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ADOPTION OF ANESTHESIA INFORMATION MANAGEMENT SYSTEMS BY US ANESTHESIOLOGISTS

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ABSTRACT. Objective. Electronic medical records (EMR) may increase the safety and efficiency of healthcare. Anesthesia care is a significant component of the perioperative period, yet little is known about the adoption of anesthesia information management systems (AIMS) by US anesthesiologists, particularly in non-academic settings. Herein, we report the results of a survey of US anesthesiologists regarding adoption of AIMS and anesthesiologist-perceived advantages and barriers to AIMS adoption. **Methods.** Using the e-mail database of the American Society of Anesthesiologists, we solicited randomly selected US anesthesiologists to participate in a survey of their AIMS adoption, perceived advantages and barriers to AIMS. Two and then 3 weeks after the initial mailing, a follow-up e-mail was sent to each anesthesiologist. The study was closed 4 weeks after the initial mailing. **Results.** Five thousand anesthesiologists were solicited; 615 (12.3%) responses were received. Twenty-four percent of respondents had installed an AIMS, while 13% were either installing a system now or had selected one, and an additional 13% were actively searching. Larger anesthesiology groups with large case loads, urban settings, and government affiliated or academic institutions were more likely to have adopted AIMS. Initial cost was the most frequently cited AIMS barrier. The most commonly cited benefit was more accurate clinical documentation (79%), while unanticipated need for ongoing information technology support (49%) and difficult integration of AIMS with an existing EMR (61%) were the most commonly cited problems. There were no barriers cited significantly more often by non-adopters than adopters. **Conclusions.** At least 50% of our survey respondents were currently using, installing, planning to install, or searching for an AIMS. However, the strength of any conclusion is undermined by a low survey response rate and potential bias as respondents using or searching for an AIMS may be more likely to participate. Nonetheless, challenges exist for anesthesiologists considering AIMS adoption including cost. Furthermore, important questions remain regarding payment for anesthesia services and the relationship of AIMS and ''meaningful use'' as defined by the Centers for Medicare & Medicaid Services.

KEY WORDS. electronic health records, informatics, anesthesia information management system.

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INTRODUCTION

Electronic medical records (EMR) may increase the safety and efficiency of healthcare [1]. Public officials and various organizations have called for the development and use of EMR by physicians and other healthcare providers.

Recent studies have documented the utilization of EMR in ambulatory [2] and inpatient settings. Unfortunately, more than 90% of hospitals in the United States have neither a comprehensive nor basic EMR [3].

Surgical care occurs during 30% of hospital admissions [4]. Anesthesia care is a very significant component of the perioperative period, yet very little is known about the prevalence of anesthesia information systems (AIMS) in US healthcare facilities. Indeed, the presence of an AIMS was not included in a recent major national survey of inpatient EMR use [5]. A recent survey of 140 US academic anesthesia departments revealed that at least 44% were currently using, searching for, or planning to acquire an AIMS [6]. However, the prevalence of adoption of AIMS in non-academic settings is unknown.

The primary objective of this study is to quantify the adoption of AIMS by anesthesiologists in the US. Using the e-mail database of the American Society of Anesthesiologists, a survey methodology was carried out to determine not only the prevalence of AIMS but also anesthesiologist-perceived advantages and barriers to AIMS. We hypothesized that financial constraints would be the most commonly cited barrier to AIMS adoption. Further, we hypothesized that larger anesthesiology groups (>50 physicians) with large case loads (>5,000 cases per year), urban settings, and practices affiliated with government or academic institutions would be most likely to have adopted AIMS. Among current users of AIMS, realized benefits, problems and satisfaction with AIMS were quantified. The secondary objective was to compare perceived barriers to adoption of AIMS among adopters versus non-adopters.

METHODS AND MATERIALS

Before survey distribution, the study received Institutional Review Board (IRB) approval. The requirement for written informed consent was waived by the IRB.

Survey development and administration

A review of recent literature on EMR and AIMS adoption was undertaken to identify common reasons for adoption or non-adoption of healthcare information technology. Survey development included questions regarding basic demographics, anesthesia group size and location (US region), AIMS implementation status, and perceived barriers to AIMS adoption (see attached survey). A branched-logic survey approach was used so respondents would not be asked irrelevant questions based upon previous responses.

