The primary end point was intraoperative sufentanil consumption.

Adrenocorticotrophic hormone (ACTH) and cortisol were measured at 4 time points during the day of surgery. Data were analyzed by Kruskal–Wallis and Mann–Whitney *U* tests and by mixed model and area under the curve (AUC) analyses for group comparisons and time effects of stress hormones.

RESULTS: The total amount of sufentanil administration ($\mu\text{g}\cdot\text{kg}^{-1}\cdot\text{minute}^{-1}\cdot 10^{-3}$) differed between the groups (median [quartiles]: control = 5.6 [4.4–6.4], SPI = 7.2 [4.8–8.4], PPI = 2.0 [1.8–2.9], NoL = 3.8 [3.3–5.1]; PPI versus SPI, -5.1 [-6.6 to -1.3], $P < .001$; NoL versus SPI, -3.0 [-5.2 to 0.2], $P = .024$; control versus SPI, -1.6 [-3.7 to 1.7], $P = .128$; NoL versus PPI, 1.7 [0.6 – 3.4], $P < .001$; control versus PPI, 3.4 [2.0 – 4.6], $P < .001$; control versus NoL, 1.6 [-0.2 to 3.3], $P = .017$) (Hodges–Lehmann estimator [99% confidence interval {CI}], *P* values). The AUC analysis indicated differences among groups in cumulative ACTH levels (ng·liter⁻¹·minute, natural logarithm (ln)-transformed data) of NoL versus PPI (-1.079 [-1.950 to -0.208], $P = .001$) and PPI versus SPI (1.192 [0.317 – 2.068], $P = .001$), as well as differences in cortisol levels ($\mu\text{g}\cdot\text{liter}^{-1}\cdot\text{minute}$) for PPI versus SPI ($46,710$ [$21,145$ – $72,274$], $P < .001$), NoL versus SPI ($27,645$ [3163 – $52,126$], $P = .003$), and control versus SPI ($31,824$ [6974 – $56,675$], $P = .001$) (differences in means [99% CI], *P* value). Secondary end points (postoperative recovery, pain level, and analgesia medication) showed no differences.

CONCLUSIONS: The type of analgesia nociception monitoring affected the total amount of sufentanil administered. Lower sufentanil doses in the PPI group were associated with an increased endocrine stress response. Titration by SPI caused no opioid reduction compared to the control but was associated with a reduced endocrine stress response.

一項關於2020年麻醉自動化系統地位的敘述性綜述：在2020年的地位如何？

Autonomous Systems in Anesthesia: Where Do We Stand in 2020? A Narrative Review
Zaouter, Cédric MSc, MD*; Joosten, Alexandre MD, PhD†; Rinehart, Joseph MD‡; Struys, Michel M. R. F. MD, PhD, FRCA §, ||; Hemmerling, Thomas M. MSc, MD, DEAA¶
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眾所周知，幾乎社會每個方面，無論好壞，都變得越來越依賴技術的發展。技術的進步使自動化系統（也稱為機器人）成為包括醫學在內的多個領域中不可或缺部分。機器人在麻醉中的應用可分為三種類型。首先是藥理機器人。這些機器人基於閉環系統，可在全身麻醉和鎮靜期間進行更好的個性化麻醉藥輸注，以實現最佳體內穩態。最近證據表明，自動化系統可以很好地控制血流動力學參數，要優於手術室中的手動控制。第二種類型的機器人是機械的。它們使要求高手工靈巧度的任務變為自動化機械性複製成為可能。這種機器人比人類更準確，因此對患者來說更安全。第三類是認知機器人，也稱為決策支援系統。這種類型機器人能夠識別需要人工干預的關鍵臨床情況。當這些事件發生時，系統會通知主治醫生，描述相關的臨床觀察結果，提出相關的治療選擇，並且在主治醫生允許的情況下甚至可以進行治療。認知機器人也許可以提高患者的安全性。麻醉機器人不僅可以使主治醫生擺脫重複性工作，而且還可以減輕精神負擔，使他們能夠專注於需要人類智慧的任務，例如分析性和臨床性方法，搶救決策和與病人間互動。然而，還需要進行進一步的研究來測試這三種類型機器人的組合，以同時保持多種生物學變數的穩態，並在大規模人群中測試這種組合的安全性。

