TITLE: Anesthesia Information Management Systems for Patients Undergoing Surgery: Clinical Effectiveness and Guidelines

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RESEARCH QUESTIONS

1. What is the clinical effectiveness of using Anesthesia Information Management Systems (AIMS) for adult patients undergoing surgery?

2. What are the evidence-based guidelines regarding the use of AIMS for adult patients undergoing surgery?

KEY FINDINGS

Two non-randomized studies were identified, regarding the clinical effectiveness of using Anesthesia Information Management Systems (AIMS) for adult patients undergoing surgery.

METHODS

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2015, Issue 1), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2010 and January 18, 2015. Internet links were provided, where available.

The summary of findings was prepared from the abstracts of the relevant information. Please note that data contained in abstracts may not always be an accurate reflection of the data contained within the full article.

SELECTION CRITERIA

One reviewer screened citations and selected studies based on the inclusion criteria presented in Table 1.

Table 1: Selection Criteria	
Population	Adult patients undergoing surgery
Intervention	Anesthesia Information Management Systems (AIMS)
Comparator	Monitoring and recording of patient values by anesthesiologist and nurses in the operating room (OR)
Outcomes	Clinical effectiveness (benefits, patient safety, harms) Guidelines
Study Designs	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials, non-randomized studies, evidence-based guidelines

RESULTS

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials, non-randomized studies, and evidence-based guidelines.

Two non-randomized studies were identified regarding the clinical effectiveness of using AIMS for adult patients undergoing surgery. No health technology assessments, systematic reviews, meta-analyses, or evidence-based guidelines were identified.

Additional references of potential interest are provided in the appendix.

OVERALL SUMMARY OF FINDINGS

Two non-randomized studies examined specific patient outcomes associated with the use of AIMS.

A study by Nair et al.[1] incorporated an AIMS-based clinical decision support system in order to better manage intraoperative hypotension and hypertension. The AIMS technology automatically captured data on blood pressure and inhaled drug concentration variables, providing real-time notification messages. The duration and frequency of hypotensive episodes with concurrent high concentration of inhaled drug were significantly reduced. However, no significant reduction in hypertensive episodes was found.

A study by Kooij et al.[2] utilized automated reminders for physicians to address postoperative nausea and vomiting (PONV) in adult patients undergoing general anesthesia for elective non-cardiac surgery. There was a statistically significant reduction in the number of patients experiencing PONV in the 24 hours following surgery when automated reminders were incorporated, as guideline adherence by physicians was improved.

REFERENCES SUMMARIZED

Health Technology Assessments
No literature identified.

Systematic Reviews and Meta-analyses
No literature identified.

Randomized Controlled Trials
No literature identified.

Non-Randomized Studies

1. Nair BG, Horibe M, Newman SF, Wu WY, Peterson GN, Schwid HA. Anesthesia information management system-based near real-time decision support to manage intraoperative hypotension and hypertension. Anesth Analg. 2014 Jan;118(1):206-14. PubMed: PM24247227

