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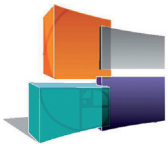

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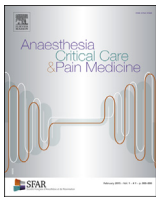

Original Article

An anaesthesia information management system as a tool for a quality assurance program: 10 years of experience

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ABSTRACT

Introduction: Anaesthesia Information Management Systems (AIMS) generate large amounts of data, which might be useful for quality assurance programs. This study was designed to highlight the multiple contributions of our AIMS system in extracting quality indicators over a period of 10 years.
Methods: The study was conducted from 2002 to 2011. Two methods were used to extract anaesthesia indicators: the manual extraction of individual files for monitoring neuromuscular relaxation and structured query language (SQL) extraction for other indicators which were postoperative nausea and vomiting (PONV), pain, sedation scores, pain-related medications, scores and postoperative hypothermia. For each indicator, a program of information/meetings and adaptation/suggestions for operating room and PACU personnel was initiated to improve quality assurance, while data were extracted each year.
Results: The study included 77,573 patients. The mean overall completeness of data for the initial years ranged from 55 to 85% and was indicator-dependent, which then improved to 95% completeness for the last 5 years. The incidence of neuromuscular monitoring was initially 67% and then increased to 95% ($P < 0.05$). The rate of pharmacological reversal remained around 53% throughout the study. Regarding SQL data, an improvement of severe postoperative pain and PONV scores was observed throughout the study, while mild postoperative hypothermia remained a challenge, despite efforts for improvement.
Discussion: The AIMS system permitted the follow-up of certain indicators through manual sampling and many more via SQL extraction in a sustained and non-time-consuming way across years. However, it requires competent and especially dedicated resources to handle the database.

1. Introduction

The computerized recording of anaesthesia charts, or Anaesthesia Information Management Systems (AIMS), has been available for anaesthesia providers for over two decades [1]. They were originally designed to replace traditional, voluntary, hand recording systems [2]. Automated anaesthesia records and computerized data are described as being more accurate since the phenomena of smoothing, or resistance to the reporting of extreme values, cannot be present [3,4] and, at the least, they create more time for patient-surveillance. Both systems lack total accuracy. For example, the AIMS system does not rely solely on automated parameter recording since self-reporting (e.g.: adverse events) remains necessary and might be under-reported or less accurate [3,5]. In parallel, this information technology generates huge databases, which allow anaesthesia providers to rapidly consult each anaesthesia record, thus avoiding the waiting time associated with paper record retrieval and transfer. However, data extraction by SQL (Structured Query Language) is also available and can be used to monitor certain data categories, such as intra- or postoperative immediate outcomes [6]. The effective monitoring of medical activity is an integral part of any assurance quality program, together with sustained control of multiple indicators. We previously published a brief report on the overall trends in the main indicators of our quality assurance program for 9 consecutive years [7]. The primary objective of the present study was to quantify the effect of several interventions or changes in practice during 10 consecutive years in our anaesthesia department.

2. Patients and methods

In March 2001, our operating rooms were equipped with the ARK^{TM} system integrated with ADU S/5 workstations

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(Datex-Ohmeda General Electric) for the computerized recording of anaesthesia records and recognized as an AIMS. In order to allow for a washout period during which staff (including users and administrators) became collectively familiar with the system, the actual study period ran from 2002 to 2011. While interventions by anaesthesia providers are indexed manually, physiologic data and vital signs are recorded automatically (e.g.: EKG, pulse, blood pressure, temperature, ventilatory parameters related to anaesthesia machines and inhalational gas consumption). All patients who had anaesthesia, be it general, sedation, regional or local with anaesthesia surveillance, were considered. Upon arrival in the Postoperative Anaesthesia Care Unit (PACU), several clinical items must be manually recorded into the system (e.g.: respiratory status, pain and postoperative nausea and vomiting [PONV], sedation scores and their respective related medications, or central temperature). Our institution's local ethics committee authorized our department to extract information from the database for our quality assurance program and subsequently publish general results (*Avis* n° 92012/33465).

