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## MISCELLANEOUS

### Profile of drug administration errors in anesthesia among anesthesiologists from Santa Catarina



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#### KEYWORDS

Medical errors;  
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#### Abstract

**Introduction:** Anesthesiology is the only medical specialty that prescribes, dilutes, and administers drugs without conferral by another professional. Adding to the high frequency of drug administration, a propitious scenario to errors is created.

**Objective:** Assess the prevalence of drug administration errors during anesthesia among anesthesiologists from Santa Catarina, the circumstances in which they occurred, and possible associated factors.

**Materials and methods:** An electronic questionnaire was sent to all anesthesiologists from Sociedade de Anestesiologia do Estado de Santa Catarina, with direct or multiple choice questions on responder demographics and anesthesia practice profile; prevalence of errors, type and consequence of error; and factors that may have contributed to the errors.

**Results:** Of the respondents, 91.8% reported they had committed administration errors, adding the total error of 274 and mean of 4.7 (6.9) errors per respondent. The most common error was replacement (68.4%), followed by dose error (49.1%), and omission (35%). Only 7% of respondents reported neuraxial administration error. Regarding circumstances of errors, they mainly occurred in the morning (32.7%), in anesthesia maintenance (49%), with 47.8% without harm to the patient and 1.75% with the highest morbidity and irreversible damage, and 87.3% of cases with immediate identification. As for possible contributing factors, the most frequent were distraction and fatigue (64.9%) and misreading of labels, ampoules, or syringes (54.4%).

**Conclusion:** Most respondents committed more than one error in anesthesia administration, mainly justified as a distraction or fatigue, and of low gravity.

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**PALAVRAS-CHAVE**

Erros médicos;  
Erros de medicação;  
Anestesiologia;  
Anestesia

## Perfil de erros de administração de medicamentos em anestesia entre anesthesiologistas catarinenses

**Resumo**

**Introdução:** A anestesiologia é a única especialidade médica que prescreve, dilui e administra os fármacos sem conferência de outro profissional. Somando-se a alta frequência de administração de fármacos, cria-se o cenário propício aos erros.

**Objetivo:** Verificar a prevalência dos erros de administração de medicamentos durante anestesia, entre anesthesiologistas catarinenses, as circunstâncias em que ocorreram e possíveis fatores associados.

**Materiais e métodos:** Um questionário eletrônico foi enviado a todos os anesthesiologistas da Sociedade de Anestesiologia do Estado de Santa Catarina contendo respostas diretas ou de múltipla escolha sobre dados demográficos e perfil da prática anestésica do entrevistado; prevalência de erros, tipo e consequência do erro; e fatores que possivelmente contribuíram para os erros.

**Resultados:** Dos entrevistados, 91,8% afirmaram ter cometido erro de administração, somando total de erros de 274 e média de 4,7 (6,9) erros por entrevistado. O erro mais comum foi substituição (68,4%), seguido por erro de dose (49,1%) e omissão (35%). Apenas 7% dos entrevistados referiram erros de administração no neuroeixo. Quanto às circunstâncias dos erros, ocorreram principalmente no período matutino (32,7%), na manutenção da anestesia (49%), com 47,8% sem danos ao paciente e 1,75% com maior morbidade com dano irreversível e em 87,3% dos casos a identificação imediata. Quanto aos possíveis fatores contribuintes, os mais frequentes foram: distração e fadiga (64,9%) e leitura errada dos rótulos de ampolas ou seringas (54,4%).

**Conclusão:** A maioria dos anesthesiologistas entrevistados cometeu mais de um erro de administração em anestesia, principalmente justificado como distração ou fadiga, de baixa gravidade.

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**Introduction**

Drug administration errors are important causes of morbidity and mortality,<sup>1,2</sup> accounting for about 7000 deaths per year in the United States,<sup>3</sup> resulting in direct health costs and possibly avoidable human suffering.<sup>2</sup> Anesthesiology is the only medical specialty that prescribes, dilutes, and administers drugs without conferral by another professional. Adding to the high frequency of drug administration, as well as its potency and application urgency, it creates a favorable setting for errors and to the disastrous consequences of such failure.

Thus, there are several studies reporting drug administration errors as an important cause of anesthetic morbidity and mortality. In a 1984 study, evaluating anesthesia incidents, the most frequently reported were respiratory system shut-down and needle Exchange.<sup>4</sup> In another study performed in Denmark of deaths related to anesthesia, medication errors were the second leading cause, second only to airway and ventilation problems. When associated with deaths from medication errors and infusion pump problems, they become the study leading cause of mortality.<sup>5</sup>

Over the past 60 years, many studies have assessed the prevalence of drug administration error in anesthesia, but prospective works designed specifically to study the issue arose only in the last decade.<sup>6–10</sup> Such works reported incidences ranging from one error for each 133–450 anesthesia applications. Considering the higher incidence, it was

estimated that each anesthesiologist makes seven mistakes a year and consequently causes damage in two patients over a career.<sup>2</sup>

Thus, together with the growing interest in issues concerning the patient safety during anesthesia, it is of great value to examine the prevalence of medication errors among anesthesiologists in Santa Catarina, as well as the verification of the factors that contribute to the error.

