Anesthesia Information Management Systems: A New Venture

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ABSTRACT
The technological innovations in all the sectors of medical specialty have improved not only clinical practice but also administrative work to a great extent. Along with clinical practice, modern technology has replaced traditional techniques of record-keeping and storing piles of paperwork. An anesthesia information management system (AIMS) is an electronic record system that allows the collection, storage, and presentation of patient data during the perioperative course. Anesthesia information management systems (AIMS) have implemented the smooth transition from simple, automated intraoperative record-keeping in a selected few institutions to widely adopted, modern and sophisticated hardware and software solutions that are integrated into a hospital's electronic health record system which contributes to the documentation of patient's entire perioperative experience. The availability of AIMS helps to proliferate and allows sharing of the data across multi-institutional collaborations. Visual analytics and advanced analytics techniques such as machine learning may be applied to AIMS data, to offer even more benefits. Our hospital is a tertiary care, Joint Commission International (JCI) reaccredited hospital, with technological advancement in storing health records in various hospital locations such as operation theaters, wards, Intensive Care Units (ICUs), administrative work, and billing systems.

Keywords: Anesthesia, Anesthesia information management system, Information system, Hardware, Software.

Introduction
Digitalization in all industries has brought novelty in technology. However, technology in health care has made a dramatic revolution in practice such as patient registration, data monitoring, and laboratory tests. The technological innovations in the medical specialty are keeping electronic health records (EHRs). The specialty of anesthesiology has shown a great change in clinical as well as technological advancements¹ and has implemented a new system of keeping EHR of the patient during the perioperative period.

An anesthesia information management system (AIMS) enables accurate data collection, storage, and presentation of patient medical information in a digital format.² These specific forms provide record-keeping capabilities as well as quick access to the summary and data for the end-user.³ This information is useful for auditing, research, and improving practice.

The AIMS installation is composed of software, hardware components, and physiologic device within a hospital's EHR system.⁴ The software is installed on each anesthetic workstation like operating room (OR), post-anesthesia care unit (PACU), and intensive care units (ICU). AIMS hardware includes a transportable computer workstation with keyboards, bar code scanners, and syringe pumps.⁵ However, AIMS is definitely a modern technology that reduces financial costs and improves efficiency.

A Transformation to New Era
Dr Codman and Dr Cushing, two surgeons, pioneered the use of paper documenting a patient’s physiologic condition during anesthesia⁶ in the 1890s. The normal practice in the 1900s was to keep a paper anesthetic record. However, in the 1970s and 1980s, there was a strong trend toward electronic perioperative data acquisition, storage, retrieval, and formatting.⁶ In the 1970s, computers were used to record patients’ data, and in the 1980s, Duke Automatic Monitoring Equipment System was developed to capture patient data directly from the monitors.⁷ Subsequently, the demand for AIMS rose from 75% in 2014 to 90% in 2020.⁸

Electronic health record (EHR) systems Epic, Cerner, and others⁹ (Fig. 1) have been installed extensively in hospitals. The AIMS component enhances interoperability and access to other EHR components including laboratory findings and automated order entry, as well as secondary uses like research and quality improvement projects.

AIMS are employed not just in the perioperative phases of operating room (OR) care, but also in other settings where patients are cared for, including intensive care units, wards, labor and delivery suites, and acute pain services.¹⁰

Functioning of AIMS during Perioperative Period (Documentation in Action)
The most valuable system, AIMS, provides for the preservation and documentation of reliable data, which is the foundation for making decisions at the point of care.¹¹ AIMS collects data from devices such as patient monitors, anesthesia machines, and drug infusion records. Clinical events such as anesthesia induction, patient positioning, insertion of invasive lines such as central venous catheterization and arterial line insertion, the start of surgery, end of the surgery, administration of medications,

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Source of support: Nil
Conflict of interest: None

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Advantages of AIMS

The advantages of AIMS in hospital systems are described in the peer-reviewed literature (Annexure 1). It has described the advantages in the category of patient safety and quality of care, documentation, operations management, cost containment and reimbursement, and clinical research which showed improved and promising results. According to an assessment of the research, AIMS can give a good net return on investment in four areas: (1) more effective staff scheduling and lower personnel costs, (2) lower anesthetic drug prices, (3) better charge/billing capture, and (4) appropriate hospital reimbursement due to improved hospital coding are among these areas. It was shown that institutes were able to control their billing rate for epidural catheters, central lines, and arterial catheters by configuring their AIMS software so that individual clinicians were prompted for documentation of invasive operations when the system identified triggering events. Due to accurate documentation, revenue cycles improved and payment for services was appropriate. The accuracy of AIMS data does not differ whether patient variables are entered through the console manually or automatically from the monitors. AIMS has a valuable contribution in medicolegal cases mainly to review clinical records in the defense process.