    BACKGROUND: Intraoperative hypotension and hypertension are associated with adverse clinical outcomes and morbidity. Clinical decision support mediated through an anesthesia information management system (AIMS) has been shown to improve quality of care. **We hypothesized that an AIMS-based clinical decision support system could be used to improve management of intraoperative hypotension and hypertension.** METHODS**: A near real-time AIMS-based decision support module, Smart Anesthesia Manager (SAM), was used to detect selected scenarios contributing to hypotension and hypertension.** Specifically, hypotension (systolic blood pressure <80 mm Hg) with a concurrent high concentration (>1.25 minimum alveolar concentration [MAC]) of inhaled drug and hypertension (systolic blood pressure >160 mm Hg) with concurrent phenylephrine infusion were detected, and anesthesia providers were notified via "pop-up" computer screen messages. AIMS data were retrospectively analyzed to evaluate the effect of SAM notification messages on hypotensive and hypertensive episodes. RESULTS: **For anesthetic cases 12 months before (N = 16913) and after (N = 17132) institution of SAM messages, the median duration of hypotensive episodes with concurrent high MAC decreased with notifications** (Mann Whitney rank sum test, P = 0.031). However, the reduction in the median duration of hypertensive episodes with concurrent phenylephrine infusion was not significant (P = 0.47). The frequency of prolonged episodes that lasted >6 minutes (sampling period of SAM), represented in terms of the number of cases with episodes per 100 surgical cases (or percentage occurrence), declined with notifications for both hypotension with >1.25 MAC inhaled drug episodes (delta = -0.26% [confidence interval, -0.38% to -0.11%], P < 0.001) and hypertension with phenylephrine infusion episodes (delta = -0.92% [confidence interval, -1.79% to -0.04%], P = 0.035). For hypotensive events, the anesthesia providers reduced the inhaled drug concentrations to <1.25 MAC 81% of the time with notifications compared with 59% without notifications (P = 0.003). For hypertensive episodes, although the anesthesia providers' reduction or discontinuation of the phenylephrine infusion increased from 22% to 37% (P = 0.030) with notification messages, the overall response was less consistent than the response to hypotensive episodes. **CONCLUSIONS: With automatic acquisition of arterial blood pressure and inhaled drug concentration variables in an AIMS, near real-time notification was effective in reducing the duration and frequency of hypotension with concurrent >1.25 MAC inhaled drug**

episodes. However, since phenylephrine infusion is manually documented in an AIMS, the impact of notification messages was less pronounced in reducing episodes of hypertension with concurrent phenylephrine infusion. **Automated data capture and a higher frequency of data acquisition in an AIMS can improve the effectiveness of an intraoperative clinical decision support system**.

2. Kooij FO, Vos N, Siebenga P, Klok T, Hollmann MW, Kal JE. Automated reminders decrease postoperative nausea and vomiting incidence in a general surgical population. Br J Anaesth. 2012 Jun;108(6):961-5.
    PubMed: PM22382396

    BACKGROUND: Guidelines to minimize the incidence of postoperative nausea and vomiting (PONV) have been implemented in many hospitals. In previous studies, we have demonstrated that guideline adherence is suboptimal and can be improved using decision support (DS). **In this study, we investigate whether DS improves patient outcome through improving physician behaviour.** METHODS: **Medical information of surgical patients is routinely entered in our anaesthesia information management system (AIMS), which includes automated reminders for PONV management based on the simplified risk score by Apfel and colleagues. This study included consecutive adult patients undergoing general anaesthesia for elective non-cardiac surgery who were treated according to the normal clinical routine**. The presence of PONV was recorded in the AIMS both during the recovery period and at 24 h. Two periods were studied: one without the use of DS (control period) and one with the use of DS (support period). DS consisted of reminders on PONV both in the preoperative screening clinic and at the time of anaesthesia. RESULTS: **In the control period, 981 patients, of whom 378 (29%) were high-risk patients, received general anaesthesia. Overall, 264 (27%) patients experienced PONV within 24 h. In the support period, 1681 patients, of whom 525 (32%) had a high risk for PONV, received general anaesthesia. In this period, only 378 (23%) patients experienced PONV within 24 h after operation. This difference is statistically significant (P=0.01). CONCLUSION: Automated reminders can improve patient outcome by improving guideline adherence**.

Guidelines and Recommendations
No literature identified.

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APPENDIX – FURTHER INFORMATION:

Non-Randomized Studies – Retrospective Data Usage

3.   Frank SM, Rothschild JA, Masear CG, Rivers RJ, Merritt WT, Savage WJ, et al. Optimizing preoperative blood ordering with data acquired from an anesthesia information management system. Anesthesiology. 2013 Jun;118(6):1286-97.
PubMed: PM23695091

