Thrita. 2014 March; 3(1): e14744. DOI: 10.5812/thrita.14744

Published online 2014 February 10. **Brief Report**

Incidence and Distribution of Inadvertent Severe Intraoperative Hypothermia During Cancer Surgery: a Retrospective Single Center Study

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Received: September 9, 2013; **Revised:** October 2, 2013; **Accepted:** October 10, 2013

Background: Inadvertent perioperative mild hypothermia is a common side effect of anesthesia and surgery. This complication has multiple origins. Hypothermia can negatively affect postoperative outcome. However, it might be prevented by specific measures.
Objectives: As part of a quality assurance program, we assessed the incidence of severe intraoperative hypothermia in association with specific surgery and procedures. The next step consisted of a series of measures to decrease its incidence.
Patients and Methods: After approval of our institutional review board, we used our computerized recording of anesthesia and postoperative care chart database (DEIO Archive Browser®) to extract the anesthetic files of patients who have experienced severe and mild hypothermia (< 34.5°C) and (≥ 34.5°C and < 35.5°C) between 2005 and 2006.
Results: A total of 12780 patients were screened between 2005 and 2006, 36 patients in 2005 and 38 in 2006 had severe hypothermia. A high percentage (33%) of peripheral surgery (breast surgery) was found in this group of patients. The percentage of mild hypothermia was around 0.5%. After analysis and discussion in the Quality Control Management meeting, several basic suggestions were made. Consequently, the number of patients experiencing severe hypothermia decreased by 50% in 2007, but the percentage of mild hypothermia did not change.
Conclusions: This study revealed the incidence of severe intraoperative hypothermia in our cancer hospital and we managed to decrease this incidence by simple measures. In addition, it suggests that severe hypothermia does not occur only in prolonged surgery and measures to prevent this complication should be undertaken for all patients. Automated anesthesia recording file is a useful tool to monitor the quality assurance program pertaining intraoperative hypothermia.

Keywords: Surgery; Anesthesia; Hypothermia

1. Background

Although mild and severe intraoperative hypothermia may provide some benefits, including cerebral protection during complex vascular and neurosurgical procedures (1), inadvertent intraoperative mild hypothermia represents a serious challenge for anesthesia providers and surgeons. Hypothermia has many proven adverse consequences, including cardiovascular complications (2, 3), increased wound infection (4), modified immune and surgical stress response (4, 5), increased blood loss (6), decreased metabolism of anesthetics drugs, such as paralyzing agents (7), postoperative discomfort with chills and shivering (8), prolonged recovery in the post anesthetic care unit (PACU) (9), and an overall increase in duration of the hospital stay (10). Since early '90s, our department took multiple steps to prevent profound perioperative hypothermia, including active and passive warming, temperature monitoring, and staff information. Nevertheless, this complication is still encountered. In addition, we noticed that several patients had an even more severe hypothermia (< 34.5°C).

2. Objectives

As a part of the first step in a quality assurance program, data were extracted from our computerized anesthesia record database (DEIO) to detect the incidence and identify factors promoting this adverse event. After their analysis, we suggested simple measures to decrease severe hypothermia during surgery.

3. Patients and Methods

Since 2001, our operating rooms are equipped with new computerized storing of anesthesia record software, DEIO Archive Browser that is linked to our anesthesia machine and the corresponding monitoring device AS5 (Datex-Ohmeda Inc., Madison, WI, The USA). Therefore,

Implication for health policy/practice/research/medical education:
This study highlights the use of anesthesia record database in a quality assurance program by identifying a parameter to monitor and, subsequently, the follow-up of the same parameter after corrective measures.

this allows for an intra-hospital online recording of most data related to the anesthesia and postoperative care unit (PACU). Intraoperative vital parameters, respiratory machine parameters, target-controlled infusion (TCI) drug delivery systems, inhalational gas consumption, bispectral index, and electronic temperature probe connected to the anesthesia device are detected and values are stored automatically. Drug injection, regional procedures, and other events, including operation times, unexpected events (for example, rashes), and infrared temperature probing are entered manually into the system by anesthesia providers. Once surgery and anesthesia are finished, and before leaving the operating room for the PACU, the patient file is saved.

