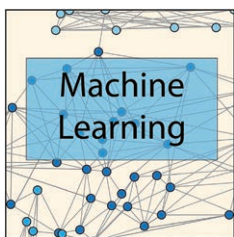


649 Development and Validation of a Deep Neural Network Model for Prediction of Postoperative In-hospital Mortality

Several perioperative risk scores have been proposed to assist in guiding clinical decisions and prioritization of care. Deep neural network models based on intraoperative clinical features were developed to predict postoperative in-hospital mortality in patients undergoing surgery under general anesthesia. The data consisted of 59,985 surgical records with 87 features extracted at the end of each surgery, 80% of which were used as the training data set while 20% were used to test final model performance. The in-hospital mortality rate was less than 1%. The deep neural network model with the highest area under the receiver operating characteristics curve was that in which the feature set was reduced from 87 to 45 features, to which American Society of Anesthesiologists Physical Status was added (0.91; 95% CI, 0.88 to 0.93). The highest logistic regression model area under the receiver operating characteristics curve included that for the same data (0.90; 95% CI, 0.87 to 0.93). The Risk Stratification Index had the highest area under the receiver operating characteristics curve (0.97; 95% CI, 0.94 to 0.99). See the accompanying Editorial View on [page 619](#). (Summary: M. J. Avram. Image: A. Johnson, Vivo Visuals.)



663 Machine-learning Algorithm to Predict Hypotension Based on High-fidelity Arterial Pressure Waveform Analysis

Clinicians often must manage the onset of arterial hypotension in the operating room or the intensive care unit with essentially no warning. A predictive algorithm based on a machine-learning model for potential real-time prediction of hypotension was developed using large data sets of high-fidelity arterial pressure waveform recordings. The algorithm, based on the complex analysis of 3,022 individual features per cardiac cycle, was able to detect physiologic signatures caused by weakening of the cardiovascular compensatory mechanisms that typically occur before hypotension and that affect cardiac preload, afterload, and contractility. Thus, machine-learning techniques in the algorithm quantify the complex processes of cardiac compensatory mechanisms mathematically rather than the statistical relationships captured by most machine-learning-based algorithms. The algorithm predicted arterial hypotension with a sensitivity and specificity of 88% (95% CI, 85 to 90%) and 87% (95% CI, 85 to 90%) 15min before a hypotensive event (area under the receiver operating characteristics curve 0.95; 95% CI, 0.94 to 0.95). See the accompanying Editorial View on [page 619](#). (Summary: M. J. Avram. Image: J. P. Rathmell.)



689 Liposomal Bupivacaine Does Not Reduce Inpatient Opioid Prescription or Related Complications after Knee Arthroplasty: A Database Analysis

Liposomal bupivacaine has been approved for injection around the surgical site with the expectation that encapsulated bupivacaine will be released slowly from its lipid-based structure, thereby combining the ease of a single shot technique with the longevity of effect associated with prolonged infusion. The hypothesis that liposomal bupivacaine has limited clinical influence on inpatient opioid prescription (as oral morphine equivalents) in patients who received multimodal analgesia, including peripheral nerve blocks, was tested in a retrospective cohort study of 88,830 patients undergoing primary knee replacement between 2013 and 2016. A clinically meaningful reduction of the inpatient opioid prescription was designated *a priori* to be at least -15%. Liposomal bupivacaine was used in 21.2% of patients with substantial interhospital variation in its use and increased use over time. When controlling for relevant covariates, use of liposomal bupivacaine was not associated with a clinically meaningful reduction in overall inpatient opioid prescription (adjusted effect -9.3%; 95% CI, -11.1 to -7.5%). See the accompanying Editorial View on [page 623](#). (Summary: M. J. Avram. Image: J. P. Rathmell.)



769 Standardized Unloading of Respiratory Muscles during Neurally Adjusted Ventilatory Assist: A Randomized Crossover Pilot Study

Neurally adjusted ventilatory assist is a spontaneous breathing mode controlled by the electrical activity of the diaphragm that provides ventilatory assist proportional to the electrical activity of the diaphragm with an adjustable factor called neurally adjusted ventilatory assist level. The primary aim of this study was to assess the feasibility of titrating neurally adjusted ventilatory assist to different levels of diaphragm unloading according to an approach based on the neuroventilatory efficiency index, which describes the capacity of the respiratory muscles to convert the electrical activity of the diaphragm to ventilatory volume, in a randomized crossover pilot study of 10 patients intubated and ventilated for more than 48h, who had started weaning from mechanical ventilation. Neurally adjusted ventilatory assist was titrated to unloading targets in most patients. At moderate levels of respiratory muscle unloading the diaphragm activity was higher, distribution of ventilation shifted toward the dorsal regions of the lungs and was slightly more homogenous, and airway pressure was slightly reduced, but this did not translate into significant improvements in gas exchange. (Summary: M. J. Avram. Image: J. P. Rathmell.)