AIMS: Clinical Decision Support

Anesthesia information management system (AIMS) offers clinical decision support into either clinical (especially protocols and guidelines) or administrative processes. Clinical decision support systems based on AIMS improve various elements of clinical performance and patient care, especially when they are incorporated into clinical workflow and consist of evidence-based recommendations rather than assessments (Annexure 2).

AIMS: A Boon

The application of AIMS has facilitated research, multicentre study projects, and anesthesia practices. Various studies using AIMS have been published by the Multi-centre Perioperative Outcomes Group and the Anaesthesia Quality Institute’s National Anaesthesia Clinical Outcomes Registry. It is important to get clear, consistent perioperative data through valid and reliable documentation to execute high-quality outcomes in clinical as well as reporting systems.

Role in Various Sectors

The AIMS has benefits such as legibility, faster data entry, reduction in human errors, enhanced data completeness, cost savings, and easy access to previous records.

Quality Assurance

Quality assurance has made significant improvements in anesthesia practice. AIMS enables the recovery of unbiased and error-free data from a vast database, which is especially useful in critical incident situations.

Legal Protection

Unlike other specialties, anesthesiologists can be involved in medicolegal matters, where AIMS can assist in court because the data presented is more accurate and unbiased than handwritten records, allowing anesthesiologists to support their clinical judgments. The artifact recorded by these systems may support charges of malpractice in the event of an unfavorable outcome, and AIMS plays a significant part in risk management strategy by providing complete, legible, and contemporaneous recording of care.
Organization of Anesthesia Department
Various hospital specialties necessitate anesthetic care. AIMS provides precise information on operating room time, surgery duration, and anesthesia occurrences. This information is useful for estimating medicine, equipment, and other inventory quantities. With the use of reliable data and feedback suggestions, AIMS assists in the formulation of departmental protocols and guidelines.16

Administration
The resources and inventories are managed effectively through AIMS directly connecting to the purchasing department.

Cost-effective
AIMS reduces a lot of paperwork and hence the requirement of staff, which is again quite economical.16

Tracking Patient’s Movements during the Hospital Stay
The patient details with regards to location, sequence of perioperative events such as hemodynamics, recovery, etc., are automatically documented. This maintains transparency in the system, keeping a healthy bond between clinicians and relatives of the patient.

Drawbacks
Some physicians are hesitant to utilize AIMS due to a desire to save paper records, the high expense of installation and maintenance, anesthetic providers’ inattention, medicolegal issues, and reluctance to change clinical workflow patterns. However, many studies have proved AIMS to be more accurate and more reliable than paper records.17 The return on investment outweighs the cost of AIMS installation.

Criteria to Select AIMS Project Installation Company
The selection goal should specify the proposed installation’s precise requirements, as well as the geographical requirement and the clinical activities that must be supported. Once a vendor has been chosen, they should detail their systems’ ability to handle a catastrophic incident (e.g., a server failure, power loss, or network interruption) as well as their redundancy methods. The system stability, user interface, system responsiveness and security, and network connectivity should all be highlighted in the AIMS software and hardware demonstration18 (Annexure 3).

Future Prospects of AIMS
AIMS will become more widely used in India’s high-tech hospitals in the next years, with improved user interfaces, mobility, and connectivity within hospital EHRs. Because the increase in patient care is less visible, AIMS adoption is slower than other available technologies such as newer physiologic monitors or current-generation anesthetic machines. AIMS are anticipated to become a crucial modality for providing the lowest cost, highest efficiency while also improving the quality of care provided and that this is attainable with proper planning. A large number of resources are required for a successful AIMS implementation. The time spent on training, installation, and program customization is included in these resources. A modern-era AIMS will depict improved standardization, interoperability, and integration of the system.21 An AIMS will aid an attentive, conscientious, meticulously vigilant anesthesiologist with the help of detailed record-keeping and good knowledge of current trends in the practice and is less likely to be judged negligent in case of his patient care.