The initial survey draft underwent several revisions in an effort to achieve clarity and content validity. Assistance was provided by the Survey Research Center, Mayo Clinic, Rochester, MN.

An introductory statement with a link to the survey website was sent to the American Society of Anesthesiologists (ASA), who then distributed it by e-mail to 5,000 US anesthesiologist members of the society in active practice. Two and then 3 weeks later, a follow-up survey was sent to all the selected anesthesiologists. The survey was closed 4 weeks after the initial mailing.

Statistical methods

The authors of the study did not have access to the ASA's e-mail database. All responses were anonymous. The results of the survey were tabulated by the Survey Research Center and sent to the authors for statistical analysis. Overall survey results were summarized using frequencies and percents. 95% confidence intervals were calculated using the exact binomial method. Analysis comparing adopters versus non-adopters was performed using chi-squared tests. P values < 0.05 were considered statistically significant.

RESULTS

The survey was initially distributed on February 24, 2010 and closed on March 25, 2010. Although the survey was intended only for anesthesiologists in active practice, 615 (12.3%) responded including 7 who identified themselves as retired or not in active practice and 2 who selected "other." Demographics are shown in Table 1; the respondent's region of practice (N = 603) was evenly distributed across the United States, including Northeast (24%), Midwest (24%), South (29%), and West (23%).

Overall, 84% of the respondents had EMR capabilities. Notable in Table 2 is that 24% of respondents had installed an AIMS, while an additional 13% were either installing a system now or had selected one, and an additional 13% were actively searching. Twenty-one percent of respondents noted no plans to install an AIMS. Among those who had selected an AIMS or were searching, 41% indicated they were more than a year from installation.

As hypothesized, larger anesthesiology groups (>50 physicians) with large case loads (>5,000 cases per year), urban settings, and practices affiliated with government or academic institutions were significantly more likely to have adopted AIMS (Fig. 1). Of note, there were 174 responders from academic institutions, 8 from Federal

Table 1. Demographics

	n (%)	95% CI
Training background (N = 615)		
Anesthesiologist in active practice	606 (99)	98–99
Anesthesiologist—retired or not in active practice	7 (1)	0–2
Other	2 (0)	0–1
Region of practice (N = 603)		
United States Northeast (CT, NH, NJ, NY, MA, ME, PA, RI, VT)	145 (24)	21–27
United States Midwest (IL, IN, IA, KS, MI, MN, MO, NB, ND, OH, SD, WI)	146 (24)	21–28
United States South (AR, AL, DC, DE, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN, TX, VA, WV)	176 (29)	26–33
United States West (AK, AZ, CA, CO, HI, ID, MT, NM, NV, OR, UT, WA, WY)	136 (23)	19–26
Primary practice site (N = 603)		
Urban	519 (86)	83–89
Rural	84 (14)	11–17
Size of anesthesiology group (N = 606)		
Solo practice	25 (4)	3–6
2–10 anesthesiologists	146 (24)	21–27
11–20 anesthesiologists	129 (21)	18–25
21–50 anesthesiologists	163 (27)	23–30
More than 50 anesthesiologists	143 (24)	20–27
Number of anesthetics preformed (N = 599)		
Less than 1,000	15 (2)	1–4
1,000–5,000	77 (13)	10–16
5,001–10,000	130 (22)	18–25
10,001–20,000	160 (27)	23–30
20,001–50,000	157 (26)	23–30
More than 50,000	60 (10)	8–12
Type of primary practice site (N = 602)		
An academic/university (teaching) center	174 (29)	25–33
Community hospital—for profit	79 (13)	10–16
Community hospital—not for profit	281 (47)	43–51
Federal government (VA Hospital System, Indian health center, military)	8 (1)	0–2
State or local government hospital	6 (1)	0–2
Free standing ambulatory surgery center	34 (6)	4–7
Office based	9 (1)	1–2
Other	11 (2)	1–3

institutions e.g. Veterans Administration hospitals, and 6 from State institutions (Table 3).