（周循 譯 陳傑 校）

As most of us are aware, almost every facet of our society is becoming, for better or worse, progressively more technology-dependent. Technological advancement has made autonomous systems, also known as robots, an integral part of our life in several fields, including medicine. The application of robots in anesthesia could be classified into 3 types of robots. The first ones are pharmacological robots. These robots are based on closed-loop systems that allow better-individualized anesthetic drug titration for optimal homeostasis during general anesthesia and sedation. Recent evidence also demonstrates that autonomous systems could control hemodynamic parameters proficiently outperforming manual control in the operating room. The second type of robot is mechanical. They enable automated motorized reproduction of tasks requiring high manual dexterity level. Such robots have been advocated to be more accurate than humans and, thus, could be safer for the patient. The third type is a cognitive robot also known as decision support system. This type of robot is able to recognize crucial clinical situation that requires human intervention. When these events occur, the system notifies the attending clinician, describes relevant related clinical observations, proposes pertinent therapeutic options and, when allowed by the attending clinician, may even administer treatment. It seems that cognitive robots could increase patients' safety. Robots in anesthesia offer not only the possibility to free the attending clinicians from repetitive tasks but can also reduce mental workload allowing them to focus on tasks that require human intelligence such as analytical and clinical approach, lifesaving decision-making capacity, and interpersonal interaction. Nevertheless, further studies have yet to be done to test the combination of these 3 types of robots to maintain simultaneously

the homeostasis of multiple biological variables and to test the safety of such combination on a large-scale population.

2. 簡易血流動力學資料足以發現出血

Parsimony of Hemodynamic Monitoring Data Sufficient for the Detection of Hemorrhage

Pinsky, Michael R. MD*; Wertz, Anthony MS†; Clermont, Gilles MD*; Dubrawski, Artur PhD†

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背景：個體化的血流動力學監測方法尚未得到充分驗證。因此作者在豬手術模型中評估了從無創監測（NIM）轉向有創監測時，由於可以連續監測並且有可以參考的穩定基線而可能得到辨別出血能力的改善。

方法：將38只約克夏豬麻醉後30min開始以20 mL / min的速度放血直至平均動脈壓降至30 mm Hg，收集期間的NIM，中心靜脈（CVC），動脈（ART）和肺動脈（PAC）導管，混合靜脈血氧飽和度和心輸出量資料的生理波形（WF）資料（250 Hz）。放血前生理資料為每個受試者單獨定義了個人穩定基線。套入模型使用平均超過20秒視窗的簡單血流動力學指標（SM）進行評估，每分鐘採樣一次，使用隨機森林分類模型點對點和對波形進行分析來識別出血，無論個體基線是否穩定，並使用交叉驗證來使模型過度擬合減小到最低。調整模型參數以檢測穩定狀態或出血狀態。比較每個樣本的基線和該組平均值。通過比較低假陽性率（FPR）和最短出血時間，評估出血檢測的及時性。使用受試者工作特徵的一種變體來評估預測性能，該變體分別針對真陽性率和真陰性率，側重於最小化FPR和假陰性率（FNR）。

結果：與使用通用基線資料相比，將模型引用到個體化基線可以提高所有監測導管的出血檢測性能。從SM到B2B和WF的細微性增加逐漸提高了出血檢測能力。在出血檢測時間、低FPR和FNR方面，有創監測均優於NIM。在這方面，當參考SM分析的個體化基線時，PAC和ART+PAC表現最好；對於B2B CVC，PAC和ART+PAC表現最好；而對於WF PAC，CVC、ART+CVC和ART+PAC表現同樣好於其他監測方法。在沒有個體化基線的情況下，NIM在各層面表現都很差，而所有監測導管在SM方面的表現都相似，B2B-PAC和ART+PAC表現最好，而在WF-PAC方面，ART、ART+CVC和ART+PAC表現同樣好於其他監測方法。

結論：通過增加採樣頻率和參考個體化基線，提高血流動力學監測的特異性，可顯著提高有創監測的出血檢測能力。

（周循 譯 陳傑 校）

Background: Individualized hemodynamic monitoring approaches are not well validated. Thus, we evaluated the discriminative performance improvement that might occur when moving from noninvasive monitoring (NIM) to invasive monitoring and with increasing levels of featurization associated with increasing sampling frequency and referencing to a stable baseline to identify bleeding during surgery in a porcine model.

Methods: We collected physiologic waveform (WF) data (250 Hz) from NIM, central venous (CVC), arterial (ART), and pulmonary arterial (PAC) catheters, plus mixed venous O₂ saturation and cardiac output from 38 anesthetized Yorkshire pigs bled at 20 mL/min until a mean arterial pressure of 30 mm Hg following a 30-minute baseline period. Prebleed physiologic data defined a personal stable baseline for each subject independently. Nested models were evaluated using simple hemodynamic

metrics (SM) averaged over 20-second windows and sampled every minute, beat to beat (B2B), and WF using Random Forest Classification models to identify bleeding with or without normalization to personal stable baseline, using a leave-one-pig-out cross-validation to minimize model overfitting. Model hyperparameters were tuned to detect stable or bleeding states. Bleeding models were compared use both each subject's personal baseline and a grouped-average (universal) baseline. Timeliness of bleed onset detection was evaluated by comparing the tradeoff between a low false-positive rate (FPR) and shortest time to bleed detection. Predictive performance was evaluated using a variant of the receiver operating characteristic focusing on minimizing FPR and false-negative rates (FNR) for true-positive and true-negative rates, respectively.