Upon arrival at the PACU, central temperature (tympanic), respiratory rate, (numerical) pain scores, nausea and vomiting, sedation scores (categorical variables), and other events, such as chills, are recorded manually by a nurse, while other vital signs are recorded automatically in the DEIO Archive Browser. All patients' data are also recorded as a PDF file (including the operating room and the PACU), which is printed and enclosed to his hospital file when leaving the PACU. The database is also available by keywords for system and quality assurance administrators. The interface is not intuitive and each data extraction needs several hours of specific trainings. We used descriptive statistics to present data. Values were presented as mean ± SD, percentage, or categorical, as appropriate.

Because of a broad definition in the literature (11), we arbitrary defined mild hypothermia as a temperature < 35.5°C and ≥ 34.5°C, while severe hypothermia was considered as < 34.5°C.

4. Results

The total number of patients enrolled in these two consecutive years was 12780, with a precision of 95%. The incidence of mild and severe hypothermia is displayed in Table 1.

The mean temperature of patients having severe hypothermia was 34.3 ± 0.23°C in 2005 and 34.13 ± 0.14°C in 2006. Two patients in 2005 and one in 2006, who had postoperative ventilation, had a temperature < 34°C. Demographic characteristics of the patients having severe hypothermia, duration of anesthetic and surgical procedures, and the length of stay in the PACU are presented in Table 2. Different types of surgery, related to the severe hypothermia, are illustrated in Table 3.

We implemented corrective measures including intraoperative monitoring of body temperature in every surgical patient, increasing room temperature whenever it's possible (between 21°C and 24°C), changing all passive blanket, and gradually purchasing more effective new forced active warming device and blankets. We rechecked the incidence of severe hypothermia a year later and noticed a significant decrease of its incidence (< 50%). Nevertheless, the incidence of mild hypothermia remained identical to the rates before implementing these measures: 312 patients out of a total number of 6130 (0.5%).

5. Discussion

This study shows that the incidence of inadvertent mild and severe hypothermia in our patients was 0.5% and 0.05%, respectively. Surprisingly, this incident was not limited only to prolonged surgery. It also occurred in short and peripheral surgeries (breast surgery), as well as interventional radiology. Mild hypothermia might have showed a broader limit in reference to the literature (11). However, for the sake of our quality assurance program, we focused initially on severe hypothermia (< 34.5°C), since we believed that the incidence of this level of hypothermia should be decreased significantly in a first quick step. Nevertheless, we did not ignore mild hypothermia. The incidence of hypothermia (< 35.5°C) is variable in the

Table 1. Incidence of Severe and Mild Hypothermia

Type of Hypothermia	Year 2005, n = 6290	Year 2006, n = 6490
Mild, No. (%)	308 (4.8)	287 (4.2)
Severe, No. (%)	36 (0.5)	38 (0.5)

Table 2. Demographic Characteristics and Duration of Procedures in Patients With Severe Hypothermia

Parameters	Year 2005, n = 36	Year 2006, n = 38
Age, y, mean ± SD	59 ± 12	58 ± 12
Weight, kg, mean ± SD	65 ± 13	61 ± 12
Height, cm, mean ± SD	165 ± 7	162 ± 8
Sex (F/M) , mean ± SD	23 ± 13	26 ± 12
ASA [a] (1/2/3/4)	4/20/12/0	2/27/9/0
Duration of anesthesia, min, mean ± SD	212 ± 130	239 ± 126
Duration of surgery, min, mean ± SD	163 ± 110	181 ± 120
Length of stay at PACU [a], min, mean ± SD	110 ± 52	106 ± 38

[a] Abbreviations: ASA, American Society of Anesthesiologist classification; PACU, anesthesia and postoperative care unit.