BACKGROUND: The maximum surgical blood order schedule (MSBOS) is used to determine preoperative blood orders for specific surgical procedures. Because the list was developed in the late 1970s, many new surgical procedures have been introduced and others improved upon, making the original MSBOS obsolete. The authors describe methods to create an updated, institution-specific MSBOS to guide preoperative blood ordering. METHODS: Blood utilization data for 53,526 patients undergoing 1,632 different surgical procedures were gathered from an anesthesia information management system. A novel algorithm based on previously defined criteria was used to create an MSBOS for each surgical specialty. The economic implications were calculated based on the number of blood orders placed, but not indicated, according to the MSBOS. RESULTS: Among 27,825 surgical cases that did not require preoperative blood orders as determined by the MSBOS, 9,099 (32.7%) had a type and screen, and 2,643 (9.5%) had a crossmatch ordered. Of 4,644 cases determined to require only a type and screen, 1,509 (32.5%) had a type and crossmatch ordered. By using the MSBOS to eliminate unnecessary blood orders, the authors calculated a potential reduction in hospital charges and actual costs of $211,448 and $43,135 per year, respectively, or $8.89 and $1.81 per surgical patient, respectively. CONCLUSIONS: An institution-specific MSBOS can be created, using blood utilization data extracted from an anesthesia information management system along with our proposed algorithm. Using these methods to optimize the process of preoperative blood ordering can potentially improve operating room efficiency, increase patient safety, and decrease costs.

4.   Frank SM, Savage WJ, Rothschild JA, Rivers RJ, Ness PM, Paul SL, et al. Variability in blood and blood component utilization as assessed by an anesthesia information management system. Anesthesiology. 2012 Jul;117(1):99-106.
PubMed: PM22531332

BACKGROUND: Data can be collected for various purposes with anesthesia information management systems. The authors describe methods for using data acquired from an anesthesia information management system to assess intraoperative utilization of blood and blood components. METHODS: Over an 18-month period, data were collected on 48,086 surgical patients at a tertiary care academic medical center. All data were acquired with an automated anesthesia recordkeeping system. Detailed reports were generated for blood and blood component utilization according to surgical service and surgical procedure, and for individual surgeons and anesthesiologists. Transfusion hemoglobin trigger and target concentrations were compared among surgical services and procedures, and between individual medical providers. RESULTS: For all patients given erythrocytes, the mean transfusion hemoglobin trigger was 8.4 +/- 1.5, and the target was 10.2 +/- 1.5 g/dl. Variation was significant among surgical services (trigger range: 7.5 +/- 1.2-9.5 +/- 1.1, P = 0.0001; target range: 9.1 +/- 1.2-11.3 +/- 1.4 g/dl, P = 0.002), surgeons (trigger range: 7.2 +/- 0.7-9.8 +/- 1.0, P = 0.001; target range: 8.8 +/- 0.9-11.8 +/- 1.3 g/dl,

P = 0.001), and anesthesiologists (trigger range: 7.2 +/- 0.8-9.6 +/- 1.2, P = 0.001; target range: 9.0 +/- 0.9-11.7 +/- 1.3 g/dl, P = 0.0004). The use of erythrocyte salvage, fresh frozen plasma, and platelets varied threefold to fourfold among individual surgeons compared with their peers performing the same surgical procedure. CONCLUSIONS: The use of data acquired from an anesthesia information management system allowed a detailed analysis of blood component utilization, which revealed significant variation among surgical services and surgical procedures, and among individual anesthesiologists and surgeons compared with their peers. Incorporating these methods of data acquisition and analysis into a blood management program could reduce unnecessary transfusions, an outcome that may increase patient safety and reduce costs.