Results: In general, referencing models to a personal baseline resulted in better bleed detection performance for all catheters than using universal baselined data. Increasing granularity from SM to B2B and WF progressively improved bleeding detection. All invasive monitoring outperformed NIM for both time to bleeding detection and low FPR and FNR. In that regard, when referenced to personal baseline with SM analysis, PAC and ART + PAC performed best; for B2B CVC, PAC and ART + PAC performed best; and for WF PAC, CVC, ART + CVC, and ART + PAC performed equally well and better than other monitoring approaches. Without personal baseline, NIM performed poorly at all levels, while all catheters performed similarly for SM, with B2B PAC and ART + PAC performing the best, and for WF PAC, ART, ART + CVC, and ART + PAC performed equally well and better than the other monitoring approaches.

Conclusions: Increasing hemodynamic monitoring featurization by increasing sampling frequency and referencing to personal baseline markedly improves the ability of invasive monitoring to detect bleed.

使用圍術期資料早期檢測非心臟手術患者射血分數降低的心衰：一種機器學習方法

Early Detection of Heart Failure With Reduced Ejection Fraction Using Perioperative Data Among Noncardiac Surgical Patients: A Machine-Learning Approach

Mathis, Michael R. MD*, †, ‡; Engoren, Milo C. MD*; Joo, Hyeon MS, MHI*; Maile, Michael D. MD, MS*; Aaronson, Keith D. MD, MS §; Burns, Michael L. MD, PhD*, †; Sjoding, Michael W. MD, MSc†, ‡, ||; Douville, Nicholas J. MD, PhD*; Janda, Allison M. MD*; Hu, Yaokun MS*; Najarian, Kayvan PhD†, ‡; Kheterpal, Sachin MD, MBA*, †

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背景：射血分數降低的心力衰竭（HFrEF）造成嚴重的醫療負擔。鑒於其症狀性質和常常隱匿起病，只有在臨床表現提示進一步評估後才能作出診斷。早期檢測 HFrEF 可以進行早期干預以改變疾病進展。圍術期收集的精細資料可能是提高 HFrEF 診斷率的一種未充分利用的方法。作者假設術後最終診斷為 HFrEF 的患者可以通過術前和術中資料的機器學習方法進行識別。

方法：回顧了 2010 年至 2016 年間在學院第四監護中心接受全麻下大型外科手術成人患者的圍術期資料。排除已知 HFrEF、射血分數保留的心衰、術前危重症或接受心臟、心臟病或電生理檢查的患者。患者分為健康對照組和未診斷 HFrEF 組。未診斷 HFrEF 定義為術前缺乏 HFrEF 診斷，但術後 730 天內確診。未診斷 HFrEF 的診斷由臨床專家回顧判定，排除繼發於

圍術期突發事件的 HFrEF 或與 HFrEF 自然疾病進展無關的任何事件的病例。利用 628 例術前和 1195 例術中的圍術期資料，建立了包括 L1 正則 logistic 回歸、隨機森林模型和極端梯度增強的機器學習模型來檢測未診斷的 HFrEF。訓練/驗證和測試資料集用於參數調整。使用受試者工作特徵曲線 (AUROC) 下面積、陽性預測值和其他標準度量來評估測試集模型性能。

結果：分析 67697 例病例，279 例 (0.41%) 患者有未診斷 HFrEF。logistic 回歸模型、隨機森林模型、極端梯度增強模型的 AUROC 分別為 0.869 (95% 置信區間, 0.829–0.911), 0.872 (0.836–0.909) 以及 0.873 (0.833–0.913)。相應的陽性預測值分別為 1.69% (1.06%–2.32%), 1.42% (0.85%–1.98%), 和 1.78% (1.15%–2.40%)。

結論：利用圍術期資料的機器學習模型可以很好地檢測出未診斷 HFrEF。然而，該病的低患病率導致低陽性預測值，並且為了使臨床意義上的敏感性閾值具有可操作性，在模型檢測後需高特異性試驗（如超聲心動圖或心臟生物標記物）進行驗證。未來的研究需要在其他中心外部驗證演算法性能，並探索將演算法嵌入圍術期電子健康記錄中以供臨床醫生即時使用的可行性。

(周循 譯 陳傑 校)

Background: Heart failure with reduced ejection fraction (HFrEF) is a condition imposing significant health care burden. Given its syndromic nature and often insidious onset, the diagnosis may not be made until clinical manifestations prompt further evaluation. Detecting HFrEF in precursor stages could allow for early initiation of treatments to modify disease progression. Granular data collected during the perioperative period may represent an underutilized method for improving the diagnosis of HFrEF. We hypothesized that patients ultimately diagnosed with HFrEF following surgery can be identified via machine-learning approaches using pre- and intraoperative data.