**Objective**

Check the prevalence of drug administration errors during anesthesia among anesthesiologists in Santa Catarina, as well as the circumstances in which they occurred, and assess the possible associated factors.

**Method**

We developed an electronic questionnaire (Appendix 1), with three sections of questions. The questions were either direct or multiple choice, when appropriate, and more than one answer could be checked. The first section dealt with demographic data (sex and age), as well as the interviewee anesthetic practice profile: number of years working with anesthesiology, hours worked per week, and degree of specialization. The second section had questions on prevalence of errors among respondents, number of remembered

errors, type, detection time, and worst consequence of a committed error. The last section investigated the factors that may have contributed to the error.

The questionnaire was sent by e-mail twice, with four-week interval, together with an explanatory text on the research nature, subject relevance, and informed consent for the use of data to all associated anesthesiologists of the Society of Anesthesiology of the State of Santa Catarina (SAESC) in the year 2013. Participation in the study was voluntary upon acceptance of the terms sent via email.

The software used for sending the questionnaire and storage of responses was the Survey Monkey and for statistical analysis and chart preparation, Microsoft Excel was used.

## Results

The questionnaire was sent to members of the Anesthesiology Society of the State of Santa Catarina in July and August 2013, 30 days apart. Of the 376 members of SAESC, 61 answered the questionnaire, and the response rate was 16.2%.

Regarding demographic data, the mean age of respondents was 39 (standard deviation, 10.8) years, and 80.3% were male. The mean working time with anesthesiology including residency training was 13 (10.6) years, and the mean weekly working hours was 59 (20.1) hours. As for specialization, only 16.4% were still attending residency, 45.9% had an anesthesiology expert title, and 37.7% had a superior title in anesthesiology.

As shown in Fig. 1, 91.8% of respondents said they have committed a drug administration error, with a total number of 274 errors and a mean error of 4.7 (6.9) per interviewee. The most common type of error was replacement, committed by 68.4% of respondents, followed by dose error (49.1%) and omission (35%). With regard to neuraxial drug administration error, only 7% of respondents reported its occurrence. Fig. 2 shows error types and percentages.

As for the circumstances in which the errors occurred, the majority reported to have occurred in the morning (32.7%), followed by the afternoon (21.8%) and evening (16.3%) periods. However, 29% of respondents did not remember the time the error occurred. Most of the errors occurred during

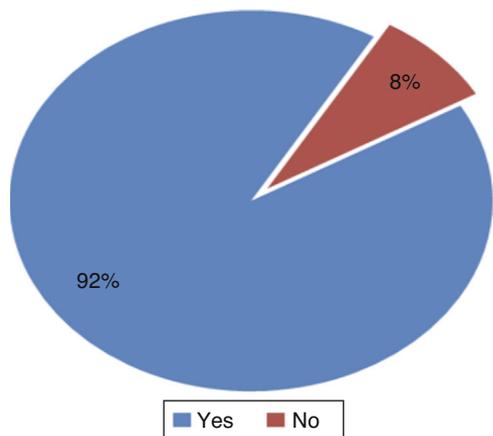


Figure 1 Prevalence of drug administration error among Santa Catarina anesthesiologists.

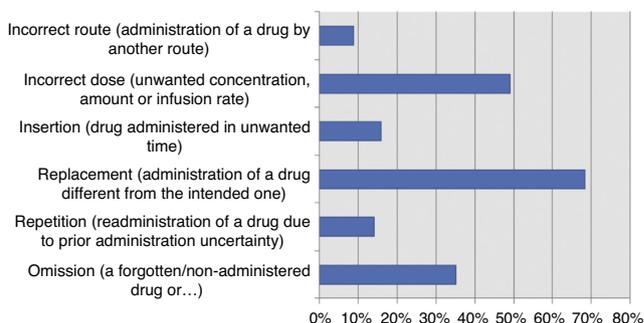


Figure 2 Types of errors and prevalence.

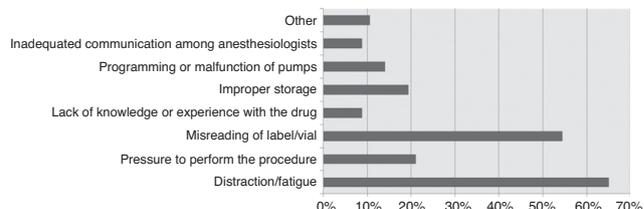


Figure 3 Factors that respondents believed had contributed to the errors.

maintenance of anesthesia (49%), followed by the induction of anesthesia (30.9%) and extubation (12.7%) periods. A minority of respondents reported having committed errors in the preanesthetic (5.5%) or postanesthetic (1.8%) periods.

