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# Body temperature, Aldrete-Kroulik index, and patient discharge from the Post-Anesthetic Recovery Unit\*

TEMPERATURA CORPORAL, ÍNDICE ALDRETE E KROULIK E ALTA DO PACIENTE DA UNIDADE DE RECUPERAÇÃO PÓS-ANESTÉSICA

TEMPERATURA CORPORAL, ÍNDICE ALDRETE Y KROULIK Y ALTA DEL PACIENTE DE LA UNIDAD DE RECUPERACIÓN POST-ANESTÉSICA

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## ABSTRACT

Patient discharge from post-anesthetic recovery (PAR) depends, among other factors, on normothermia and the patient's score on the Aldrete-Kroulik index. The objective of this study was to verify the relationship between the Aldrete-Kroulik index and body temperature in patients. This study was performed at the University of São Paulo University Hospital. Convenience sampling was used, and the sample consisted of 60 patients of ages between 18 and 60 years who underwent general anesthesia. The patients' body temperature was obtained by tympanic measurement, and the Aldrete-Kroulik index was measured on admission and at discharge from post-anesthetic recovery. The data were processed using SPSS, considering a significance level of 5%, and the Spearman and Wilcoxon tests were applied. In conclusion, no significant correlation was found between the two parameters for discharge.

## DESCRIPTORS

Hypothermia  
Recovery Room  
Patient discharge  
Perioperative nursing

## RESUMO

A alta do paciente da recuperação pós-anestésica (RPA) depende, dentre outros fatores, do retorno à normotermia e do escore alcançado pelo Índice de Aldrete e Kroulik. Sendo assim, o objetivo deste estudo foi verificar a relação entre o Índice de Aldrete e Kroulik e a temperatura corporal dos pacientes. O local de pesquisa foi o Hospital Universitário da Universidade de São Paulo. O cálculo amostral foi determinado por conveniência e foi constituído por 60 pacientes, entre 18 e 60 anos, submetidos à anestesia geral. Foram verificados a temperatura corporal na região timpânica e o Índice de Aldrete e Kroulik do paciente na recepção e alta da recuperação pós-anestésica. Os dados obtidos foram processados pelo pacote estatístico SPSS, com um nível de 5% de significância, e aplicaram-se o teste de Spearman e o teste de Wilcoxon. Conclui-se que não houve correlação significativa entre os dois parâmetros indicativos de alta.

## DESCRIPTORES

Hipotermia  
Sala de Recuperação  
Alta do paciente  
Enfermagem perioperatória

## RESUMEN

El alta del paciente de la recuperación post-anestésica (RPA) depende, entre otros factores, del retorno a la normotermia y del puntaje alcanzado por el Índice de Aldrete y Kroulik. Así, se objetivó verificar relación entre el Índice de Aldrete y Kroulik y la temperatura corporal de los pacientes. Estudio realizado en el Hospital Universitario de la Universidad de São Paulo. El cálculo de la muestra se determinó por conveniencia y se constituyó de 60 pacientes, edad entre 18 y 60 años, sometidos a anestesia general. Se verificó temperatura corporal en región timpánica e Índice de Aldrete y Kroulik del paciente en recepción y alta de recuperación post-anestésica. Los datos se procesaron con software estadístico SPSS, con nivel de 5% de significatividad, se aplicaron las pruebas de Spearman y el test Wilcoxon. Se concluyó en que no existió correlación significativa entre los dos parámetros indicadores del alta.

## DESCRIPTORES

Hipotermia  
Sala de Recuperación  
Alta del paciente  
Enfermería perioperatoria

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## INTRODUCTION

Body temperature is among the most rigorously controlled physiological parameters of an organism. The system responsible for this function permits variations between 0.2° and 0.4° Celsius (°C) around 37°C to maintain its metabolic functions<sup>(1)</sup>. Therefore, temperature measurement should be the as trustworthy as possible. Body temperature can be measured from several locations, and tympanic measurement is the one that provides the value closest to the central temperature<sup>(2)</sup>.

During surgery and anesthesia, unintentional hypothermia is a common occurrence due to the direct inhibition of thermoregulation by the anesthetics, the patient's reduced metabolism and exposure to the cold environment of the operating room, besides the infusion of cold liquids<sup>(3)</sup>. Hypothermia can be classified as mild (34°C to 36°C); moderate (30°C to 34°C), and severe (less than 30°C).

After surgery, patients are usually transferred to post-anesthetic recovery (PAR) with mild hypothermia, unstable vital signs, reduced motor activity and protective reflexes, and an altered conscious level. Patients remain in this unit until recovering these functions, which guarantees their prevention against possible postoperative complications<sup>(4)</sup>.