Table 3. Different Types of Surgery in Patients Having Severe Hypothermia

Type of Surgery	Year 2005, n = 36	Year 2006, n = 38
Prolonged abdominal surgery	9	13
Breast surgery	12	13
Prolonged otorhinolaryngology	8	6
Short otorhinolaryngology	4	1
Interventional radiology	3	5

available literature, varying from 4% to 25%. On the other hand, very few studies have reported the incidence of severe hypothermia (< 34.5°C), specifically.

Shortcomings of the present study are the fact that the preoperative (upon arrival in the operating room) temperature is not recorded in our database. According to the National Institute for Health and Care Excellence (NICE) guidelines CG65, warming should be initiated once the temperature is below 36°C in the ward and maintained throughout the intra-operative phase, while all patients should have their temperature monitored before induction of anesthesia.

In addition, ambient room temperature was recorded neither in the anesthesia chart, nor in the operating chart. Ambient temperature has great influence on the anesthetized patient; hypothermia is significantly more frequent when the ambient temperature decreases to 21°C (12). The other major tool to fight hypothermia is active warming; however, due to risk of burning, it cannot be used if intraoperative temperature is not monitored. The incidence of severe hypothermia in our hospital is not negligible. We deliberately did not differentiate between emergency and scheduled surgery, since the outcome is the same for all patients. The incidence of severe hypothermia in this group of patients can be used as a final indicator of quality assurance program. The mechanism of hypothermia is probably multifactorial, including an initial decrease in temperature due to heat redistribution (almost 1°C in the first 40 minutes after induction), radiation, convection, cold fluid infusion, surgical site evaporation, decreased metabolism, decreased tissue perfusion, or due to specific type of surgery. To a lesser degree, heat loss might be the consequence of conduction, evaporation and through respiration of cold anesthetic gases (12). High risk patients for hypothermia are children and elderly, in addition to those with preoperative temperature < 36°C, combined general and regional anesthesia, major or intermediate and prolonged surgery (12). However, some of our patients with severe hypothermia had prolonged abdominal or otorhinolaryngeal surgery, yet a non-negligible percentage of them had peripheral surgery, including breast or interventional radiology procedures. Breast surgery requires a relatively large body exposure, especially when it is bilateral and/or when reconstructive surgery, which additionally requires relatively long preparation time, is performed in the same intervention. Additionally, covering the site with warming blanket is impossible. We also encountered severe hypothermia in 10% of these patients in interventional radiology, in which no surgical skin incision is necessary. Our supposition is that in this setting, undersized tables, in addition to the small and less ergonomic environments, do not permit adequate prevention of hypothermia.

We took several simple measures to decrease the incidence of sever hypothermia, including training and providing information to all operating room personnel. However, the measures should be sustainable and the results should be verified regularly, to be efficient. This approach is facilitated by the computerized recording of anesthesia chart and the database. Also, it can help to verify the indicator. Mild hypothermia is still a challenge and a special focus is necessary, especially in the preoperative setting. In fighting against inadvertent intraoperative mild hypothermia, which is much more difficult to prevent, simple measures, such an increasing room temperature, are generally very difficult to apply. This is mainly due to surgeon's discomfort that can adversely affect the surgical outcome. Heat redistribution, after induction of anesthesia, is almost unavoidable, unless a pre-warming is performed. Unfortunately, this procedure is very difficult to perform in all patients.

The anesthesia database recording system not only permitted us to detect these cases, but it also enabled us to follow the result of our actions. Obviously, the indicator is the annual rate of patients having mild to severe intraoperative hypothermia.

This study provides a background for our future research plans, aiming to evaluate the specific short-term and long-term outcomes of hypothermia in patients undergoing cancer surgery.

Acknowledgments

There are no acknowledgements.

Authors' Contribution

Cyrus Motamed designed the research and wrote the manuscript. Jean Louis Bourgain extracted data from the database and designed the study.

Financial Disclosure

There is no conflict of interest.

Funding/Support

This research was financially supported from the internal funds of the department of anesthesia.

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