Methods: Perioperative data were reviewed from adult patients undergoing general anesthesia for major surgical procedures at an academic quaternary care center between 2010 and 2016. Patients with known HFrEF, heart failure with preserved ejection fraction, preoperative critical illness, or undergoing cardiac, cardiology, or electrophysiologic procedures were excluded. Patients were classified as healthy controls or undiagnosed HFrEF. Undiagnosed HFrEF was defined as lacking a HFrEF diagnosis preoperatively but establishing a diagnosis within 730 days postoperatively. Undiagnosed HFrEF patients were adjudicated by expert clinician review, excluding cases for which HFrEF was secondary to a perioperative triggering event, or any event not associated with HFrEF natural disease progression. Machine-learning models, including L1 regularized logistic regression, random forest, and extreme gradient boosting were developed to detect undiagnosed HFrEF, using perioperative data including 628 preoperative and 1195 intraoperative features. Training/validation and test datasets were used with parameter tuning. Test set model performance was evaluated using area under the receiver operating characteristic curve (AUROC), positive predictive value, and other standard metrics.

Results: Among 67,697 cases analyzed, 279 (0.41%) patients had undiagnosed HFrEF. The AUROC for the logistic regression model was 0.869 (95% confidence interval, 0.829–0.911), 0.872 (0.836–0.909) for the random forest model, and 0.873

(0.833–0.913) for the extreme gradient boosting model. The corresponding positive predictive values were 1.69% (1.06%–2.32%), 1.42% (0.85%–1.98%), and 1.78% (1.15%–2.40%), respectively.

Conclusions: Machine-learning models leveraging perioperative data can detect undiagnosed HFrEF with good performance. However, the low prevalence of the disease results in a low positive predictive value, and for clinically meaningful sensitivity thresholds to be actionable, confirmatory testing with high specificity (eg, echocardiography or cardiac biomarkers) would be required following model detection. Future studies are necessary to externally validate algorithm performance at additional centers and explore the feasibility of embedding algorithms into the perioperative electronic health record for clinician use in real time.

自動脈氧飽和度波形分析追蹤麻醉誘導期間血壓變化：一項概念驗證研究

Automated Pulse Oximeter Waveform Analysis to Track Changes in Blood Pressure During Anesthesia Induction: A Proof-of-Concept Study

Ghamri, Yassine MSc*; Proença, Martin PhD†; Hofmann, Gregory MSc*; Renevey, Philippe PhD†; Bonnier, Guillaume PhD†; Braun, Fabian PhD†; Axis, Alexandre MD*; Lemay, Mathieu PhD†; Schoettker, Patrick MD*

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背景：術中低血壓與術後併發症和死亡有關。示波肱動脈袖帶用於測量大多數外科病人的動脈壓（AP），但可能會錯過AP的急性變化。作者假設脈氧飽和度波形分析有助於監測麻醉誘導期間收縮壓（SAP）和平均動脈壓（MAP）的變化。

方法：在40名需要全身麻醉和有創性AP監測的擇期手術患者中評估脈氧飽和度波形分析演算法（光學血壓監測[oBPM]）的性能，以評估SAP、MAP及其在全身麻醉誘導期間的變化。採用四象限圖和極座標圖比較有創監測（對照）和oBPM評估的SAP和MAP的急性AP變化（>20%）。演算法的追蹤能力是根據在不斷增加的時間跨度（從30秒到5分鐘）內發生的變化來評估的。研究次要目的是評估oBPM演算法是否符合醫療器械進步協會（AAMI）制定標準。在演算法校準後的不同時刻，從30秒到5分鐘，評估oBPM估計絕對SAP和MAP值的準確性和精確度。

結果：由oBPM評估的SAP和MAP的快速變化（發生在≤60秒的時間跨度內）與有創監測AP的變化有很好的相關性（最壞情況下Pearson相關為0.94 [0.88, 0.97] [95%可信區間]，且一致率為100% [100%, 100%]，角一致率為±30°的100% [100%, 100%]）。趨勢預測能力隨著變化發生時間跨度的延長而逐漸下降，最壞情況下Pearson相關為0.89 (0.85, 0.91)，一致率為97% (95%, 100%) 角度一致率為90% (85%, 94%)。關於準確度和精確度，oBPM衍生SAP值在校準後2分鐘內符合AAMI標準，而oBPM衍生MAP值在任何時候都符合標準。

結論：脈氧飽和度波形分析有助於追蹤麻醉誘導期間SAP和MAP的快速變化。在初始校準後至少5分鐘內，觀察到該方法衍生MAP與對照的有創監測的良好一致性。將來該方法可用於追蹤間歇示波測量之間AP的變化，並在檢測到AP的顯著變化時自動觸發臂袖充氣。

（周循 譯 陳傑 校）

Background: Intraoperative hypotension is associated with postoperative complications and death. Oscillometric brachial cuffs are used to measure arterial pressure (AP) in most surgical patients but may miss acute changes in AP. We

hypothesized that pulse oximeter waveform analysis may help to detect changes in systolic AP (SAP) and mean AP (MAP) during anesthesia induction.