700 Anesthesia Care Team Composition and Surgical Outcomes

The hypothesis that there would be differences in surgical outcomes between anesthesia care teams consisting of physician anesthesiologists and anesthesiologist assistants and those consisting of physician anesthesiologists and nurse anesthetists was tested using a large data set of administrative health claims for patients enrolled in the traditional fee-for-service Medicare plan. The final sample consisted of 443,098 surgical cases representing 353 types of surgery from 845 hospitals between 2004 and 2011, in 421,230 of which the care team included a nurse anesthetist and in 21,868 of which it included an anesthesiologist assistant. After adjusting for observable and unobservable differences in case mix, patient characteristics, and hospital characteristics, the mortality for cases with anesthesiologist assistant care teams was 1.6% (95% CI, 1.4 to 1.8%) whereas that for cases with nurse anesthetist care teams was 1.7% (95% CI, 1.7 to 1.7%). The risk-adjusted length of stay was

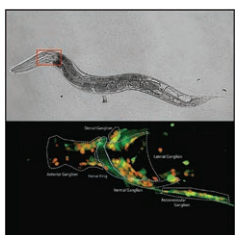
approximately 6.4 days for both groups, and the adjusted medical spending differed by \$56. See the accompanying Editorial View on [page 627](#). (Summary: M. J. Avram. Image: J. P. Rathmell.)



821 Reducing the Incidence of Substance Use Disorders in Anesthesiology Residents: 13 Years of Comprehensive Urine Drug Screening

The overall incidence of substance use disorders during the years 1995 to 2009 was 2.16 (95% CI, 1.95 to 2.39) per 1,000 resident-years according to data obtained from the American Board of Anesthesiology. The purpose of the current study was to determine if a comprehensive substance use disorder prevention program including preplacement and random urine drug testing as a condition for employment as an anesthesia resident could reduce the incidence of substance use disorders in one residency program. Between 1994 and 2003, the 10 yr before beginning the drug testing program, there were four episodes of substance use disorders in 292 anesthesiology residents (1.4%) or 0.0056 incidents per resident-year. In the 13 yr since establishment of the comprehensive drug testing program (2004

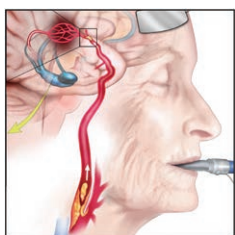
to 2016), there were no episodes of substance use disorders in 387 anesthesiology residents, an incidence of 0 (97.5% CI, 0 to 0.00368) incidents per resident-year. (Summary: M. J. Avram. Image: ©ThinkStock.)



733 Breakdown of Neural Function under Isoflurane Anesthesia: *In Vivo*, Multineuronal Imaging in *Caenorhabditis elegans*

The nervous system of the nematode *Caenorhabditis elegans* consists of exactly 302 neurons. *C. elegans* has a behavioral response to volatile anesthetics that is similar to that of higher-order organisms. The hypothesis that anesthesia is caused by induced dyssynchrony between neurons, rather than suppression of individual neuron activity, was tested by measuring neuronal activity in *C. elegans* expressing the calcium-sensitive fluorophore GCaMP6s in specific command neurons noninvasively and in parallel within the behavioral circuit controlling forward and reverse crawling. At 4% isoflurane, *C. elegans* had minimal spontaneous movement and no response to external stimulation. Exposure to isoflurane induced randomized, uncoordinated neuronal activity within an inherently well-organized

circuit. Quantification of correlations between neurons, spectral analysis of neuronal dynamics, as well as the entropy and multiinformation of the neuronal signals demonstrated that randomized dyssynchrony in neuronal signaling corresponded with the anesthetic state. See the accompanying Editorial View on [page 629](#). (Summary: M. J. Avram. Image: Adapted from original article.)



829 Neurocognitive Function after Cardiac Surgery: From Phenotypes to Mechanisms (Review Article)

Postoperative delirium and postoperative cognitive dysfunction occur frequently after cardiac surgery and are associated with decreased quality of life and increased mortality risk. This review begins with the definitions of delirium and postoperative cognitive dysfunction. Although postoperative delirium and postoperative cognitive dysfunction are distinct disorders measured with different instruments at differing times, similarities in their likely mechanisms, risk factors, and long-term sequelae suggest they may be part of an underlying neurobiologic continuum. Therefore, the potential pathophysiologic mechanisms of and possible prevention strategies for both disorders are discussed together. Key questions for future research on delirium and cognitive dysfunction after cardiac surgery are identified

with the caveat that interventions designed to reduce postoperative cognitive dysfunction or delirium by targeting a single risk factor may have counterbalancing effects. The review concludes with the suggestion that optimizing postcardiac surgery neurocognitive function will likely require an individualized, patient-centered approach to managing multiple determinants of brain function. (Summary: M. J. Avram. Image: Adapted from original article.)