In Table 4 all anesthesiologists, regardless of their AIMS status or plans, were asked about potential advantages of AIMS (N = 593); whereas, only those who have installed or are installing, selected or are searching for an AIMS were asked about barriers to AIMS implementation (N = 290). As expected, initial cost was the most frequently cited AIMS barrier (52%). Table 5 summarizes reported funding sources among anesthesiologists with installed, selected or currently installing AIMS. Hospital (88%) was the most frequently cited source. Multiple funding sources are possible.

Table 6 summarizes the perceived benefits, problems, and satisfaction with AIMS among current users. Of note, the most commonly cited benefit was more accurate clinical documentation (79%), while unanticipated need for ongoing information technology (IT) support (49%) and difficult integration of AIMS with existing EMR (61%) were the most commonly cited problems. More than 75% of current AIMS users were at least somewhat satisfied with their AIMS.

Table 2. AIMS Status and compatibility

	n (%)	95% CI
AIMS status (N = 606)		
Installed	145 (24)	21–27
We have selected an AIMS, not installed yet	51 (8)	6–11
Installing an AIMS now	30 (5)	3–7
Searching for an AIMS now	79 (13)	10–16
Don't know	173 (29)	25–32
No plans to install AIMS	128 (21)	18–24
AIMS Timeframe (N = 127) (selected or searching for AIMS)		
0–6 months	14 (11)	6–16
7–12 months	35 (28)	20–35
More than 12 months	52 (41)	32–49
Unsure	26 (20)	13–27
AIMS and EMR compatibility (N = 212) (installed, selected or installing an AIMS)		
Integrated- patient data can be moved from one to the other	100 (47)	40–54
Free standing—the AIMS creates an electronic anesthesia record, but the AIMS neither receives nor sends data to the institution's EMR	59 (28)	22–34
Unsure	53 (25)	19–31

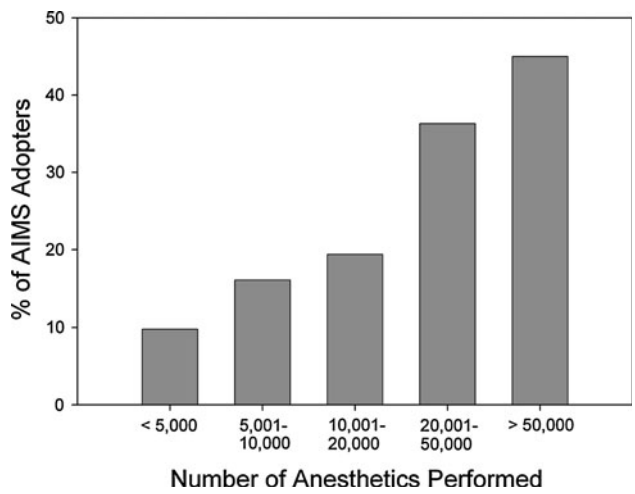

Fig. 1. Percent Anesthesia Information Management System adopters versus number of anesthetics performed per year.

Our secondary objective was to compare perceived barriers to adoption among adopters versus non-adopters of AIMS. Ongoing IT costs, lack of IT support and lack of an AIMS compatible with the institution's overall EMR were barriers cited significantly more often by adopters of AIMS versus non-adopters. However, there were no barriers cited significantly more often by non-adopters than adopters.

DISCUSSION

Based on this survey, 24% of US anesthesiologists are currently using an AIMS, with an additional 13% either installing an AIMS or waiting to install an identified system. Initial cost was the most frequently cited AIMS barrier. Although 79% of current users noted more accurate clinical documentation, significant problems

Table 3. Prevalence of AIMS adoption

	Yes	No	Delta	95% CI	*P*
Large anesthesiology groups (>50 anesthesiologists)	65/143 (45%)	80/463 (17%)	0.28	0.19–0.37	<0.001
Large case loads (>50,000 anesthetics performed per year)	27/60 (45%)	118/539 (22%)	0.23	0.10–0.36	<0.001
Urban settings	134/519 (26%)	10/84 (12%)	0.14	0.06–0.22	0.006
Academic or Federal/State Government Institutions	91/188 (48%)	53/414 (13%)	0.36	0.28–0.43	<0.001
Use of EMR	144/510 (28%)	1/96 (1%)	0.27	0.23–0.32	<0.001