Our clinical procedures strongly encourage anaesthesia providers to index all non-automated administrative, clinical and pharmacological interventions in order to decrease the percentage of incomplete files. During this period, our quality management team started concomitantly monitoring anaesthesia care indicators via manual searches using the PDF storage database (personal anaesthesia file for each patient, Archive Browser®) and by SQL extractions over the entire database for specific indicators. All items extracted by SQL analysis were manually verified for a small number of patients during a short period of time in order to rule out duplicate or missing files. For the purposes of quality assurance in our anaesthesia department, we selected several indicators for extraction: the percentage of pharmacological reversals and instrumental monitoring of neuromuscular blockades, opioid consumption for the intraoperative period and while in the post-anaesthetic care unit (PACU). Other extracted indicators included: pain scores upon arrival, morphine and other analgesic drug consumption, sedation scores, central temperature (tympanic) and PONV scores, which are all manually indexed by the PACU personnel.

Results were analysed and meetings on morbidity/mortality were organized in order to issue suggestions for improvements. Indicators were therefore re-checked in further assessments.

The suggested interventions and changes in practice were:

- muscle relaxants: the mandatory use of our neuromuscular monitoring system NMT Datex-Ohmeda®, which is connected to our anaesthesia station and the AIMS system and reversal of neuromuscular blockade and extubation according to updated general clinical guidelines;
- intra- and postoperative pain management was initially guided by promoting multimodal non-opioid analgesia, and the decrease of postoperative morphine, epidural analgesia using local anaesthetics for major thoracoabdominal surgery, and the progressive shift to use of remifentanil for early extubation;
- postoperative nausea and vomiting was initially managed at the discretion of the anaesthesiologists. However, after a primary evaluation in 2005 [8], a new protocol using intraoperative dexamethasone and droperidol with odansetron in the PACU was initiated in 2006. This protocol was then readjusted in 2012;
- postoperative inadvertent hypothermia was discussed every 2 years not only with anaesthesia providers, but also with other operating room actors. Guidelines were issued concerning the management of room temperature, monitoring of intraoperative temperature, and blankets to be available for the patients before entering the operating room area, and the availability of an adequate number of active warming devices.

All data for one patient are recorded as a PDF file, which is printed and added to his/her hospital file when leaving the PACU. The database is also searchable by keywords for system and quality assurance administrators; however, data extraction is not intuitive and requires several hours of training, which can be considered as a limitation of the system. Items, such as the presence and quality of neuromuscular blockade monitoring data (when SQL extraction was not possible), were extracted manually by sampling through a fixed period and for a limited number of patients (200).

2.1. Statistical analysis

Results are presented as percentages or means ± standard deviations when appropriate.

Because of the data distribution and the number of missing files in the initial period only, descriptive numbers with their trends are presented. Comparative statistics were performed for a limited number of patients as concerns muscle relaxant monitoring, or for years in which missing files were less than 10% by using ANOVA or Chi^2 tests as appropriate. A P value of 0.05 was considered to be statistically significant.

3. Results

The data were collected over 10 consecutive years from 2002 to 2011. The total number of patients registered for this period was 77,573.

The mean completeness or exhaustivity of the data ranged from 90% in 2002 to > 95% in 2011. However, this was item-dependent; the worst case was the PONV score, which started as low as 50% and attained 86% in 2011.

3.1. Monitoring neuromuscular blockades

Although the percentage of reversal could be rapidly accessed by SQL (51 to 57% across years), the incidence of instrumental monitoring could not be extracted from the database and required manual retrieval from patient samples. The incidence of neuromuscular blockade monitoring was 67% for a selected sample of 200 patients receiving muscle relaxants in the first assessment in 2005. After quality assurance specific guidelines were issued, this percentage increased to 94% 6 months later in another sample of 200 patients. This percentage remained stable in further analyses. The rate of reversal remained steady at around 53%. It should be noted that access to the anaesthesia file PDF database is much easier in comparison to that of the real anaesthesia chart selection and review of archives.

3.2. Pain scores and opioid consumption

The percentage of patients entering the PACU with a high pain score (on a five-point scale) despite anticipation is displayed in Fig. 1. To decrease this incidence of high pain scores, we issued a new postoperative analgesic protocol in 2009. The complete results have not yet been extracted because of a database change/upgrade in 2011. Nevertheless, a steady decline in overall morphine consumption has been recorded (Fig. 2). On the contrary, a significant increase in remifentanil (23% in 2002 versus 92% in 2011, $P < 0.01$) was noted at the expense of sufentanil without affecting overall sedation scores (Fig. 3), thus highlighting an increase in the concomitant use of other non-opioid based analgesics (Fig. 4).

3.3. Postoperative nausea and vomiting (PONV)

The percentages associated with the various PONV scores during the study period are represented in Fig. 5. A significant