5. Nair BG, Peterson GN, Newman SF, Wu WY, Kolios-Morris V, Schwid HA. Improving documentation of a beta-blocker quality measure through an anesthesia information management system and real-time notification of documentation errors. Jt Comm J Qual Patient Saf. 2012 Jun;38(6):283-8.
    PubMed: PM22737780

    BACKGROUND: Continuation of perioperative beta-blockers for surgical patients who are receiving beta-blockers prior to arrival for surgery is an important quality measure (SCIP-Card-2). For this measure to be considered successful, name, date, and time of the perioperative beta-blocker must be documented. Alternately, if the beta-blocker is not given, the medical reason for not administering must be documented. METHODS: Before the study was conducted, the institution lacked a highly reliable process to document the date and time of self-administration of beta-blockers prior to hospital admission. Because of this, compliance with the beta-blocker quality measure was poor (-65%). To improve this measure, the anesthesia care team was made responsible for documenting perioperative beta-blockade. Clear documentation guidelines were outlined, and an electronic Anesthesia Information Management System (AIMS) was configured to facilitate complete documentation of the beta-blocker quality measure. In addition, real-time electronic alerts were generated using Smart Anesthesia Messenger (SAM), an internally developed decision-support system, to notify users concerning incomplete beta-blocker documentation. RESULTS: Weekly compliance for perioperative beta-blocker documentation before the study was 65.8 +/- 16.6%, which served as the baseline value. When the anesthesia care team started documenting perioperative beta-blocker in AIMS, compliance was 60.5 +/- 8.6% (p = .677 as compared with baseline). Electronic alerts with SAM improved documentation compliance to 94.6 +/- 3.5% (p < .001 as compared with baseline). CONCLUSIONS: To achieve high compliance for the beta-blocker measure, it is essential to (1) clearly assign a medical team to perform beta-blocker documentation and (2) enhance features in the electronic medical systems to alert the user concerning incomplete documentation.

Review Articles

6. Bajwa SJ. Amalgamation of management information system into anaesthesiology practice: A boon for the modern anaesthesiologists. Indian J Anaesth [Internet]. 2014 Mar [cited 2015 Jan 22];58(2):121-6. Available from:
    http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4050925
    PubMed: PM24963173

    Over the years, traditional anaesthesia record keeping system has been the backbone of

anaesthesiology ever since its introduction in the 1890s by Dr. Harvey Cushing and Dr. Ernest A. Codman. Besides providing the important information regarding patients' vital physiologic parameters, paper records had been a reliable source for various clinical research activities. The introduction of electronic monitoring gadgets and electronic record keeping systems has revolutionised the anaesthesiology practice to a large extent. Recently, the introduction of anaesthesia information management system (AIMS), which incorporates all the features of monitoring gadgets, such as electronic storage of large accurate data, quality assurance in anaesthesia, enhancing patient safety, ensuring legal protection, improved billing services and effecting an organisational change, is almost a revolution in modern-day anaesthesiology practice. The clinical research activities that are responsible for taking anaesthesiology discipline to higher peaks have also been boosted by the amalgamation of AIMS, enabling multicenter studies and sharing of clinical data. Barring few concerns in its installation, cost factors and functional aspects, the future of AIMS seems to be bright and will definitely prove to be a boon for modern-day anaesthesiology practice.

7. Wilbanks BA. An integrative literature review on accuracy in anesthesia information management systems. Comput Inform Nurs. 2014 Feb;32(2):56-63.
    PubMed: PM24429834

    An anesthesia information management system is a dynamic electronic documentation system that generates the legal records of patient care while the patient is receiving anesthesia. The generated documentation can be used to guide patient care, facilitate billing for services, and be used for clinical research. The purpose of this article was to synthesize the previous empirical and theoretical literature pertaining to the concept of accuracy in documentation in a wide range of disciplines in order to refine the concept and more effectively guide future research, clinical practice, and policy development in anesthesia informatics. The basic definition of accuracy is generally agreed upon, but the exact method of measuring accuracy is very different across disciplines. The concept of accuracy is defined in the published literature using the terms completeness, comprehensiveness, correctness, precision, legibility, readability, quantity of data, redundancy of data, clearness of data, concordance of data, and legitimacy. In nursing, accuracy can be defined as the presence of correct data that provide a complete, comprehensive, and precise representation of patient care. In anesthesia, accuracy is often defined in terms of correctness and completeness of data. Correctness, completeness, comprehensiveness, and precision are the primary constituents of accuracy with each discipline emphasizing different aspects.