Regarding the worst consequence of an error, 47.8% of those who made mistakes reported that the errors did not bring harm to the patient, 43.9% reported less morbidity with reversible damage, with increased time to extubation or postanesthetic recovery. Higher morbidity with reversible damage requiring invasive monitoring was reported by 7% of respondents, and higher morbidity with irreversible damage was reported by only one respondent (1.75%). No deaths were reported. For 87.3% of respondents who had made mistakes, the error identification was immediate.

Regarding the possible factors that respondents believed had contributed to the errors, the most common were: distraction and fatigue (64.9%), misreading the labels of vials or syringes (54.4%), pressure to perform the procedure (21%), and improper storage (19%), as shown in Fig. 3.

## Discussion

This study showed that the absolute majority of anesthesiologists have committed a drug administration error, and some of them already committed more than one error. Notably, most of these errors brought little consequence and low morbidity, with no report of death. This result is in agreement with the literature on the subject. This is a complex issue and, as such, difficult to study, with a great variety of types of studies on the subject and few prospective studies.

A Canadian study, with a design similar to this, reported that 85% of that country anesthesiologists have committed an error or "quasi error", with four cases of death reported as a direct consequence of drug administration error, although most of them did not result in morbidity.<sup>11</sup>

Regarding the incidence of errors in anesthesia, two Australian works retrospectively evaluated a national database

for monitoring incidents, reporting that it was 7% and 10% of all incidents reported.<sup>12,13</sup> In another study with similar method, this incidence was 21% of reported incidents and 0.36% regarding the number of anesthesia in the period, but the study also included side effects and drug reactions.<sup>7</sup>

In prospective studies, the commonly used method is a prospective monitoring of incidents in which, for any anesthesia performed, there is a form that must be filled (even negatively) and handed at the end of surgery. In these studies there is really a denominator and the incidence of errors may be more accurately determined. The highest incidence reported in a New Zealand study<sup>6</sup> was 0.75%, or one error for every 133 anesthesia applications, much like the results of a recent Chinese prospective study<sup>9</sup> reporting an incidence of 0.73%, or one error for each 136 anesthesia applications.

In our study, the most common type of error was drug replacement, followed by incorrect dose and omission. Older studies assume that an error occurs when the wrong drug or dose is given,<sup>11,12,14</sup> and other types of error, such as omission and incorrect route of administration, were considered only in more recent studies. There is no doubt that these three types of error are the most common, however, its incidence varies with the studies. In most studies, replacement errors are the most frequent.<sup>6,8</sup> In a multicenter study by Llewellyn et al., it is interesting that the replacement errors were more common when aggregating the data for the three participating hospitals; however, when data from the pediatric hospital are evaluated separately, dose errors are as frequent as replacement.<sup>8</sup> This finding probably reflects the wide variations in weight among pediatric patients, requiring frequent and unusual dilutions.

In contrast to other prospective studies, the most common error reported by Zhang et al.<sup>9</sup> was omission. This result is perhaps what most reflects the reality, given the high possibility of memory bias involving omissions: if the drug dose has been forgotten, it is unlikely that the individual remember to report it.

In accordance with most prospective studies,<sup>8,9</sup> our study showed that most of the errors occur during maintenance of anesthesia because this is the longest period of anesthesia, in which most of the drug is administered or simply because this is a time when monitoring is decreased.<sup>9</sup> The day period most commonly reported for the occurrence of errors were matutinal and vespertine. Only 16% of the errors occurred at night, though possibly an even smaller fraction of surgeries occurred in this period.

Fatigue, hastiness, and inattention undermine the ability of anesthesiologists to monitor actions in which they are extremely skilled and usually pay no attention. Thus, similar vials or syringes are interpreted as correct and applied wrongly, a well-known failure of the cognitive process.<sup>12</sup> Fatigue and distraction were the contributing factors most frequently cited by respondents. In an initial assessment, in addition to the high workloads cited by respondents, it is easy to conclude that the resulting fatigue from overwork makes the gaps in cognitive process more likely, leading to the error and, consequently, to a tendency of an individual error approach.

