

## **Filling the Gaps of Current Monitoring to Optimize and Individualize Anesthesia Delivery**

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**Introduction:** Anesthesia delivery is based on population-models without widespread or reliable tools for predicting or optimizing anesthetic care at an individualized level. With surgical advances enabling care of increasingly higher risk patients, new anesthetic techniques and monitoring technologies present an unprecedented challenge and opportunity for providers to efficiently and effectively interpret and integrate all available data in real-time to make the best clinical decisions possible, tailored to each individual patient. Optimal anesthetic management includes not only patient safety, but also effectiveness and economic efficiency throughout the entire perioperative period. This includes medication usage, neuromuscular blockade, post-operative nausea and vomiting (PONV), opioid use, blood product use, emergence time, and post-operative recovery. Despite the availability of extensive electronic medical records (EMR) and high fidelity anesthesia monitors, a cohesive Anesthesia Information Management System (AIMS) and clinical decision support system is not available to this end. To fill this important gap, we reviewed the growing body of literature to determine the shortcomings of current implementations to enable us to design an anesthesia monitoring infrastructure at Brigham and Women's Hospital (BWH) addressing these needs.

**Methods:** An electronic search of the literature was conducted using PubMed with search terms including "clinical decision support", "anesthesia information management systems", "smartpilot", "navigator", and combinations of these terms. Searches were limited to publications related to current information system implementations. Nineteen studies of the methodology, implementation, and perioperative quality measures of current AIMS and perioperative clinical decision support systems were reviewed. A separate set of searches was conducted using PubMed with search terms including "operating room cost per minute", "anesthesia efficiency", and combinations of these terms. Studies were selected with focus on anesthesia-modifiable quality and safety outcomes relevant to AIMS, yielding seven studies reviewing perioperative cost estimates and operating room economic models.

**Results:** Review of AIMS shows technologies that are in early development using EMR codes to improve measures of safety and quality, such as antibiotic use, PONV prophylaxis

medication administration, blood glucose monitoring, blood pressure monitoring, and temperature monitoring. While novel clinical decision support systems using pharmacokinetic and pharmacodynamic models can provide greater insight into drug delivery, few studies were identified validating impact on clinical outcomes. Optimization of medication dosing and emergence times were studied outcomes; however, these population-based models supported a limited number of pharmacologic agents and surgery types, and they lacked the ability to individualize modeling based on patient-specific parameters, such as past medication response, medical history, and laboratory data. A key example for future potential was one preliminary study examining anesthesia optimized for patients with renal disease. Zero studies revealed an integrated system collectively targeting the key variables known to affect perioperative quality outcomes.

**Conclusion:** AIMS and clinical decision support systems can provide clinical and pharmacologic insights that may improve anesthetic delivery. However, more robust models are needed, including more patient characteristics and monitoring data as input variables, in addition to improved automated EMR data extraction, to target key clinical parameters that can improve patient safety and perioperative efficiency. These insights are being used to construct an anesthesia monitoring infrastructure at BWH to enable the creation and testing of mathematical predictive models targeting key clinical variables to deliver expert anesthetic care and improve operating room safety, effectiveness, and patient outcomes.