A persistent hypothermia in the PAR can cause several complications, which may be metabolic, respiratory, and cardiovascular, particularly if associated with risk factors and compensatory shivering<sup>(5-6)</sup>.

A study that aimed at identifying the most frequent nursing diagnosis during post-anesthetic recovery found that an unbalanced body temperature (mild hyperthermia) ranked at a noteworthy position, with a frequency of 100%<sup>(3)</sup>.

Unintentional hypothermia is common in PAR, and it usually does not impede patients from being discharged, as long as their clinical parameters, assessed using the Aldrete-Kroulik index, suggest they should be transferred back to the original unit, i.e., when a total score between 8 and 10 is obtained.

The Aldrete-Kroulik index was created and validated in 1970. In 1995, the original authors revised the instrument. Since its development, it has been used to assess patients and their evolution in the post-anesthetic period by analyzing their muscle activity, breathing, circulation, consciousness and oxygen saturation. The score ranges between 0 and 2 for each parameter, in which zero (0) indicates conditions of greater severity, one (1) corresponds to an intermediate level, and two (2) represents reestablished functions. This assessment index has been used in

the United States, Mexico, Colombia, Panama, Argentina, Brazil, and Spain, besides having been implemented in many hospitals in other countries.

According to the referred index, most PAR patients achieve a maximum score in the clinical parameters assessment after two hours in the unit, but body temperature is not included in this assessment.

In the everyday routine at the PAR, it can be empirically observed that even patients discharged with a score 10 on the Aldrete-Kroulik index might have hypothermia, which may persist during his/her transportation and become worse until they arrive back to their original unit, thus increasing the possibility of complications due to this condition.

Therefore, we wondered if there was any relationship between the patient's body temperature and the indication for discharge determined by the Aldrete-Kroulik index.

Unintentional hypothermia is common in PAR, and it usually does not impede patients from being discharged, as long as their clinical parameters, assessed using the Aldrete-Kroulik index, suggest they should be transferred back to the original unit, i.e., when a total score between 8 and 10 is obtained.

## OBJECTIVE

To verify the relationship between the Aldrete-Kroulik index and the body temperature of PAR patients; to verify the body temperature and Aldrete-Kroulik index of PAR patients.

## METHOD

This prospective cross-sectional study was performed at the anesthetic recovery unit of a University Hospital in São Paulo, SP, Brazil, which is located on the 2<sup>nd</sup> floor of the Hospital and has seven beds. The nursing team is comprised by one nursing technician and one nurse for each shift. The studied period was between October and

November of 2007.

The convenience sample consisted of 60 patients admitted to the PAR, of both genders, of ages between 18 and 60 years, who had underwent elective surgery with a minimum duration of two hours, with general anesthesia and no prior pathologies that could affect their body temperature. The patients' body temperature was measured using an infrared radiation tympanic thermometer on admission and at discharge. None of the patients were excluded during the study.

The patients' anesthetic risk was assessed using the Classification proposed by the American Society of Anesthesiology (ASA), which was performed by the anesthesiologist, and consists of evaluating the patients' clinical examination and the presence of comorbidities<sup>(7)</sup>. The physiological condition of PAR patients was evaluated using the Aldrete-Kroulik index because of its acceptability,

since its creation in 1970, and because of its purpose, i.e., to systemize the evaluation of the physiological conditions of PAR patients in a simple and objective way<sup>(8)</sup>.

Data collection was performed on Monday to Friday, in the afternoon shift, because this period is characterized as the one with the greatest number of patient admissions at the referred unit. The instrument that was used was designed by the researcher, and consisted of two parts. Part I: sample characterization data (age, gender, type of anesthesia, type of surgery, and physical condition according to ASA). Part II – Parameters: body temperature of the PAR patient on admission and at discharge, and the patient's score on the Aldrete-Kroulik index also on admission and at discharge.

This study was approved by the Research Ethics Committee at University of São Paulo University Hospital (HU-USP) (Register CEP-HU/USP: 824/08 A - SISNEP-CAAE: 0028.0.198.196-09), in compliance with the regulations of the National Health Council Resolution 196/96 and other complementary laws.

The data were analyzed using the Statistical Package for Social Sciences 14.0. The continuous variables were presented as minimum, maximum, means, and standard deviation. The categorical data were presented as absolute and relative frequencies. The Kolmogorov-Smirnov, T test, and Wilcoxon's test were used, considering a significance level of 5%.