Synopsis
A large number of peer-reviewed studies have demonstrated that these high-tech devices may improve operating room efficiency while also improving the quality of care provided and that this is attainable with proper planning. A large number of resources are required for a successful AIMS implementation. The time spent on training, installation, and program customization is included in these resources. A modern-era AIMS will depict improved standardization, interoperability, and integration of the system.21 An AIMS will aid an attentive, conscientious, meticulously vigilant anesthesiologist with the help of detailed record-keeping and good knowledge of current trends in the practice and is less likely to be judged negligent in case of his patient care.

References
**ANNEXURE 1**

**Benefits of AIMS in Various Sectors of Hospital**

- **Effect on patients**
  - Facilitation of real-time intraoperative decision support
  - Helps the anesthesia care team to focus on the patient, rather than recording vital signs
  - Accurate recording of intraoperative data and patient responses to anesthesia
  - Better clarity and availability of historical records
  - Improved patient safety and quality of care

- **Effect on Departmental Management**
  - Provides cost analysis by provider/type of surgery/patient
  - Improvement in billing accuracy and timeliness
  - Satisfies the Joint Commission requirements for legible and comprehensive patient records
  - Facilitates verification of Accreditation Council for Graduate Medical Education case requirements for trainees (residents/fellows)
  - Simplifies compliance with concurrency and other regulatory issues

- **Effect on the practice of anesthesia**
  - Provides precise, high-resolution records that can be used for educational purposes
  - Allows researchers to quickly search for rare events or specific occurrences across a large number of cases
  - Facilitates individual provider performance tracking
  - Helps in maintaining quality assurance functionality through the creation of more complete and precise records
  - Integration with other hospital databases allows assessment of short and long-term patient outcomes
  - Provision of additional legal protection via the availability of unbiased, precise, and accurate information

- **Support of clinical quality improvement programs**
- **Enhancement of clinical risk management**
- **Detection of controlled substance diversion**

**ANNEXURE 2**

**AIMS-based Clinical Decision Support**

**Quality Assurance**

- Maintenance of normothermia notifications
- Presurgical antibiotic management notifications

**Medication Support**

- Drug-drug interaction check
- Drug-dose calculations
- Drug re-dosing reminders
- Drug-allergy check

**Regulatory and Compliance Support**

- Concurrency checking
- Ensuring electronic records contain elements required for billing

- Attending physician attestation statements
- Case times (start of anesthesia care, end of anesthesia care)
- Case type (general/MAC/regional)
- Patient details (ASA physical status)

**Support Around Critical Events**

- Algorithm display and guidance (malignant hyperthermia, ACLS, ASA difficult airway algorithm)
- Critical event detection (chaotic ECG + no pulse-ox wave form → consider ventricular fibrillation)

ACLS advanced cardiac life support, ASA American Society of Anesthesiologists, ECG electrocardiogram, MAC monitored anesthesia care

**ANNEXURE 3**

**Key Points when Selecting an AIMS**

- What phases will the AIMS manage? (e.g., preoperative, intraoperative, postoperative phases)
- How will the AIMS merge with the existing departmental/hospital workflows?
- What will be the scope of the AIMS and the overall project?
- What will the location of AIMS support? (e.g., operating room, labor and delivery room, off-site locations, ambulatory surgical area, intensive care units)
- Is physical infrastructure compatible to support system deployment? (e.g., hardware for use in the operating rooms, dedicated or shared network connections, secure location for the primary and backup servers)
- Who will be the system support personnel? (e.g., hospital or anesthesia department)
- Will the support be during working/business hours only or 24/7?
- Will the AIMS stand alone or will it interface with existing clinical systems?
- How will the installation, system customization, initial testing, and deployment occur?
- How will the system be installed and maintained? (e.g., phased roll-out or all-at-once implementation)
- Who will take responsibility for the initial and ongoing training for end-users?
- Who will provide the ongoing system maintenance, development, and upgrades?
- Will there be any backup systems included?
- Will there be redundancy of staff whilst AIMS is deployed?
- What is the cost-benefit ratio/balance?
- Where will the server be located in the hospital? (need to know in case of an emergency)
- Will the system require update at frequent intervals or will it get updated automatically?