Evaluation of bedbath in critically ill patients: impact of water temperature on the pulse oximetry variation

AVALIAÇÃO DO BANHO NO LEITO DE DOENTES CRÍTICOS: IMPACTO DA TEMPERATURA DA ÁGUA NA VARIAÇÃO DA OXIMETRIA DE PULSO

EVALUACIÓN DEL DO BAÑO EN EL LECHO DEL ENFERMO CRÍTICO: IMPACTO DE LA TEMPERATURA DEL AGUA EN LA VARIACIÓN DE LA OXIMETRÍA DE PULSO

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ABSTRACT
This is a participant study, quasi-experimental, of a before and after type. A quantitative approach of biophysiological measures was used, represented by the saturation of oxygen measured by pulse oximeter (SpO₂), and recorded on three occasions: before, during and after the bedbath in critically ill patients hospitalized at the ICU of a University Hospital in Brazil. Objective: to compare the SpO₂ in various stages of the bath, with and without control of water temperature. Data collection was performed between December 2007 and April 2008 on a convenience sample consisting of 30 patients aged over 18 who had classification in TISS-28 from level II. Results show that water temperature control means a lower variation of SpO₂ (p<0.05). No marked differences in variation of saturation between men and women or between age groups were established. In conclusion, heated and constant water temperature during the bedbath is able to minimize the fall of SpO₂ that occurs while handling patients during procedures.

KEY WORDS
INTRODUCTION

The hospital environment aims at care for people with health disorders, who have specific needs. This service is delivered by professionals in various sectors within specific health units. Seriously ill patients need more specialized environments, which can guarantee the preservation of vital organ functioning and maintained clinical stability.

Intensive Care Units (ICUs) are sectors that have special equipment and trained people to attend to the needs of seriously ill or risk patients who require uninterrupted medical and nursing care(2). Besides these resources, there are standards relating to the physical environment that have to be met to ensure appropriate care for these people. Regarding environmental temperature, Brazilian legislation demands that temperature be controlled between 21 and 24°C, with relative humidity between 40 and 60%(3). It is also important to note that an ICU is not restricted to the provision of life-support services, and that patients’ needs for comfort and welfare should be prioritized.

In daily nursing care, however, some techniques are clearly relegated to the background. The explanation may be the fact that various professionals consider them less important(2), and thus delegate them to other team members. These techniques include the bed bath, a practice that involves complex expertise and that, if held in inappropriate conditions, may cause variations in patients’ clinical state, whose implications can cause instability and risks to the patients.

In a review of scientific literature, it was observed that bed bathing is a matter of controversy among nurses. In a study on nursing aspects professionals recovered in health care, the aspect professionals most important was the bath, mentioned by 79.5% of the 88 participants in the study(4). However, in another study with 32 nurses in Rio de Janeiro (Brazil), which sought the meaning of the art of bed bath for nurses, statements that characterized the bath as an exhausting, manual and routine work were expressed, strengthening the idea of a non-prestigious procedure(2).

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METHOD

Participant, quasi-experimental, before-and-after study in which the quantitative approach of biophysiological measures was used, represented by oxygen saturation through the pulse oximeter (SpO₂) measure, recorded in three blocks: before, during and after the bed bath of critical patients hospitalized at the ICU of a university hospital in Brazil.

A convenience sample of critical patients was recruited, set at 30 individuals through a sample size calculation. Patients were selected through the following eligibility criteria: patients of both sexes, aged over 18 years, admitted to the ICU, which were in monitoring of oxygen saturation by a pulse oximeter, classified as level II in the Therapeutic Interventions Score System-28 (TISS-28) and whose family agreed to sign the Informed Consent. TISS-28 is a pioneer system to classify patient severity and the nursing workload, created by Cullen in 1974(5).

In compliance with Resolution 196/96 by the Brazilian National Health Council, this study was submitted to a Research Ethics Committee for evaluation and approved under process number 0148.258.000-07. This Resolution contemplates all ethical standards set forth in the Helsinki Declaration of 1975. An Informed Consent Term was elaborated with data to identify the patient, identification of those responsible for the work, the research aims, the procedures for participating and the benefits that can be obtained.

To carry out this study, besides the material needed for the bed bath, an ICCEL HT-208® thermo-hygrometer and its...
own thermometer unit were used, which permits checking the water, verifying environmental temperature, relative humidity and water temperature; water temperature was maintained through a Logen Scientific® Hot Plate, lent from the Analytical Chemistry Department of a federal university.