Methods: In 40 patients scheduled for an elective surgery necessitating general anesthesia and invasive AP monitoring, we assessed the performance of a pulse oximeter waveform analysis algorithm (optical blood pressure monitoring [oBPM]) to estimate SAP, MAP, and their changes during the induction of general anesthesia. Acute AP changes (>20%) in SAP and MAP assessed by the reference invasive method and by oBPM were compared using 4-quadrant and polar plots. The tracking ability of the algorithm was evaluated on changes occurring over increasingly larger time spans, from 30 seconds up to 5 minutes. The second objective of the study was to assess the ability of the oBPM algorithm to cope with the Association for the Advancement of Medical Instrumentation (AAMI) standards. The accuracy and precision of oBPM in estimating absolute SAP and MAP values compared to the invasive method was evaluated at various instants after algorithm calibration, from 30 seconds to 5 minutes.

Results: Rapid changes (occurring over time spans of ≤ 60 seconds) in SAP and MAP assessed by oBPM were strongly correlated and showed excellent concordance with changes in invasive AP (worst-case Pearson correlation of 0.94 [0.88, 0.97] [95% confidence interval], concordance rate of 100% [100%, 100%], and angular concordance rate at $\pm 30^\circ$ of 100% [100%, 100%]). The trending ability tended to decrease progressively as the time span over which the changes occurred increased, reaching 0.89 (0.85, 0.91) (Pearson correlation), 97% (95%, 100%) (concordance rate), and 90% (85%, 94%) (angular concordance rate) in the worst case. Regarding accuracy and precision, oBPM-derived SAP values were shown to comply with AAMI criteria up to 2 minutes after calibration, whereas oBPM-derived MAP values were shown to comply with criteria at all times.

Conclusions: Pulse oximeter waveform analysis was useful to track rapid changes in SAP and MAP during anesthesia induction. A good agreement with reference invasive measurements was observed for MAP up to at least 5 minutes after initial calibration. In the future, this method could be used to track changes in AP between intermittent oscillometric measurements and to automatically trigger brachial cuff inflation when a significant change in AP is detected.

鎖骨上路臂叢阻滯與肌間溝路臂叢阻滯對肩關節手術後急性鎮痛效果的比較:一項系統評價和薈萃分析

Is Supraclavicular Block as Good as Interscalene Block for Acute Pain Control Following Shoulder Surgery? A Systematic Review and Meta-analysis

Aronson, Hussain, Nasir MD, MSc*; Costache, Ioana MD†; Kumar, Nicolas BSc*,‡; Essandoh, Michael MD, FASE*; Weaver, Tristan MD*; Wong, Patrick MD†; Tierney, Sarah MD†; Rose, Peter MD†; McCartney, Colin J. L. MBChB, PhD, FRCA, FRCPC†; Abdallah, Faraj W. MD, MSc†, §

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背景：肌間溝路臂叢阻滯（ISB）是肩部手術後急性疼痛管理的首選技術，但其呼吸相關的副作用促使人們尋求替代方法。鎖骨上路臂叢阻滯（SCB）被建議作為 ISB 的替代方案，但兩者鎮痛效果和呼吸保護作用比較的證據卻並不一致。作者比較了 SCB 和 ISB 對肩部手術的鎮痛作用和呼吸影響的差異。

方法：納入物件為肩部手術中對 ISB 和 SCB 進行比較的試驗。SCB 作為可替代方案的前提為其在（1）術後 24 小時口服嗎啡累積消耗當量（主要結局，非劣效性界值 $\Delta = -25$ mg）和（2）術後疼痛（次要結局，非劣效性界值 $\Delta = 4.0$ cm \cdot 小時 $^{-1}$ ）方面非劣於 ISB；並在（3）阻滯後呼吸功能障礙（主要結局）方面優於 ISB。同樣對阿片類藥物相關副作用和阻滯相關併發症也進行評估。

結果：分析了 15 項研究（共 1065 例患者）。對於單次阻滯，SCB 分別在 24 小時嗎啡消耗量、24 小時疼痛評分方面，非劣於 ISB 【(SCB-ISB 的均值差，MD [95% 置信區間 {CI}] = -3.11 mg [-9.42 至 3.19]， $\Delta = -25$ 毫克)；(MD = 0.78 cm \cdot hour $^{-1}$ [0.07-1.49]， $\Delta = 4.0$ cm \cdot hour $^{-1}$)】；並在呼吸功能障礙發生率方面優於 ISB（優勢比 [OR] [95% CI] = 0.08 [0.01-0.68]）。類似地，對於連續阻滯，SCB 在 24 小時嗎啡消耗量方面非劣於 ISB (MD = 0.46 mg [-6.08 至 5.15]， $\Delta = -25$ mg)，在呼吸功能障礙發生率方面優於 ISB (OR = 0.22 [0.08 - 0.57])。SCB 在輕度阻滯相關不良事件發生率方面優於 ISB（單次阻滯和連續阻滯分別為 OR = 0.36 [0.20-0.68] 和 OR = 0.25 [0.15-0.41]）。因此，拒絕零假設，SCB 被認為是 ISB 的可接受替代方案。

