



Original Contribution

Automated anesthesia carts reduce drug recording errors in medication administrations – A single center study in the largest tertiary referral hospital in China



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ABSTRACT

Aim: To clinically evaluate a type of patented automated anesthesia cart in medication administrations in anesthesia.

Materials and Methods: This was a prospectively randomized open label clinical trial. In 10 designated operating suits in the First Affiliated Hospital of Zhengzhou University, in China. 1066 cases originated from 10,812 medication administrations in anesthesia were randomized. 78 registered anesthesiologists managed the medication. The patients received medication administrations in anesthesia with either an automated or a conventional manual cart. American Society of Anesthesiologists (ASA) score, sex, duration of anesthesia and surgical specialty, errors in administration of medications (incorrect medication given (substitution), medication not given (omission) and drug recordings errors"), compliance and satisfaction were recorded.

Results: The total error rate was 7.3% with the automated anesthesia carts (1 in 14 administrations) and 11.9% with conventional manual carts (1 in 8 administrations). Automated anesthesia carts significantly reduced the drug recording error rate compared to conventional manual carts ($P < 0.01$). However, no significant difference of substitution or errors omission errors was found between groups of automated anesthesia carts and conventional manual carts. The anesthesiologists' compliance with the automated anesthesia carts was unsatisfactory, and all the errors in medication recordings with the automated anesthesia carts were due to the incorrect use of the carts. Most of the participating anesthesiologists preferred the automated anesthesia carts ($P < 0.05$).

Conclusions: The utilization of automated anesthesia carts reduced the drug recording errors in medication administrations of anesthesia.

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1. Introduction

Operating room is an environment with rapid workflow. Anesthesiologists are usually too busy with problem-solving, decision-making and implementation. Hence, there is no surprising for the occasion that anesthesiologists lose their focus and make mistakes when performing tasks. When conducting to anesthesia, errors in medication administrations are particularly problematic and ought to be strictly prevented. Hence it is crucial to develop safe and errorless drug delivery strategies, up to now several techniques attempting to reduce or even eliminate errors during medication administrations in anesthesia have begun to take effect [1].

The First Affiliated Hospital of Zhengzhou University is a licensed tertiary referral hospital, and is the largest hospital in China with 8000-licensed beds [2], With 99 surgical suites and 152 anesthesiologists on

staff, the hospital manages approximately 600 surgical cases each day, nearly 100,000 cases yearly. With such large amount of anesthesia cases, the traditional manual method in implementation of medication administrations is beset with difficulties. Hence, we introduced automated anesthesia carts into our surgical area in 2014 to improve the safety and quality through system improvement. The automated anesthesia cart consists of an intelligent computer system and management cart which stores the drugs that will be administrated in anesthesia. The automated anesthesia carts present favorable management and clear labels, among which the system computer of automated anesthesia cart automatically records the information of medications given during anesthesia.

Although the automated anesthesia carts are universally used in many hospitals in America and Canada, in China it has been demonstrated the drug administration error is of concern based on large prospectively collected datasets at a large tertiary hospital. Anaesthetists were required to return a study form anonymously indicating whether or not a drug administration error had occurred [3]. However, there has been yet no study by trained observers on the evaluation of medication

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administrations with automated anesthesia carts, especially in a large scale. In this study, we conducted a prospective via random open label clinical trial to assess the impact of automated anesthesia carts on reducing errors of medication administrations in anesthesia.

2. Materials and methods

2.1. Cart groups

All participating anesthesiologists had received formal training on using the automated anesthesia carts (a-Med 600, DIH Anesthesia Management System, DIH Technology, China). Before surgery, all patients scheduled for anesthesia were given an information sheet that informed them of the study and they could either agree or decline to participate in the study as they wish.

Surgical suites were set up for provision of anesthesia with either the automated anesthesia carts or conventional manual carts according to the randomization schedule at the beginning of each week. The operating cases selected and surgical specialties represented were chosen to give a broad general anesthesia case mix but not emergency and critical cases ($ASA \geq 4$).

The automated anesthesia carts equipped with an intelligent computer system which showed drugs list in the trolley drawers correspondingly. Every drug was set in an independent box with a transparent cover. The automated anesthesia carts stored the same medicines as the traditional carts did and had the similar layout which anesthesiologists were familiar to. In addition, the drugs in automated anesthesia carts were separately stored with clear visible labels (Fig. 1). Medication record is automatically compiled by computer for a real-time read-out and a hardcopy of the complete record could be printed out at the end of anesthesia.

While using the half-open conventional manual carts, anesthesiologists had to manually locate the medications used in anesthesia from the carts and record the category and quantity of the medications by hand writing (Fig. 2).

2.2. Variables of interest

Six registered pharmacists in our hospital were assigned as observers to collect data after they were trained for this study. Training

included reading an introductory textbook of anesthesia [4], observing at least 10 cases and the correct use of the automated anesthesia carts. During the study, the observers visited the operating theatre at the beginning and the end of every case. The observers with no relevant conflict of interest were explicitly asked to oversee the study processes.

2.3. Preoperative variables

The American Society of Anesthesiologists (ASA) score, sex, duration of anesthesia and surgical specialty of all the patients participating in this study were recorded.

2.4. Errors in medication administrations

In this study, medication errors in anesthesia consisted of “Incorrect medication given (substitution)”, “Medication not given (omission)” and “Drug recording errors” according to the sources of errors of medication administrations. Substitution errors meant incorrect drug selection. Omission errors meant the failure of an ordered dose of drug to a patient before the next scheduled one. Drug recording errors meant “drug given but not recorded” or “incorrect records”.

To facilitate the identification of errors in medication administrations, we took a full inventory of the contents of the anesthetic drug drawers before each case. Anesthesiologists were asked to retain all ampoules and vials. Empty sharp bins were used to facilitate calculating drugs inadvertently discarded during each case. At the end of each case, the drugs used were identified by the same means as stated above and the remaining contents of the drug drawers against the preoperative inventory were reconciled. The medication administration record on tags and the quantities of the used drugs were generalized either by a computer (automated anesthesia carts) or by anesthesiologists (conventional manual carts). Discrepancies between medication administration record and information of actual use of drugs verified by observers were considered as errors in medication administrations for further analysis.

2.5. Compliance

At the end of each case, the observers assessed the anesthesiologists' compliance with the procedural rules of automated anesthesia carts.



Fig. 1. The automated anesthesia cart.

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