One of the researchers collected all data through observation and recording of variations in SpO₂ and water temperature. These data were recorded every two minutes in a form containing: patient identification data, total TISS-28 score, water temperature, environmental temperature and relative humidity before, during and after the bed bath. In line with a thesis, the periods before and after the bath were set at 15 minutes before and after the procedure, respectively\(^5\). Water temperature was measured and recorded from the beginning of the bath until the end of the procedure.

To maintain uniformity in collected measures, the pulse oximeter was placed on the index finger of the right hand of all selected patients. A glove was used on this hand to avoid interference from illumination in the ideal functioning of the oximeter, and to prevent its contact with water, which could damage it. Each patient was submitted to a control bath, carried out in normal conditions, and experimental bath, in which the water temperature was kept constant and heated to 40°C\(^9\). The collected information was included in a spreadsheet for statistical analysis.

It is important to assure that the measurement and selection risks were minimized so as not to interfere in the study result. The former was controlled by using the same instrument in the two measurements performed on each patient; the second was avoided through the use of a before and after research design.

Descriptive statistics included: media, median, variance, standard deviation and variation coefficient, Pearson’s coefficient and percentage difference.

Statistical inference included a parametric test of hypotheses. The test chosen was student’s t-test, appropriate to compare paired samples of equal variances. To carry out this test, the statistical package NCSS / PASS 2000 Dawson Edition was used, which permits one- and two-tailed testing, according to the alternative hypothesis formulated. The confidence interval used was set at 95%, and the level of significance (\(\alpha\)) was previously fixed at 0.05.

### RESULTS AND DISCUSSION

The sample comprised 50% of male patients, with an average age of 50 ± 14 years (CV = 33.5%), mainly in TISS Class II (93.33%). It is important to stress that patients within TISS Class III presented the scores near the minimum necessary for this classification (35 points), which leaves them in conditions similar to those in Class II.

The analysis of Figure 1 shows that the median and the third quartile (Q3) for the sexes are very close, despite the greater dispersion presented by males, which indicates greater variation of age. The main intergroup difference is found in the first quartile (Q1), showing that the first 25% of the male sample are younger than those in the female sample.

![Figure 1 - Gender and age of patients to assess SpO₂ during the bed bath](source: ICU of Hospital Universitário Antônio Pedro, Brazil / Dec 2007 - Apr 2008)

Considering all patients’ dependence on ventilation support, examining the fraction of inspired oxygen (FiO₂) offered to each patient during the control and trial bath is important. To illustrate this, FiO₂ was compared between both baths, and their percentage differences observed during 14 observations revealed higher FiO₂ during trial baths.

FiO₂ is a variable that can interfere directly in saturation. Thus, the existence of linear correlation between FiO₂ and SpO₂ during the pre-bath was assessed through Pearson’s coefficient. The results were \(r = -0.22\) in control and \(r = -0.26\) in experiment, which means a weak negative linear correlation\(^10\). It is important to note that r-values in control and experiment are very close, indicating regularity in ventilation patterns on both occasions.

During the observation of baths, it was understood that, in general, average SpO₂ decreased when comparing the moments before and after bathing, both in control and experiment. However, it should be noted that the change occurred in the experiment was lower than that observed in control. Thus, it can be assumed that the variation in tissue oxygenation depends on factors other than water temperature. These factors can be related to patient movement by the nursing staff, exposure to low temperatures characteristics of the ICU, massaging the skin, placing the patient in specific positions, sedation, state of alertness or use of vasoactive drugs. All these are connected to possible interference in SpO₂, because they could represent a cardiovascular commitment, increasing...
the demand for oxygen in tissues, or cause negative im-
acts on ventilation mechanisms.

Figure 2 shows average SpO2 behavior before, during
and after control and experiment baths. This time evolu-
tion shows a drop in SpO2 during the procedure, which is
smaller during the experiment. In the post-bath control,
saturation increases, returning to values close to the initial
experiment, and also an important recovery in control.

Analyzing the variation in the SpO2 intervals before and
during the control and experiment, it is observed that, in
control, there is a sharp drop in SpO2 during the procedure
when compared to the moment before the technique. In
the experiment, however, this reduction was less promi-
nent. A comparison between percentage differences be-
fore and during the control and experiment baths shows
that 87% of patients experienced less variation in oxygen
saturation during the bath intervention. It is important to
emphasize that seven patients showed increased average
SpO2 during the experiment bath, while one patient did
not show any variation.