Table 4. AIMS advantages and barriers

	n (%)	95% CI
AIMS advantages (N = 593)		
More accurate clinical documentation	405 (68)	65–72
Improved regulatory compliance	378 (64)	60–68
Reduced workload for anesthesiologist	181 (31)	27–34
Improved patient safety	232 (39)	35–43
Increased revenue, capture of charges	268 (45)	41–49
Better data for quality improvement	403 (68)	64–72
Improved operating room efficiency	142 (24)	21–27
Easier tracking of supplies	242 (41)	37–45
Better data for research	321 (54)	50–58
No advantages over paper record	88 (15)	12–18
AIMS barriers (N = 290) (installed, installing, selected or searching for an AIMS)		
Initial cost—lack of funding	151 (52)	46–58
Inadequate return on investment	62 (21)	17–26
Lack of expertise/champion among anesthesia colleagues	97 (33)	28–39
Competition for funding from other information technology (IT) projects	83 (29)	23–34
Ongoing IT costs	95 (33)	27–38
Lack of IT support dedicated specifically to AIMS	121 (42)	36–47
Lack of system that meets anesthesiologist's needs	103 (36)	30–41
Lack of system that integrates with institution's EMR	124 (43)	37–48
Fear of inaccurate records, legal implications	115 (40)	34–45
Lack of support from hospital administration	43 (15)	11–19
Resistance from anesthesiologists	104 (36)	30–41
No clear benefit over paper record	35 (12)	8–16

Table 5. Funding sources among installed, selected or currently installing AIMS

	n (%)	95% CI
AIMS funding (N = 208)		
Anesthesia department	54 (26)	20–32
Hospital	183 (88)	84–92
Government agency	15 (7)	4–11
School of medicine/university	8 (4)	1–6
Industry	3 (1)	0–3
Private	3 (1)	0–3
Other, please specify below	2 (1)	0–2

persist for users including the need for ongoing IT support and inadequate integration with an existing EMR.

Despite significant challenges to adoption, a number of factors may drive practices to adopt AIMS including improved efficiency and accuracy of anesthesia records [7], billing [8], quality assurance data, and research. Other potential AIMS advantages include clinical decision support (e.g. electronic provision of timely clinical practice guidelines), visual reminders of clinical requirements such as antibiotic administration [9], and improved legal defense in medical liability situations. In the future, linkage of AIMS to the Anesthesia Quality Institute database may be advantageous in terms of quality and payment initiatives.

A guide for AIMS implementation is available [10], but an anesthesia department ''clinical champion'' is vital to success of the transition from paper to electronic anesthesia records [11]. Important questions remain regarding the relationship of AIMS and anesthesiologists to the ''meaningful use'' criteria as defined by the Centers for Medicare & Medicaid Services and the Office of National Coordinator.

The Federal government recently released regulations that in the near-term link use of EMR to payment incentives. In 2015, payment penalties will begin to be assessed if eligible providers do not demonstrate ''meaningful use'' of EMR based on the government's criteria [12]. Under the current provision, ''only those anesthesiologists who provide 90% or more of their covered services in an inpatient or emergency room setting (POS Codes 21 and 23) will be exempt from the penalties that will begin in 2015 if a provider fails to meet the meaningful use requirements'' [13].

