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Bed Bath and Sleep in Critically Ill Patients - An Observational Study

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ABSTRACT

Purpose: *Critically ill patients are at risk of sleep deprivation. Sleep promotion should be routinely implemented. Passive body heating has the potential to promote sleep. It is not known whether it can be obtained with a bed bath in the intensive care unit.*

Methods: *In this cross-sectional observational study, we compared the sleep of 30 adult critically ill patients in two sequential nights – without and with bed bath, recording potential intervening environmental and clinical factors. Additionally, we monitored the impact of baths on participants' body temperature, checking for correlations between changes triggered by bath and sleep parameters. Sleep was assessed with bispectral index and with Richards-Campbell Sleep Questionnaire. Environmental noise and luminance were measured with decibel and lux meters. Temperature was measured with iButtons sensors.*

Results: *Patients had reduced total sleep time in both nights of observation (medians of 170 and 177 minutes), without reaching deep sleep. There was no difference in sleep between both nights of observation. We recorded high noise levels in both nights of observation (57dB) and bathing nights were associated with greater exposure to light. There was moderate correlation between epigastric temperature oscillation with bathing and sleep volume, but epigastric temperature predicts neither total sleep volume nor continuous sleep volume.*

Conclusion: *In critically ill adult patients, nighttime bed baths do not correlate with sleep, but are associated with increased exposure to light. Post-bath epigastric skin temperature correlates with sleep volume but does not predict it.*

Keywords

Sleep, Sleep deprivation, Circadian rhythm, Intensive care unit.

Introduction

Critically ill patients are at risk of sleep deprivation during intensive care unit (ICU) treatment. Environmental, physiological, care-related and disease severity factors can compromise ICU rest [1-4], potentially increasing risk of cognitive impairment, delirium, difficulty weaning from mechanical ventilation, immune dysfunction, lasting psychological sequelae, and death [5]. Pharmacological [6] and non-pharmacological strategies [7] that promote sleep in the ICU should be implemented by the assistance team whenever possible.

Passive body heating, with the aid of an external heat source, has the potential to warm the trunk [8-11] and manipulate the distal-proximal gradient of body temperature [12-14], reducing sleep-onset latency [15] and stimulating deep, more restful sleep [13,16,17]. It can be obtained with electric blankets [18], immersion baths [8,12] and aspersion baths [19]. Critically ill patients usually receive aspersion baths in their own bed, at the time of best logistical convenience to the ICU team. The capacity of the aspersion bath, performed in the ICU bed, to promote passive body heating and stimulate sleep has never been tested.

In this study, we compared the volume, duration and perceived quality of sleep in a sample of critically ill patients in two sequential nights – the first, without performing a bed bath and the second, in which the patient took a bath in bed. Concomitantly, we recorded the potentially intervening factors in sleep in both nights – ambient temperature, noise and luminance; perceived pain intensity; severity of the clinical condition; and uses of opioids, benzodiazepines and norepinephrine. Additionally, we monitored the impact of bed baths on the participants' body temperature, checking for correlations between changes triggered by bath and sleep parameters. We assume that the bath performed in the ICU bed is capable of stimulating sleep, through the manipulation of skin temperature.

Method

This cross-sectional observational study was conducted in an 8-bed surgical ICU of a public tertiary hospital. It was carried out in compliance with the 1975 Declaration of Helsinki (revised in 2000). All participants consented in writing before starting the monitoring.

An *a priori* paired test with a two-tailed alpha of .5 and a power level of .8 indicated a necessary sample size of 28 participants to detect differences in deep sleep parameters, considering an effect size of 0.56, based on previous research [11]. A convenience sample was surveyed and screening for eligibility among patients admitted to the aforementioned ICU was performed every day of the week. Only one patient was monitored each night, as there was only one sleep monitoring device available for the study. Data were collected by the same researcher, from August 2018 to June 2019. Collection was stopped when data from 30 patients had been recorded.

Adult (18 years and over) patients of both sexes, undergoing treatment for diseases of low or moderate severity, with the prospect of staying the next two subsequent nights in the ICU and who were sufficiently lucid to understand and accept the terms of free and informed consent were included in the study. Patients undergoing surgical procedures were included in the study the day after the surgical intervention, to minimize the effect of anesthetics on sleep. Patients who presented discomfort with the monitoring equipment, clinical deterioration that compromised the ability to understand and accept the terms of free and informed consent, individuals whose data could not be recorded throughout the night and patients in delirium, identified by screening with the Confusion Assessment Method for Intensive Care Unit (CAM-ICU) [20] instrument were excluded.

Study participants were hospitalized in individual boxes measuring 12 square meters, with wooden and glass partitions. All boxes had a multiparameter monitor and as needed, infusion pumps and a mechanical ventilator. The audible alarms on the sleep monitoring equipment were all off. There was no active protocol for sleep promotion at the time of data collection, and no participants wore earplugs or eye masks.

After recruitment, participants' demographic, anthropometric and clinical data were recorded. The severity of the illness presented by the individual was estimated in both days of monitoring with the Acute Physiology and Chronic Health Evaluation II (APACHE II) index [21].