All patients experienced decline in average SpO2 during
the control bath. This data shows a larger variation in usual
conditions than during the experiment, which does not
necessarily mean that individuals became more unstable.
Exemplifying this, it was observed in a previous study that
small changes in oxy-hemodynamic parameters during the
bed bath do not necessarily mean clinical instability[6]. How-
ever, eleven patients (36.6%) showed average SpO2 during
the control bath below the 92% recommended as the nor-
mal limit[111]. In contrast, only two patients presented a simi-
lar result during the experiment. Besides, one of them
showed a small increase in average SpO2 when compared
to pre-bath.

Similarly, in the intervals before and after the bath,
when comparing the percentage differences between con-
trol and experiment, seven patients (23.3%) experienced
less variation in the control; one patient presented the
same percentage difference in control and experiment. It
is evident that, in the control, there is an increase in aver-
age SpO2, and seven patients showed a better saturation
in this procedure when compared to the experiment. It
shows that there are other factors interfering in satura-
tion variation.

It is important to stress that the patient who showed
the most significant difference between the procedures was
very agitated and, while changing sheets during the experi-
mental bath, he was accidentally extubated. During the first
four minutes of post-bath, a manual resuscitation bag was
used to ensure ventilation. In the interval between five and
eight minutes, a new intubation was performed. This fact
explains the reason for an individual variation as highlighted
when compared to the sample in general.

Another important event was one patient who moved,
though sedated (Ramsay I), and turned during the whole
experiment bath procedure which, as the literature says, is
one of the factors indicating low detection because it can
promote distortions in the signals sent[61]. As for the con-
tral bath, the level of sedation was higher (Ramsay IV) and
the patient did not interfere in the procedure. Regarding
the remainder, we can infer that there is physiological vari-
ability intrinsic to each patient that permitted better adap-
tation to situations they were submitted to during the bath.
This may be due to alveolar lung opening in areas previ-
ously not aired, consequently increasing the ventilation-
perfusion ratio.

As the sample contains 50% men, it is important to com-
pare SpO2 behavior during the control and experiment bath
between the sexes. For this purpose, average percentage
differences in SpO2 were calculated between both sexes for
the pre-per and pre-pos bath intervals.

The analysis of Table 1 identifies very similar behavior
between men and women during the pre-per interval in
control. This reinforces the assessments of a previous
study[60], in which the differences in transcutaneous oxygen
pressure measurement between genders during nursing ac-
tivities, among them the bed bath, were not statistically or
clinically significant. In the experiment, a significant reduc-
tion in saturation variation occurs in the two cases. It can
be noted that this change in women was still lower
when compared to men. In the pre-post interval, men
showed almost the same variation in control and experi-
ment. In the experiment, women displayed a lower range
and values closer to the pre-per interval. In this study, no
significant differences between the sexes were found, show-
ing that probably, lower rates of hemoglobin and hemat-
ocrit in women[12], which involve the transportation of a
lower oxygen volume, are not sufficient to cause harmful
changes in women’s SpO2. On the contrary, they reacted
deeper during the pre-per experiment, with a less promi-
rent change.
decrease in SpO2 when patients are subject to a bed bath, there was no significant difference between the average percentage of control and experiment during the bed bath. In pre-post intervals, it is observed that the two groups showed better control, but the younger group showed greater variation than the older. In the experiment, the younger group showed a drop in SpO2; in contrast, the older group showed considerable improvement, increasing oxygen release to tissues. Thus, in situations like sepsis, even if the patient presents SpO2 levels within the normal range, he must be assessed and monitored, at risk of developing severe hypoxia.

Due to the reduced quantity of patients included in Class III, a comparative analysis between the classifications was not possible, as this sample was not representative and, possibly would not reflect the real conditions patients with this degree of invasion are submitted to. Thus, all patients were considered as having similar levels of invasiveness.

It is important to emphasize that, while the TISS-28 is important and widely diffused in quantifying nursing work, it values screening through artifacts that are in continuous disuse, such as the Swan-Ganz catheter, the item that determines the highest scores. The system went through two major modifications in 1983 and 1996, with a view to greater measurement efficiency. It may be necessary to perform a new adaptation of the score, replacing certain practices by others, such as using tubes, or attributing higher scores to some interventions already described, since the way it is presented today cannot faithfully characterize the needs of each patient.