## RESULTS

**Table 1** - Sociodemographic and clinical characteristics of the studied patients - São Paulo, 2007

| Variables                     | N (%)     | Mean (sd)   |
|-------------------------------|-----------|-------------|
| <b>Gender</b>                 |           |             |
| Female                        | 37 (61.7) | -           |
| Male                          | 23 (38.3) | -           |
| Age (years)                   | -         | 39.4 (13.2) |
| Duration of procedure (hours) | -         | 2.09 (1.04) |
| <b>Surgery specialty</b>      |           |             |
| Gastrointestinal              | 31 (52.7) | -           |
| Oral-maxillary                | 09 (15.3) | -           |
| Orthopedic                    | 07 (11.9) | -           |
| Otolaryngology                | 05 (8.5)  | -           |
| Plastic Surgery               | 04 (6.8)  | -           |
| Head and neck                 | 02 (3.4)  | -           |
| <b>Others</b>                 | 02 (3.4)  | -           |
| <b>ASA*</b>                   |           |             |
| 1                             | 31 (51.7) | -           |
| 2                             | 25 (41.7) | -           |
| 3                             | 04 (6.6)  | -           |

\*Classification of the American Society of Anesthesiology

Table 1 shows the data regarding the sociodemographic and clinical characteristics of the patients. It is observed that most (37; 61.7%) patients were women, 31 (51.7%) did not have any preexisting underlying pathology (ASA1) and gastrointestinal surgeries predominated (31; 52.7%).

**Table 2** – Minimum, maximum, and mean temperature values on admission and at discharge from post-anesthetic recovery - São Paulo, 2007

| Temperature measurements in PAR | Minimum °C | Maximum °C | Mean °C |
|---------------------------------|------------|------------|---------|
| On admission in PAR             | 34.5       | 37.2       | 35.9    |
| At discharge in PAR             | 33.3       | 37         | 36.1    |

p= 0.023

Table 2 compares the patients' temperature measured on admission and at discharge, with the respective minimum, maximum, and mean values. A 1.2°C variation was observed between the PAR patients' minimum temperature on admission and discharge. Similarly, a 0.2°C variation occurred between the maximum temperature on admission and at discharge. The mean values show a 0.2°C variation.

The comparison between the patients' mean temperatures on admission and discharge from PAR showed a significant difference (p=0.023) between them, i.e., the tympanic temperature measurements of the patients at discharge were smaller compared to the temperatures on admission.

**Table 3** – Aldrete-Kroulik values on admission and at discharge from the Anesthetic Recovery Room - São Paulo, 2007

| Variables             | Admission | Discharge |
|-----------------------|-----------|-----------|
| Aldrete-Kroulik index | 0.611     | 0.595     |
| Temperatura           | 0.958     | 0.095     |

p≤ 0.05

The results presented in Table 3 indicate that, on admission to PAR, most patients (44; 73.4%) scored 8 on the Aldrete-Kroulik index, which indicates they could be discharged from the PAR, but because of the patients' unstable condition during the first hour post-surgery, it is recommended they stay in the unit until achieving a score 9 or 10.

**Table 4** – Association between the Aldrete-Kroulik index and body temperature on admission and discharge from PAR – São Paulo, 2007

| Aldrete-Kroulik index | Admission |              | Discharge |              |
|-----------------------|-----------|--------------|-----------|--------------|
|                       | N         | %            | N         | %            |
| 7                     | 2         | 3.3          | -         | -            |
| 8                     | 4         | 73.4         | 1         | 1.6          |
| 9                     | 11        | 18.3         | 7         | 11.7         |
| 10                    | 3         | 5            | 52        | 86.7         |
| <b>Total</b>          | <b>60</b> | <b>100.0</b> | <b>60</b> | <b>100.0</b> |

Table 4 shows the association between the PAR patients' Aldrete-Kroulik index and body temperature measured at the two proposed times. It is observed that there is no statistically significant correlation between the studied variables.

## DISCUSSION

According to literature, unintentional hypothermia is a consequence of the surgical anesthetic procedure; a clinical condition in which the body is incapable of regulating its temperature because the elements involved in this mechanisms are compromised by the drugs that depress the temperature-regulating center of the body<sup>(9)</sup>.

Thus, patients who undergo surgical anesthetic procedures are exposed to multiple factors that can alter their thermoregulation mechanisms, and, for this reason, hypothermia occurs in the post-operative period. Some of the referred factors are the temperature of the operating room, the intravenous infusion of cold solutions, patient's age, muscular relaxation, exposure of cavities, surgery time, type of surgery, and ventilation with unheated gases<sup>(9-10)</sup>.

However, it is important to identify the risk factors in the pre- and intra-operative period that could be controlled, alone or together, in order to minimize the morbidity of patients undergoing surgical procedures.