結論：對於肩部手術後的急性疼痛管理，高品質的證據表明，SCB 可以作為 ISB 的有效替代方案。SCB 在術後阿片類藥物的消耗和急性疼痛管理方面非劣於 ISB，且在術後呼吸功能障礙發生率方面優於 ISB。

（陳陳 譯 陳傑 校）

BACKGROUND: Interscalene block (ISB) is the acute pain management technique of choice for shoulder surgery, but its undesirable respiratory side effects have prompted seeking alternatives. Supraclavicular block (SCB) is proposed as an ISB alternative, but evidence of comparative analgesic and respiratory-sparing effects is inconsistent. We compared the analgesic and respiratory effects of SCB and ISB for shoulder surgery.

METHODS: Trials comparing ISB to SCB for shoulder surgery were sought. We decided a priori that SCB would be an acceptable alternative if it were noninferior for (1) postoperative 24-hour cumulative oral morphine equivalent consumption (primary outcome, noninferiority margin $\Delta = -25$ mg) and (2) postoperative pain (secondary outcome, noninferiority margin $\Delta = 4.0$ cm \cdot hour $^{-1}$); and superior for (3) postblock respiratory dysfunction (primary outcome). Opioid-related side effects and block-related complications were also evaluated.

RESULTS: Fifteen studies (1065 patients) were analyzed. In single-injection blocks, SCB was noninferior to ISB for 24-hour morphine consumption (mean difference for SCB-ISB, MD [95% confidence interval {CI}] = -3.11 mg [-9.42 to 3.19], $\Delta = -25$ mg); it was also noninferior for 24-hour pain scores (MD = 0.78 cm \cdot hour $^{-1}$ [0.07 - 1.49], $\Delta = 4.0$ cm \cdot hour $^{-1}$); and decreased the odds of respiratory dysfunction (odds ratio [OR] [95% CI] = 0.08 [0.01 - 0.68]). Similarly, in continuous blocks, SCB was noninferior to ISB for 24-hour morphine consumption (MD = 0.46 mg [-6.08 to 5.15], $\Delta = -25$ mg), and decreased the odds of respiratory dysfunction (OR = 0.22 [0.08 - 0.57]). SCB also decreased odds of minor block-related complications (OR = 0.36

[0.20 - 0.68] and OR = 0.25 [0.15 - 0.41] for single-injection and continuous blocks, respectively). Consequently, the null joint-hypothesis was rejected, and SCB can be considered an acceptable alternative to ISB.

CONCLUSIONS: For acute pain control following shoulder surgery, high-quality evidence indicates that SCB can be used as an effective ISB alternative. SCB is noninferior for postoperative opioid consumption and acute pain, and it reduces the odds of postblock respiratory dysfunction.

產科病房中的認知輔助：設計，實施與使用

Cognitive Aids in Obstetric Units: Design, Implementation, and Use

Abir, Gillian MBChB, FRCA*; Austin, Naola MD*; Seligman, Katherine M. MD†; Burian, Barbara K. PhD‡; Goldhaber-Fiebert, Sara N. MD*

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產科對於 2 位元以上患者的高風險和動態臨床監護具有獨特考慮。產科危機情況需要整個多學科團隊的有效而協調的回應。團隊執行或忽略的操作會嚴重影響圍產期和圍生期結局。認知輔助是旨在提高患者安全性，醫療保健管理效率和患者預後的工具。但是它們應與臨床判斷和培訓相結合，而非作為患者管理的絕對或詳盡的監護標準。基於類比證據顯示，當結合本地定制和執行工作時，隨著越來越多的文獻支援在產科和非產科臨床環境中的使用，尤其是存在讀者角色，危機期間認知輔助工具可以增強團隊管理能力。本文目的是總結當前對認知輔助設計、實施和在產科中使用的理解和可用資源，並強調現有的差距以促進該領域相關工作的加強。

(陳陳 譯 陳傑 校)

Obstetrics has unique considerations for high stakes and dynamic clinical care of ≥ 2 patients. Obstetric crisis situations require efficient and coordinated responses from the entire multidisciplinary team. Actions that teams perform, or omit, can strongly impact peripartum and perinatal outcomes. Cognitive aids are tools that aim to improve patient safety, efficiency in health care management, and patient outcomes.

