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Anesthesia Information Management Systems: A Review of the History, the Products, and the Adoption of These Systems

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Abstract

Anesthesia Information Management Systems (AIMS) have been growing in popularity and use over the past decade, but widespread adoption of these systems by anesthesia groups and hospitals across the country is yet to occur. The promise of AIMS reaches beyond basic anesthesia recordkeeping into a realm of complex, integrated systems with enhanced billing, improved regulatory requirements, improved communication amongst caregivers, and reduced medical-legal exposure. In fact, AIMS have been shown to improve patient care and can increase the financial performance of a group. Despite the documented benefits of AIMS, adoption of these systems is low. This paper will review the history of AIMS, examine the AIMS currently in existence, and will attempt to discover the underlying reasons behind the slow adoption rates of AIMS by providers and hospitals.

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Just as anesthesia practice has evolved over time due to evidence-based practice, safer drugs, and better equipment; likewise has the process of recording the data obtained during a procedure onto the anesthesia record. The standard anesthesiology record maintained during all anesthesia procedures is no longer limited to pen and paper. Following suit to the electronic medical record commonly utilized by nursing for documenting patient care, specialty areas of medicine have begun to develop electronic records for their particular area of expertise.

In 2001, the Anesthesia Patient Safety Foundation (APSF) explicitly stated "the APSF endorses and advocates the use of automated record keeping in the perioperative period and the subsequent retrieval and analysis of the data to improve patient safety" (APSF, 2001). In 2006, it was estimated that Anesthesia Information Management Systems (AIMS) were installed in less than 5% of operating rooms in the United States (Epstein, Vigoda, & Feinstein, 2007). "If one accepts the hypothesis that health care IT improves patient care, this lag in the adoption of AIMS is surprising, as anesthesiology has been touted as a model specialty in American medicine for the adoption of patient safety initiatives" (Halbeis, Epstein, Macario, Pearl, & Grunwald, 2008, p. 1323).

Today, that number of operating rooms with AIMS is expected to be dramatically higher based on the presence of more AIMS being available from product vendors, the mandate from the Joint Commission that records be legible and retrievable for every patient encounter, and the financial incentives (and penalties) that have been offered by the government through the Medicare and Medicaid EHR (Electronic Health Record) Incentive Programs of 2009's Health

Information Technology for Economic and Clinical Health (HITECH) Act. A 2011 estimate states that 44% of the academic anesthesia departments in the United States have either installed, implemented, or are in the process of selecting AIMS (Simpao et al, 2011, p. 422). This rise in adoption is "driven primarily by a need to address increased regulatory reporting requirements and a desire to improve routine clinical documentation" (Ehrenfeld, 2009, p. 2). Also driving the rapid adoption of AIMS is "increased AIMS functionality and increasing pressure to report data for external review, such as with pay-for-performance contracting" (Ehrenfeld & Rehman, 2011).

What is an AIMS?

An anesthesia record is used by the anesthesia provider to capture a patient's response to anesthesia and surgery by recording the events taking place during the perioperative period, such as all procedures, physiologic changes, and medications administered. "The introduction of electronic anesthesia documentation systems was attempted as early as in 1979, although their efficient application has become reality only in the past few years" (Heinrichs, Mönk, & Eberle, 1997). Initially, automated anesthesia records (AAR) were designed and built by the users. The AARs would pull physiologic data from the patient monitors and allow the anesthesia provider to input data such as comments, procedures, critical events, and medications and/or fluids administered, (Abenstein, DeVos, Abel, & Tarhan, 1992). However, a stand alone AAR is simply not much more efficient than a paper anesthesia record since it does not communicate with other systems throughout the hospital. Oftentimes, these AARs are printed out at the end of the case and the paper record is placed on the patient's chart.