To see if the variation found was statistically significant, a test of hypotheses was conducted. The test chosen was student’s t-test, appropriate for the comparison between paired samples of equal variances, such as the present study, which has two sets of data for each patient. The level of significance ($\alpha$) was 0.05. The results are shown briefly in Table 3.

Table 3 – Student’s t-test one-tailed for testing the hypothesis proposed in various stages of the bed bath, with $\alpha = 0.05$

<table>
<thead>
<tr>
<th>Phases</th>
<th>t-value</th>
<th>p-value</th>
<th>$\alpha$</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE-PER CTRL x PRE-PER EXP</td>
<td>-5.8706</td>
<td>0.000001</td>
<td>0.05</td>
<td>Rejects $H_0$</td>
</tr>
<tr>
<td>PRE-POST CTRL x PRE-POST EXP</td>
<td>-0.9093</td>
<td>0.185352</td>
<td>0.05</td>
<td>Does not reject $H_0$</td>
</tr>
</tbody>
</table>

The results showed that, when comparing the pre-per interval in control and experiment at $p < \alpha$, a statistically significant difference was found between the average percentage decrease in SpO2, when patients are subject to a bed bath with varying water temperature, and the decrease when the water temperature is constant. These data imply the rejection of $H_0$, which means, in other words, that patients exposed to constant water temperature tend to maintain the highest SpO2.
However, when comparing the pre-post interval at $p > \alpha$, which indicates that there are no statistically significant differences between the average percentage decrease in SpO$_2$ after the bath. This information permits inferring that patients can recover from the decreases suffered during the bed bath.

In this sense, it is important to note that the critical p-value in this study is 0.061. Critical p can be defined as the first p-value, amending the decision established by the test. In other words, it is the p-value that would result in the non-rejection of $H_0$. When comparing the p-value found in different stages of the bath with the critical p-value, in all ranges, the p-value is markedly lower than the critical p. This permits saying that, possibly, even in case of interference of variables involved, this does not amend to the research result, confirming the valid rejection of the null hypothesis.

**CONCLUSION**

After the presentation and discussion of results, it can be said that the objectives were fully achieved. The comparison between the average change in SpO$_2$ during the bath with and without control of water temperature showed a positive impact when water temperature is kept stable during the procedure, illustrating the appropriateness of the analysis.

It is clear that the way the bath is carried out is likely to cause instability in the clinical situation of critical patients. The water temperature, an important parameter that does not receive due attention, can cause major changes in patient stability, impairing the recovery process. It is important, therefore, to effectively monitor temperature changes, especially in critical care units. For this purpose, devices can be used that function as thermostats to guarantee the maintenance of adequate water temperature throughout the bath period. Technology needs to be improved and improve nursing care, aiming for the recovery of patients who require continuous care.

Heated and constant water temperature during the bed bath reduced the normal range of SpO$_2$, that occurs during patient manipulation. Therefore, there is a need to return to the basic precepts of the technique, which is not being developed as specified, with a view to improving the care provided to ICU patients, in an environment where various stressors and risks appear.

The results ratify the assumptions that controlled water temperature favors the maintenance of patient stability and may positively influence the timing of recovery, which is positive for individuals, the community and institutions. As the bath is an important therapeutic procedure and, at the same time, little appreciated and discussed, this evaluation permits asserting that the best way to achieve the full bed bath is to identify factors inherent in that care act that contribute to the maintenance of patients’ oxyhemodynamic stability.

Frequent discussion and review of nursing techniques and basic tasks is needed to provide improvements and advances, able to contribute to a more qualified care, allowing the team to deliver scientifically sound care.

The analysis of the impact of water temperature on SpO$_2$ variation is extremely relevant, because it permits a critical and reflexive evaluation of the technique. Thus, possible adverse effects of this practice can be minimized, providing high-quality care to critical patients. In addition, some patients’ SpO$_2$ could be improved, which could enhance their recovery process.

There were some limitations in this study. The most important one is that it was impossible to perform a blind study. Also, selected patients were submitted to a low degree of invasiveness, and it was not possible to reflect on variations that can occur with very ill patients, submitted to a lot of invasive procedures.

**REFERENCES**


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