Table 6. Benefits, problems, and satisfaction among current users of AIMS

	n (%)	95% CI
AIMS benefits (N = 137)		
More accurate clinical documentation	108 (79)	72–86
Better data for quality improvement	84 (61)	53–69
Better data for research	71 (52)	43–60
Improved regulatory compliance	94 (69)	61–76
Increased revenue—capture of charges	62 (45)	37–54
Improved operating room efficiency	29 (21)	14–28
Easier tracking of supplies	37 (27)	20–34
Reduced workload for anesthesiologist	45 (33)	25–41
Improved patient safety	47 (34)	26–42
No advantages over paper record	16 (12)	6–17
AIMS problems (N = 137)		
Unanticipated need for ongoing IT support	67 (49)	41–57
Less efficient work flow	40 (29)	22–37
Downtime that has delayed patient care	53 (39)	31–47
Downtime that has compromised patient safety	15 (11)	6–16
Unexpected costs (IT, maintenance, repair, upgrades, other)	45 (33)	25–41
Inaccurate records	26 (19)	12–26
Difficult integration of AIMS with existing hospital EMR	84 (61)	53–69
Other, please specify below	12 (9)	4–13
No significant problems	20 (15)	9–21
Satisfaction with AIMS (N = 145)		
Very satisfied	62 (43)	35–51
Somewhat satisfied	50 (34)	27–42
Neither satisfied nor unsatisfied	18 (12)	7–18
Somewhat unsatisfied	10 (7)	3–11
Very unsatisfied	5 (3)	0–6

Although the American Society of Anesthesiologists has expressed its concerns with Administration officials, the final rule does not specifically address the use of AIMS or the fact that many of the meaningful use requirements do not apply to anesthesia practice. In February 2011, the American Society of Anesthesiologists sent a letter to the Center for Medicare and Medicaid Services (CMS) requesting that meaningful use criteria be revised to ensure that eligible anesthesiologists can meet the criteria [14].

In terms of comparative literature, Egger Halbeis et al. surveyed academic anesthesia departments (2007 timeframe) and found that at least 44% had committed to AIMS, including those who had installed, were implementing, had selected, or were planning to purchase an AIMS [6]. This is similar to our survey of both academic and non-academic anesthesiologists, where we found that 50% of respondents were at least searching for an AIMS if not currently using, waiting to install or installing a system (Table 2).

In a similar study, Balust et al. conducted a web survey of European university-affiliated anesthesia departments [15]. They found that at least 15% of the departments surveyed were at least selecting if not implementing or using an AIMS, with non-adopters identifying cost as the primary barrier.

Other issues to consider when implementing an AIMS include malpractice exposure (i.e. do AIMS increase risk?) and return on investment (ROI). In 2004, Feldman surveyed 55 anesthesiology departments using an AIMS [16]. Of 24 departments responding, 41 malpractice cases had been filed since AIMS adoption, 11 of which were settled or litigated. In this small sample, none of the respondents reported that their AIMS compromised their legal defense and there were many instances where the AIMS was felt to have documented appropriate care or otherwise was helpful in litigation.

In terms of ROI, AIMS may be beneficial in areas such as charge capture, OR management, and tracking of supplies and other resources including medications [10].

However, justification for an AIMS based purely on financial considerations may be difficult because of the many assumptions that must be made regarding enhanced patient care.

There are a number of limitations of our study. First, it was a survey of individual providers rather than surgical facilities. It is likely that AIMS penetrance in US hospitals is much less than the 24% anesthesiologist adopters in our study. One recent estimate of AIMS market penetration in hospitals is between 12 and 16% [17]. We did not have direct access to the ASA's e-mail database; the respondents were anonymous. Although this approach was ideal to insure confidentiality, our results could be inflated by multiple respondents from the same institution, or by one individual who answered multiple times. To address this problem in part, we could have asked the respondents to identify their primary practice site by name; however, we have no mechanism to validate the responses. The low response rate undermines the strength of any conclusions.

It is noteworthy that our respondents were distributed evenly across the country, suggesting but not guaranteeing a representative national sample. Disappointedly, we were unable to identify any characteristics of non-adopters versus adopters in terms of perceived barriers to AIMS adoption. This data might have provided guidance to medical society and political leaders as they seek to overcome barriers to adoption among US anesthesiologists.

In summary, at least 50% of our survey respondents were currently using, installing, planning to install, or searching for an AIMS. Large anesthesiology groups (>50 physicians) with large case loads (>5,000 cases per year), urban settings, and practices affiliated with government or academic institutions were significantly more likely to have adopted AIMS. However, the strength of any conclusion is undermined by a low survey response rate and potential bias as respondents using or searching for an AIMS may be more likely to participate. Nonetheless, significant challenges exist for anesthesiologists considering AIMS adoption including cost, concerns over the need for ongoing information technology support and inadequate integration with existing EMR.

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