However, on further analysis, based on a work by Reason<sup>15</sup> and review by Wheeler et al.,<sup>16</sup> we note that there

are organizational and administrative latent conditions that contribute to the error. Factors such as the lack of standardization of ampoules, labels, pharmacological presentation, and infusion pump softwares, as well as the division of work that allows endless working hours and pressure to produce.<sup>15,16</sup>

With this in mind, it is worth noting that in our work the other contributing factors cited by respondents were misreading the labels of vials or syringes, pressure to perform the procedure, and improper storage, all of which are associated with latent conditions and not only with the individual. Thus, the error approach must also include the system, taking into account that physicians are at the end of a chain and only part of a systematic failure.<sup>15,16</sup>

Although not evaluated in this study, the pharmacological class generally more involved in the errors are the neuromuscular blockers.<sup>7,14</sup> This is a worrying fact given the devastating consequences of its unwanted administration, especially in awake patients. A Norwegian study estimated that a patient receives neuromuscular blockers every three months while awake.<sup>14</sup> The possible explanation is drug the storage in 5 mL syringes, as most opioids,<sup>7</sup> as well as its use throughout anesthesia.

Timely, it is worth noting that the high incidence of errors in anesthesiology contrasts with the low incidence of mortality and irreversible morbidity.<sup>14</sup> In our study, only one anesthesiologist reported irreversible damage and there was no report of death. Still, most anesthesiologists reported that the error detection was immediate. The fact that the drugs used in anesthesia cause significant and immediate physiological changes, combined with the specialty characteristic monitoring and constant training in critical events, might explain this finding.

As this is a problem with rare unfavorable outcome, but potentially catastrophic, it may be difficult to statistically prove the effectiveness of each safety measure. It is worth mentioning a study that reported a tendency to overall reduction of errors with the use of colored labels, although it has not reached statistical significance. A significant reduction of errors involving only an exchange of ampoules was observed.<sup>14</sup> We must remember that the aviation industry is a global security model, and that the practices adopted to reduce morbidity and mortality were not based on evidence. Logical and practical measures were established and a safety culture was created.<sup>13,17</sup>

This study has some limitations. First, this is a cross-sectional study and it is only possible to calculate the prevalence of errors with low level of evidence. Moreover, the response rate was low even when compared to similarly designed studies,<sup>11</sup> probably due to the use of the internet to send the questionnaire, as such communication vehicle probably inspires less commitment to the research.

This study concluded that the prevalence of errors committed by anesthesiologists in the state of Santa Catarina is high, which is in line with the worldwide prevalence, with drug replacement as the most frequent type of error and fatigue as the most cited contributing factor. Most drug administration errors brought low or no morbidity, but outcomes with high morbidity and irreversible damage were reported. Because the potential for damage is high, changes in personal conduct should be adopted, with awareness of new residents facing the problem, and instruction

habits such as proper labeling and conference, such as institutional, with standardization of ampoules, syringes and labels, use of bar code and colors, even if not based on evidence, in order to reduce to a minimum the potential for error and create a safety culture in anesthesiology.

## Conclusion

Most respondents made more than one anesthesia administration error, mainly justified as a distraction or fatigue, with low incidence of major consequences.

## Conflicts of interest

The authors declare no conflicts of interest.

## Appendix 1. Questionnaire

1. What is your age? (years)
2. What is your sex? (M/F)
3. How long do you work with anesthesia (including residency)? (years)
4. How many hours do you work a week?
5. What is your level of expertise?
  - Residency in progress
  - Anesthesiologist (specialist title)
  - Superior title in Anesthesiology
6. Have you ever committed a medication error? (yes/no)
7. How many times have it occurred?
8. What kind of mistakes have you committed?
  - Omission (a forgotten/non-administered drug)
  - Repetition (re-administration of a drug)
  - Replacement (administration of a drug different from the intended one)
  - Insertion (drug administered in unwanted time)
  - Incorrect dose (unwanted concentration, amount or infusion rate)
  - Incorrect route
9. Did some factor below contributed to the error?
  - Distraction or fatigue
  - Pressure to perform the procedure
  - Misreading of label/vial or similar container
  - Lack of knowledge or experience with the drug
  - Improper storage
  - Incorrect programming or malfunction of infusion pump
  - Inadequate communication among anesthesiologists
  - Other or unspecified
10. Some of your mistakes occurred by incorrect neuraxial drug administration? (yes/no)
11. What was the worst consequence of an administration error of yours?
  - No damage (error resulted in no change in the anesthesia plan or increased recovery time)
  - Minor morbidity with reversible damage (increased time to extubation or post-anesthesia recovery)
  - Major morbidity with reversible damage (invasive monitoring required for error correction)

Major morbidity with irreversible damage (myocardial infarction, heart failure, or permanent neurological sequelae)

Death

12. In what shift of the day the most serious error occurred?
  - Matutinal
  - Vespertine
  - Nightly
  - I do not remember
13. When in the perioperative period did your most serious mistake occurred?
  - Preanesthetic
  - Induction of anesthesia (or early intraoperative)
  - Maintenance of anesthesia
  - Extubation (or moments before extubation)
  - Postoperative
14. How long did it take you to identify your most serious mistake?
  - Immediate identification
  - Late identification
  - Suspected error, unconfirmed

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