According to the results on Table 2, the mean body temperature on admission was 35.9°C. Another study found higher temperatures, in which after assessing 284 patients, 27 (9.5%) presented hypothermia (below 35.5°C). This result is attributed to the effects of the surgical anesthetic process, which is well-documented in literature. Furthermore, there was a variation between the pre-operative period (37°C) and PAR (36.4°C). These authors considered that there was a small 0.6°C variation attributed to the use of heating devices in the operating room<sup>(11)</sup>.

On the other hand, the mean body temperature at discharge from PAR was 36.1°C, with a minimum value of 33.3°C and maximum value of 37°C. These results suggest that while in PAR, the patients' body temperature did not stabilize, confirming the literature findings about the effects of anesthetic agents, the low temperature of the environment and the flaws of heating protocols for surgical patients<sup>(11)</sup>.

At the studied hospital, patient heating during surgery, transportation and while in PAR complies with a rigorous protocol that establishes using a hot air insufflator (warming blanket), keeping the patient dry and protected throughout the entire anesthetic procedure until the post-operative period. Nonetheless, it was observed that some patients' temperature was below 36°C at discharge from PAR. This suggests the procedures should be reviewed and there should be continuous training of those involved in this care process.

It is known that clinical parameters such as blood pressure, breathing, muscle activity, O<sub>2</sub> saturation and consciousness were elected to comprise the Aldrete-Kroulik index, because the authors recognize them as representatives of the physiological systems that are altered by the anesthetic procedure. Ever since, this index is frequently

used in PAR, in which a score 10 indicates the moment the patient can be discharged from the unit. This score is translated as the stability of the patients' vital signs, their regaining consciousness, protective reflexes and muscular activity. However, it is emphasized that this assessment does not include the body temperature measurement, although it is stated that normothermia is important for patient discharge, as well as the effect of non-induced hypothermia in possible post-operative complications. Among these possibilities are the surgical site infection, diminished collagen and platelet function, in addition to a delayed drug metabolism<sup>(12-13)</sup>. Other studies report the presence of adverse events in PAR caused by hypothermia, which can be cardiovascular (dysrhythmias, hypertension, hypotension), respiratory (bronchospasm, hypoxia)<sup>(14-15)</sup>.

A study identified a small percentage of complications among patients in PAR, but the authors referred that this result should be reviewed, and suggest making a clearer use of the word *complication* by the whole nursing team<sup>(10)</sup>.

Shivering is a common complication, which requires greater oxygen consumption. This alteration is confronted by the results of a study performed with 300 patients, in which eight (2.7%) presented shivering and body temperature between 35.2°C and 37°C, while patients with temperatures below 35.2°C did not present this sign. The authors state the importance of the presence or absence of shivering as an indication of hypothermia, because shivering is not always exclusively associated with a low body temperature, as they can also result from the anesthesia (subaracnoidea), because they reheat slower than patients who received general anesthesia, as muscle weakness and vasodilatation persist<sup>(9-10)</sup>.

Although the patients' mean body temperature at discharge was 36.1°C, a significant variation ( $p = 0.023$ ) occurred between the minimum (33.3°C) and maximum (37°C) temperatures at discharge.

In this view, it is observed, respectively, in Tables 2 and 3, that even though patients did not reach normothermia (36.7°C) and a score 10, eight patients (13.3%) were discharged from PAR, despite the fact that no statistically significant relationship was found between the Aldrete-Kroulik index and the patient's body temperature (Table 4).

This result may be related to the fact that most patients were healthy or had a mild systemic diseases, had a stable pulse, blood pressure, motor activity, consciousness and oxygen saturation within the normal standards established by the index, which guided the discharge from PAR<sup>(11)</sup>.

Although no association was found between body temperature and the Aldrete-Kroulik index, it is highlighted that it is important to maintain normothermia for patient comfort, but also to avoid complications due to hypothermia, as stated earlier.

Therefore, it is understood that although the Aldrete-Kroulik index is frequently used and acknowledge for its proposition, it should not replace a the critical judgment of a healthcare professional, particularly in terms of body temperature measurement for a safe discharge from PAR.

## CONCLUSION

According to the present study results, no association was found between the patients' body temperature and the Aldrete-Kroulik index at the two assessment times in post-anesthetic recovery.

The patients' mean body temperature by tympanic measurement was lower on admission compared to the

temperature at discharge from post-anesthetic recovery, just as most patients obtained a score 8 on the Aldrete-Kroulik index when admitted and a score 10 at discharge.

## STUDY LIMITATIONS

It is suggested that the present study be repeated with a greater number of patients, although it was possible to apply the proposed statistical tests and a later analysis of the 60 patients that comprised the sample.

It is recommended to perform a control of the variables that could affect the temperature obtained in the Post-Anesthetic Recovery Room, for instance keeping patients warm between their transfer from the hospitalization unit to the operating room.

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