An AIMS is not only an AAR, but also a specialized electronic health record (EHR) that can interface with multiple other hospital systems like the laboratory, billing, pharmacy, radiology, and scheduling systems. The benefit of the AIMS comes from the ability to communicate automatically and bidirectionally with other hospital systems. Regarding anesthesia care, "there is no other clinical setting in which an abundance of physiologic and pharmacologic data is collected minute-to-minute" (Kadry, Feaster, Macario, & Ehrenfeld, 2012, p. 156). An AIMS has software and hardware that can interface with intraoperative monitors, thus automatically transcribing physiologic and ventilator data, which frees up the anesthesia provider to focus more time on patient safety and care rather than on documentation. These systems can also provide point-of-care alerts to the anesthesia provider of medication allergies, drug-drug interactions, medical contraindications, new laboratory results, or prompt the anesthesia provider to document any essential clinical detail that may be missing. AIMS can provide decision support tools, derived from evidence-based practice, directly to the anesthesia provider based on the patient's documented medical history, physiologic data, drug administration, and fluid therapy. Additionally, AIMS allow end users to easily access information for quality assurance, billing, statistical, and research purposes.

Benefits of AIMS

"Accurate and complete clinical documentation is essential to yielding higher quality of care and obtaining reimbursement for clinical services in the U.S" (Jao, Helgason, & Zych, 2009). Kadry et al (2012) point out that "AIMS have been shown to have benefits in 7 key areas: improved cost containment, improved operations management, improved reimbursement, improved quality of care, improved safety, improved translational research, and improved

documentation." AIMS maintain a longitudinal patient database, so previous patient encounters are easily retrievable. Since AIMS can be fully integrated with other hospital systems, all of the patient's vital data is easily accessible from the operating room. AIMS assist in the reporting of quality measures, individual provider performance, and patient outcomes. With AIMS, manual chart reviews are a thing of the past! Electronic data is queriable, easy to trend, and can be automatically sent to regulatory bodies and insurance companies. AIMS are able to analyze the patient's clinical data and use evidence-based practice models to help suggest treatments. A recent article tells how an AIMS helped diagnose malignant hyperthermia in a patient with no family history forty-five minutes after induction, based on clinical manifestations captured by the electronic chart (Maile, Patel, Blum, & Tremper, 2011). AIMS can facilitate better documentation by prompting the anesthesia provider for clinical information. With AIMS, historical records can be easily retrieved, thus improving access to key anesthesia information such as prior airway management or the patient's previous response to intraoperative anesthesia agents (Ehrenfeld, 2010). AIMS eliminates handwritten billing vouchers. "Once the required billing elements have been extracted from the AIMS, the professional services report (PSR) can be transmitted electronically at the time of case closure rather than days after the procedure has been completed" (Muravchick et al, 2008). Thus, shortening the revenue cycle, improving capture of charges, and reducing billing costs.

Anesthesia Information Management Systems

Many AIMS are available commercially from vendors and many have been developed for use in a specific facility. The range of systems available is vast; from a stand-alone AAR to a digital pen & paper (DPP) system (like that from Shareable Ink), to AIMS systems that allow the

user to point and click for documentation, to web-based systems utilizing wireless connectivity and cloud-computing architecture (like that from AnesthesiaEMR.com). If your hospital utilizes one specific vendor for their EHR, it would be best to contact that vendor to see if they have an anesthesia product and request a demonstration. A few of the commercially available AIMS systems come from the following well-known vendors: Acuitec, Cerner, DocuSys, Drager, GE Healthcare, iMDsoft, McKesson, Merge Healthcare, Philips Healthcare, Picis, and Surgical Information Systems. It is best to find a system that will be able to communicate with your hospital's existing EHR products. Remember, when selecting an anesthesia documentation product, that the anesthesia providers are not the only staff who will be affected by the change. Other departments like billing, medical records, information services, admitting, and quality assurance will be affected by the change from the paper anesthesia record to AIMS, as well.