However, they are intended to be combined with clinician judgment and training, not as absolute or exhaustive standards of care for patient management. There is simulation-based evidence showing efficacy of cognitive aids for enhancing appropriate team management during crises, especially with a reader role, with growing literature supporting use in obstetric and nonobstetric clinical settings when combined with local customization and implementation efforts. The purpose of this article is to summarize current understanding and available resources for cognitive aid design, implementation, and use in obstetrics and to highlight existing gaps that can stimulate further enhancement in this field.

非體外迴圈冠狀動脈搭橋術後體溫與全因死亡率之間的關係：一項回顧性觀察性研究

Association Between Postoperative Body Temperature and All-Cause Mortality After Off-Pump Coronary Artery Bypass Graft Surgery: A Retrospective Observational Study

Nam, Karam MD*; Jo, Woo Young MD*; Kwon, Seok Min MD*, †; Kang, Pyoyoon MD*, †; Cho, Youn Joung MD*; Jeon, Yunseok MD, PhD*; Kim, Tae Kyong MD, PhD*

背景:非體外迴圈冠狀動脈搭橋術(OPCAB)中常會發生意外的圍術期低體溫。作者調查 OPCAB 患者術後早期體溫與全因死亡率之間的關係。

方法:作者回顧了 1714 例接受 OPCAB 患者的電子病歷(中位元隨訪時間為 47 個月)。根據術後進入重症監護室時的體溫將患者分為 4 組(中度至重度低體溫, <35.5° C; 輕度低體溫, 35.5° C - 36.5° C; 正常體溫, 36.5° C - 37.5° C; 體溫過高, ≥37.5° C)。使用 Cox 比例風險模型評估體溫與全因死亡率之間的關係。還根據術後進入重症監護病房時測量體溫和術後前 3 天的平均體溫將患者分為 4 類, 評估術後早期體溫變化與全因死亡率之間的關係。

結果:與正常體溫組相比, 中度至重度低體溫組、輕度低體溫組的全因死亡率校正危險比分別為 2.030 (95% 置信區間為 1.407-2.930), 1.445 (95% 置信區間為 1.113-1.874)。在術後進入重症監護室時低體溫人群中, 與未恢復正常體溫患者相比, 之後恢復正常體溫患者的全因死亡率更低(校正危險比, 0.631; 95% 置信區間, 0.453 - 0.878), 但其全因死亡率仍然比那些始終體溫正常的人更高(校正危險比 1.435; 95% 置信區間 1.090-1.890)。

結論:即使輕度術後低體溫也與 OPCAB 術後的全因死亡率相關。與未恢復正常體溫的患者相比, 術後恢復正常體溫的患者全因死亡率更低。

(陳陳 譯 陳傑 校)

BACKGROUND: Inadvertent perioperative hypothermia is common in patients undergoing off-pump coronary artery bypass grafting (OPCAB). We investigated the association between early postoperative body temperature and all-cause mortality in patients undergoing OPCAB.

METHODS: We reviewed the electronic medical records of 1714 patients who underwent OPCAB (median duration of follow-up, 47 months). Patients were divided into 4 groups based on body temperature at the time of intensive care unit admission after surgery (moderate-to-severe hypothermia, <35.5° C; mild hypothermia, 35.5° C - 36.5° C; normothermia, 36.5° C - 37.5° C; and hyperthermia, ≥37.5° C). Cox proportional hazards models were used to assess the association between body temperature and all-cause mortality. The association between early postoperative changes in body temperature and all-cause mortality was also assessed by dividing the patients into 4 categories according to the body temperature measured at postoperative intensive care unit admission and the average body temperature during the first 3 postoperative days.

RESULTS: Compared to the normothermia group, the adjusted hazard ratios of all-cause mortality were 2.030 (95% confidence interval, 1.407 - 2.930) in the moderate-to-severe hypothermia group and 1.445 (95% confidence interval, 1.113 - 1.874) in the mild hypothermia group. Patients who were hypothermic at postoperative intensive care unit admission but attained normothermia thereafter were at a lower risk of all-cause mortality compared to patients who did not regain normothermia (adjusted hazard ratio, 0.631; 95% confidence interval, 0.453 - 0.878), while they were still at a higher risk of all-cause mortality than those who were consistently normothermic (adjusted hazard ratio, 1.435; 95% confidence interval, 1.090 - 1.890).

CONCLUSIONS: Even mild early postoperative hypothermia was associated with all-cause mortality after OPCAB. Patients who regained normothermia postoperatively were at lower risk of all-cause mortality compared to those who did not.