Certified Products

Despite the large number of AIMS that are available, the number of certified AIMS products is much smaller. A search of the Certified Health IT Product List from the Office of the National Coordinator for Health Information Technology Website found AIMS products from five different vendors that were certified to at least one of the 2011 Edition EHR certification criteria for the inpatient practice setting and AIMS products from six different vendors that were certified to at least one of the 2011 Edition EHR certification criteria for the ambulatory practice setting (HealthIT.gov website, 2013). To qualify for the healthcare stimulus incentives, your facility must be using a certified EHR product.

Reasons for Slow Adoption Rates

Much like some of their specialty area counterparts, AIMS systems have been slow in their acceptance and adoption rates by anesthesia providers. Electronic documentation systems for Obstetrics, Trauma, Pediatric Trauma, Ambulatory Care, and Post-Anesthesia Care Units, just to name a few, have been slow in their adoption rates, as well. For many years the lack of available products was the main reason that these areas were not yet utilizing electronic documentation systems. These specialty areas are so fast-paced and complex with such diverse patient scenarios, it took much longer to build a system that met documentation standards for these areas. In fact, many of today's systems were home-grown, or developed in-house by the professionals who wanted an electronic system and could not find one commercially available that fit their needs.

There are many reasons that have been noted regarding the slow adoption of these systems, but the overall frontrunner in opposition of AIMS is cost. Dr. Ehrenfeld (2009) points out that widespread adoption of AIMS has been hindered primarily by the financial barriers associated with implementation of these systems. The average cost of an AIMS system is "$4,000-$10,000 per operating room plus an additional $14, 000-$45,000 for AIMS server installation" (Ehrenfeld & Rehman, 2011). The cost of the ongoing maintenance fees and application support must also be factored in when considering installation of an AIMS. Since the benefits of the expensive AIMS are not as apparent as those of a new anesthesia machine, for example, they are often considered nonessential purchases.

Regarding cost, there may be a question as to who would benefit financially from an AIMS, the hospital or the independent anesthesia providers. Because some hospitals employ anesthesia

providers as hospital staff and some hospitals have contracts with anesthesia groups who hire independent anesthesia providers, this will affect the AIMS adoption decisions. AIMS have been proven to improve billing practices and reimbursement of anesthesia services. A 2008 survey of 61 academic anesthesia departments states that "the hospital provided funding in almost all facilities (90%), with co-funding by the anesthesia group in 35%" (Halbeis et al, 2008, p. 1323). The hospital may be more receptive to set aside capital dollars if the independent anesthesia group is willing to supplement the cost of the AIMS, since the anesthesia group will likely reap the benefit of increased financial returns. Unlike larger academic institutions, smaller hospitals may not have the revenue necessary to acquire and maintain an AIMS system, which explains the much slower adoption rates of these hospitals.

Lack of interoperability with other health information systems is another reason for slow adoption of AIMS. "Historically, the challenge for hospitals looking to invest in AIMS was that the more sophisticated commercial AIMS products were stand-alone systems, not integrated modules of a facility-wide clinical information system" (Balust & Macario, 2009). Thus, the facilities must choose between systems that serve the anesthesia department well and systems that communicate well with other hospital systems. Vendors have realized this problem and are working diligently to achieve interoperability of systems. No complete EHR system with an anesthesia product was currently on the Certified Health IT product list, but five modular EHR systems for anesthesia were listed.

AIMS with poor design are no more efficient or safe than a paper record. Scrolling through computer screens to try and access information is no different than unsuccessfully flipping through pages of a chart. If a user cannot locate the information they are looking for in the chart,

patient care is delayed and patient safety is affected. AIMS should be effortless, intuitive systems that make information retrieval easier than the paper chart. Providers may be holding out for a more intuitive system before committing to an AIMS.

Inadequate return on investment (ROI) for the hospital is another barrier to adoption. Dr. Ehrenfeld (2009, p. 2) lists four ways that installing an AIMS can contribute to a positive ROI: reduced anesthesia drug costs, improved staff scheduling and reduced staff costs, improved billing/charge capture, and improved hospital reimbursement. If the anesthesia department is already efficient in these areas, the ROI may not be as large. Furthermore, the AIMS can only rely on the information that it is provided. If the providers are not documenting appropriately and in a timely manner, the AIMS cannot properly bill, code, and fire alerts.

Implementation of an AIMS is not only costly, but is a very complex process. When hospitals and anesthesia providers decide to move in the direction of AIMS, they must go through a long process of forming a committee to steer the project, evaluating and selecting a product and/or vendor, building the product to meet their facility's needs, selecting and purchasing equipment that will work with OR space requirements, testing the new system, training their staff on the new system, implementing the AIMS into their practice, and providing ongoing support for the AIMS. The ease of continuing the paper charting method is appealing when faced with the implementation process of an AIMS.

Some providers may be slow to adopt due to immaturity of the AIMS software. It makes sense that the longer a system has been in use and the more users it has, the better the chances that the glitches have been worked out within the system. Giving the systems time to mature and be perfected could be part of the plan for many hospitals and anesthesia groups. Despite the fact

that many surveys and articles state that an AIMS produced a positive financial return, the lack of proven benefits may have some groups not wanting to deviate from their current processes of charting and billing. "In fact, if not properly configured, AIMS run the risk of increasing billing denials, Medicare and Medicaid noncompliance, security breeches, including medical identity theft and medical-legal defense difficulties" (Balust & Macario, 2009).

System downtime is another concern when considering the adoption of an AIMS. Many anesthesia providers have been affected by downtimes of other electronic systems, whether the downtime affects the entire EHR or only one application, like the computerized provider order entry system; it causes delays in chart review, delays in patient care, and increases patient safety concerns. Regarding an AIMS system, downtime "is an important consideration for all institutions planning to implement electronic anesthesia records with modern devices, which have the ability to cache device data and autovalidate" (Marian, Scamman, & Todd, 2011). If the AIMS system caches, or collects, physiologic patient data during a downtime to merge onto a patient's chart, there is a possibility of erroneously documenting these results onto another patient's chart when the system is available again if the patient has left the OR and another patient is now in that OR suite. Marian et al (2011) recommend working with the vendor to develop a fix that would stop autovalidation after a defined period of downtime, such as 10 minutes, for example.

Because of the immense variety of anesthesia cases, providers may also be concerned about the workflow change and time constraints placed on them when working with AIMS. Since some anesthesia cases can be very short, will the AIMS increase the time it takes to turnover an operating room? On the other end of the spectrum, some anesthesia cases last several hours. How will the AIMS affect provider handoff of patient care? Some groups may be concerned

about how quickly their staff will adjust to the change brought about by AIMS based on diversity of age of staff and computer skills.

The last barrier to adoption of an AIMS that will be mentioned is malpractice exposure. Unlike handwritten anesthesia records, AIMS produce a typed, legible report from the data that is entered, which would be easy to read and understand in a court of law and leaves little to no room for misinterpretation. However, since physiologic events are documented in the electronic record, a brief moment of hypotension, desaturation, or even artifact from the monitor (which would normally not be documented on the handwritten anesthesia record) may be included in the electronic medical record. This could be fuel for a malpractice claim that normally would not be included in a paper chart. Then again, a survey of AIMS users applauded AIMS for the legibility of the record and gave "no indication that the technology increased malpractice exposure" (Feldman, 2004).

Summary

Understanding the benefits of AIMS and the barriers to AIMS adoption will help anesthesia groups and hospitals who are considering implementing an AIMS at their facility. Despite the documented benefits of AIMS, adoption of these systems is currently low. "Although AIMS are not universally present in the OR, increasing pressure to provide more in-depth case-based details, such as to third-party payers or to external quality improvement organizations, will continue to drive adoption nationwide" (Ehrenfeld, 2010).

This paper has reviewed the history of AIMS, examined the AIMS currently in existence, and attempted to determine the underlying reasons behind the slow adoption rates of AIMS by

providers and hospitals. Consider these points and evaluate if your facility would benefit from an AIMS. AIMS have been noted to improve operating room efficiency, increase patient safety, and expedite billing practices, but only when built, installed, and utilized properly. Further research should be conducted in regards to AIMS, their adoption, and their impact on anesthesia practice.