8. BOSTN 束相關干預對可疑阻塞性睡眠呼吸暫停患者的術前篩查和管理：一項醫院註冊研究

BOSTN Bundle Intervention for Perioperative Screening and Management of Patients With Suspected Obstructive Sleep Apnea: A Hospital Registry Study

Raub, Dana Cand Med*; Santer, Peter MD*; Nabel, Sarah MS*; Platzbecker, Katharina MD*; Munoz-Acuna, Ronny MD*; Xu, Xinling PhD*; Friedrich, Sabine Cand Med*; Ramachandran, Satya Krishna MD*; Eikermann, Matthias MD, PhD*, †; Sundar, Eswar MD*
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背景：研究者制定並實施了一項圍術期阻塞性睡眠呼吸暫停（OSA）指南，其中包括一項術前篩查工具（BOSTN）和臨床管理路徑。疑似 OSA 具有以下兩種或兩種以上症狀：體重指數 $\geq 30 \text{ kg / m}^2$ ，觀察到呼吸暫停，大聲打鼾，白天疲倦，女性頸圍 ≥ 16.5 英寸，男性 ≥ 17.5 英寸。這項研究主要目的是評估 BOSTN 高評分與術後有創機械通氣需求之間的關係。

方法：在這項醫院註冊的研究中，分析了 2008 年 5 月至 2017 年 9 月在麻塞諸塞州波士頓的貝斯以色列女執事醫療中心（BIDMC）進行的 169,662 例非心臟手術病例。通過使用對患者相關因素和病例相關手術和麻醉學混雜因素校正後的多變數邏輯回歸，評估高 BOSTN 評分（得分 ≥ 2 ）與 7 天內有創機械通氣需求的主要結局之間的相關性。BOSTN 評分 ≥ 2 的患者被認為患有 OSA 的可能性很高。關鍵的次要結局是術後低氧，定義為拔管後 10 分鐘內外周血氧飽和度測量值 $< 90\%$ 。

結果：3170 例（2.3%）低危病例（BOSTN 評分 < 2 ）和 664 例（2.1%）高危病例（BOSTN 評分 ≥ 2 ）需要在術後 7 天內進行有創機械通氣。得分 ≥ 2 與更低的術後有創通氣概率相關（校正後比值比 [aOR] 為 0.89；95% 置信區間 [CI] 為 0.80-0.98； $P = .017$ ），拔管後低氧的風險更高（aOR, 1.34；99.3% CI, 1.21-1.48； $P < .001$ ）。得分 ≥ 2 的患者術後平均住院時間為 3.71 天，而得分 < 2 的患者平均住院時間為 4.27 天（校正後發生率 [aIRR], 0.87；99.3% CI, 0.84-0.91； $P < .001$ ）。

結論：具有高 OSA 風險的患者更少需要術後機械通氣，但術後低氧概率更高，但住院時間更短。

（陳陳 譯 陳傑 校）

BACKGROUND: We developed and implemented a perioperative guideline for obstructive sleep apnea (OSA), comprising a preoperative screening tool (BOSTN) and clinical management pathways. OSA was suspected with 2 or more of the following: body mass index $\geq 30 \text{ kg/m}^2$, observed apnea, loud snoring, daytime tiredness, and neck circumference ≥ 16.5 inches in women or ≥ 17.5 inches in men. The primary objective of this study was to assess the association between high BOSTN scores and the requirement of invasive mechanical ventilation after surgery.

METHODS: In this hospital registry study, 169,662 noncardiac surgical cases performed at Beth Israel Deaconess Medical Center (BIDMC), Boston, MA, between May 2008 and September 2017 were analyzed. We assessed the association between a high BOSTN Score (score ≥ 2) and the primary outcome of requirement of invasive mechanical ventilation within 7 days after surgery using multivariable logistic regression adjusted for patient-specific factors and case-specific surgical and anesthesiological confounders. Patients with a BOSTN Score ≥ 2 were assumed to have a high likelihood of suffering from OSA. Key secondary outcome was postoperative

desaturation, defined as a peripheral oxygen saturation measurement <90% within 10 minutes of extubation.

RESULTS: Invasive mechanical ventilation within 7 days of surgery was necessary in 3170 (2.3%) low-risk cases (BOSTN Score <2) and 664 (2.1%) high-risk cases (BOSTN Score \geq 2). A score \geq 2 was associated with significantly lower odds of requiring postoperative invasive ventilation (adjusted odds ratio [aOR], 0.89; 95% confidence interval [CI], 0.80 - 0.98; P = .017), but with an increased risk of postextubation desaturation (aOR, 1.34; 99.3% CI, 1.21 - 1.48; P < .001). Patients with a score \geq 2 were hospitalized for an average of 3.71 days after surgery, compared to 4.27 days with a score <2 (adjusted incidence rate ratio [aIRR], 0.87; 99.3% CI, 0.84 - 0.91; P < .001).

CONCLUSIONS: Patients at high risk of OSA required postoperative mechanical ventilation less frequently, had higher odds of postoperative desaturation, and were hospitalized for shorter periods of time.