When making a decision regarding AIMS adoption, remember the words of cartoonist Carl Barks, “work smarter, not harder”, and decide accordingly. Information technology should make our jobs easier, not complicate our lives.

References

Abenstein, J.P., DeVos, C.B., Abel, & Tarhan, S. (1992). Eight years experience with automated anesthesia record keeping: Lessons learned- new directions taken. *International Journal of Clinical Monitoring and Computing*, 9, 117-129.

Anesthesia Patient Safety Foundation. (2001). Anesthesia Patient Safety Foundation Newsletter 16(4). Retrieved 06/03/2013 from http://www.apsf.org/newsletters/html/2001/winter/02ARK.htm

Balust, J. & Macario, A. (2009). Can anesthesia information management systems improve quality in the surgical suite? *Current Opinion in Anaesthesiology*, 22, 215-222.

Ehrenfeld, J.M. (2009). Anesthesia information management systems: A guide to their successful installation and use. *Anesthesiology News*, September 2009, 1-7.

Ehrenfeld, J.M. (2010). Anesthesia information management systems: Clinical and operational impact. *Anesthesiology News*, August 2010, 1-8.

Ehrenfeld, J.M. & Rehman, M.A. (2011). Anesthesia information management systems: A review of functionality and installation considerations. *Journal of Clinical Monitoring and Computing*, 25(1), 71-79.

Epstein, R.H., Vigoda, M.M., & Feinstein, D.M. (2007). Anesthesia information management systems: A survey of current implementation policies and practices. *Anesthesia & Analgesia*, 105(2), 405-411.

Feldman, J.M. (2004). Do anesthesia information systems increase malpractice exposure? Results of a survey. *Anesthesia & Analgesia*, 99(3), 840-843.

Halbeis, C.B.E., Epstein, R.H., Macario, A., Pearl, R.G., & Grunwalk, Z. (2008). Adoption of anesthesia information management systems by academic departments in the United States. *Anesthesia & Analgesia*, 107(4), 1323-1329.

HealthIT.gov Website. (2013). The office of the national coordinator for health information technology: Certified health IT product list. Retrieved 06/03/2013 from http://oncchpl.force.com/ehrcert/ehrproductsearch

Heinrichs, W.,Mönk, S., & Eberle, B. (1997). Automated anesthesia record systems. *Anaesthesist*, 46(7), 574-82.

Jao, C.S., Helgason, C.M., & Zych, D.A. (2009). Implementing a computerized charge capture system to improve billing work flow and reduce errors in data entry. *Journal of Computers*, 4(2), 127-134.

Kadry, B., Feaster, W.W., Macario, A., & Ehrenfeld, J.M. (2012). Anesthesia information management systems: Past, present, and future of anesthesia records. *Mount Sinai Journal of Medicine*, 79, 154-165.

Maile, M.D., Patel, R.A., Blum, J.M., & Tremper, K.K. (2011). A case of malignant hyperthermia captured by an anesthesia information management system. *Journal of Clinical Monitoring and Computing*, 25(2), 109-111.

Marian, A., Scamman, F., & Todd, M. (2011). Downtime situations and autovalidation of cached device in an modern electronic anesthesia record. *Anesthesia & Analgesia*, 113(25), Supplement 1-64, Abstract 11.

Muravchick, S., Caldwell, J.E., Epstein R.H., Galati, M., Levy, W.J., O'Reilly, M., …Vigoda, M.M. (2008). Anesthesia information management system implementation: A practical guide. *Technology, Computing, and Simulation*, 107(5), 1598-1608.

Simpao, A., Heitz, J.W., McNulty, S.E., Chekemian, B., Brenn, B.R., & Epstein, R.H. (2011). The design and implementation of an automated system for logging clinical experiences using an anesthesia information management system. *Anesthesia & Analgesia*, 112(2), 422-429.