In the first night of observation, participants had a BIS Quatro™ sensor (Covidien IIc, Mainsfield, USA) attached to the left frontal region and connected to the BIS Vista™ Monitoring System (Covidien IIc, Mainsfield, USA) from 7 pm to 6:59 am of the following morning. BIS performed the electronic processing of the electroencephalographic record every minute during the observation period and calculated the Bispectral Index, which allowed the estimation of sleep duration and depth [22,23].The parameters recorded by the BIS were: total sleep volume and time; continuous sleep volume and time; deep sleep volume and time; and, in the second night of observation, latency for sleep onset after bath. Sleep periods lasting 10 minutes or more, with greater restorative potential, were computed as continuous [24]. Sleep time and latency for sleep onset after bath were expressed in minutes; sleep volume was expressed as a function of the area under the BIS curve *versus* time (in minutes) [22,25]. BIS values below 80 demarcated the onset of light sleep and below 40, deep sleep [23]. Immediately after installing the cranial sensor, the level of pain experienced by the individual was estimated, using the Visual-Analog Pain Scale [26], No participant bathed in the first night of observation.

In both monitoring nights of each participant, the environmental sound pressure level was recorded from 7:00 pm to 6:59 am the following morning with a professional class 1 monitor with datalogger, model DT-8852 (CEM Instruments, India), submitted to certified calibration and installed 1 meter from the head of the bed of the patient under study. The frequency of sound capture was 2 seconds; the used uptake unit was the decibel (dB); and the compensation circuit was set to slow A-weighting. The equivalent continuous noise levels (LAEq) [22] of the observation nights were calculated. The environmental luminance was also recorded throughout the night with a professional digital lux meter with datalogger model DT-8809 (CEM Instruments, India), submitted to certified calibration, installed beside the decibel meter. The frequency of ambient luminance capture was 20 seconds; the capture unit used was the Lux. Additionally, ambient temperature was constantly recorded with an iButton™ miniaturized sensor model DS1921G (Thermochron, Australia) [27] installed next to other equipment. The frequency of capture of ambient temperature was 3 minutes and the unit of capture used was the degree centigrade. Sound, luminance and temperature records were downloaded to a computer in the following mornings of both nights for analysis. Furthermore, dose-equivalents of morphine, clonazepam and norepinephrine (in milligrams/kg/day) administered between 7 am on the day of monitoring and 6:59 am the following day were calculated for each participant in both nights.

At the beginning of the second nights of monitoring of each participant, iButtons™ sensors were affixed to specific points on

the skin [27,28]: a single sensor, in the epigastrium (sensor 3); and bilaterally - in the infraclavicular fossae (sensors 1 and 2), the palms of the hands (sensors 4 and 5) and the feet soles (sensors 6 and 7). These sensors allowed the recording of skin temperature fluctuations in the frequency of one capture every 3 minutes.

Two nursing professionals performed the bath in bed on the first hours of the second nights of observation, according to the ICU routine. Immediately before the bath, the skin thermal sensors were removed. The duration of the bath and the temperature of the water used in it were recorded with a thermometer with certified calibration. The heat input in the bath was calculated by multiplying the temperature of the bath water by the duration of the bath. After the bath was over, we installed the thermal sensors again, installed the cranial sleep sensor and estimated the level of pain experienced by the individual, using the Visual-Analog Pain Scale. The post-bath distal-proximal gradient of body temperature [27] was calculated by subtracting the result of the sum of the temperatures measured in the proximal sensors (sensors 1 +2 +3) from the sum of the temperatures measured in the distal sensors (sensors 4+5+6+7). The BIS Quatro™ cranial sensor and iButtons™ thermal sensors were fixed to the participants' skin with Hypafix™ elastic tape. For calculations, we considered the values obtained after equalization of the temperatures of the thermal sensors with that of the skin, 30 minutes after their post-bath repositioning.

For the purpose of comparing the objective sleep parameters (BIS) between the first and second nights, we considered as the starting point of observation in the first night the same time at which the bath in the second night ended. From there, we matched the first and second nights logs by time, until 9 hours of log were considered in the calculations. We defined 9 hours as the maximum duration of nighttime recordings to avoid biases arising from the different start times of the baths among the participants, which would determine that the total duration of monitoring would vary between them.

In the mornings following the monitoring nights, the Brazilian Portuguese version of the Richards-Campbell Sleep Questionnaire (RCSQ)[29] was applied to patients. The total score, the average of the five domains that make up the instrument, represented the perceived quality of sleep, graded from 0 to 100 points.

Statistical Analysis

The assumption of normality of the variables was verified using the Kolmogorov-Smirnov test. The results were presented as median and 25-75% percentiles, mean and standard deviation or frequency, depending on the type of variable and data distribution. Wilcoxon signed ranks test was used to compare variables with non-normal distribution between different nights. Spearman's rank correlation coefficient was used to determine the degree of association between the distal-proximal gradient of body temperature after bathing; the temperature of the water and the duration of the bath; exposure to heat in the bath; the average oscillation of sensors 1 and 2 and sensor 3 with the bath; and sleep parameters in the second night of observation.

The scale of magnitudes proposed by Batterham and Hopkins [30] was used to interpret the correlations, being: < .1 trivial; between .1-.29 small; .3-.49 moderate; .5-.69 high; .7-.0 very high; and > .9 almost perfect. The established level of significance was 5%.

Results

After screening, 61 individuals met the inclusion criteria (Figure 1). However, 7 individuals declined to participate; 3 had delirium and could not be monitored; 9 showed rapid clinical improvement and were discharged from the ICU; 6 abandoned the study after technical failure in sleep monitoring or discomfort with the BIS sensor; 5 underwent procedures that made monitoring impossible; and 1 showed clinical deterioration, which prevented continuity of monitoring. Thus, 30 participants completed the monitoring of the two consecutive nights.

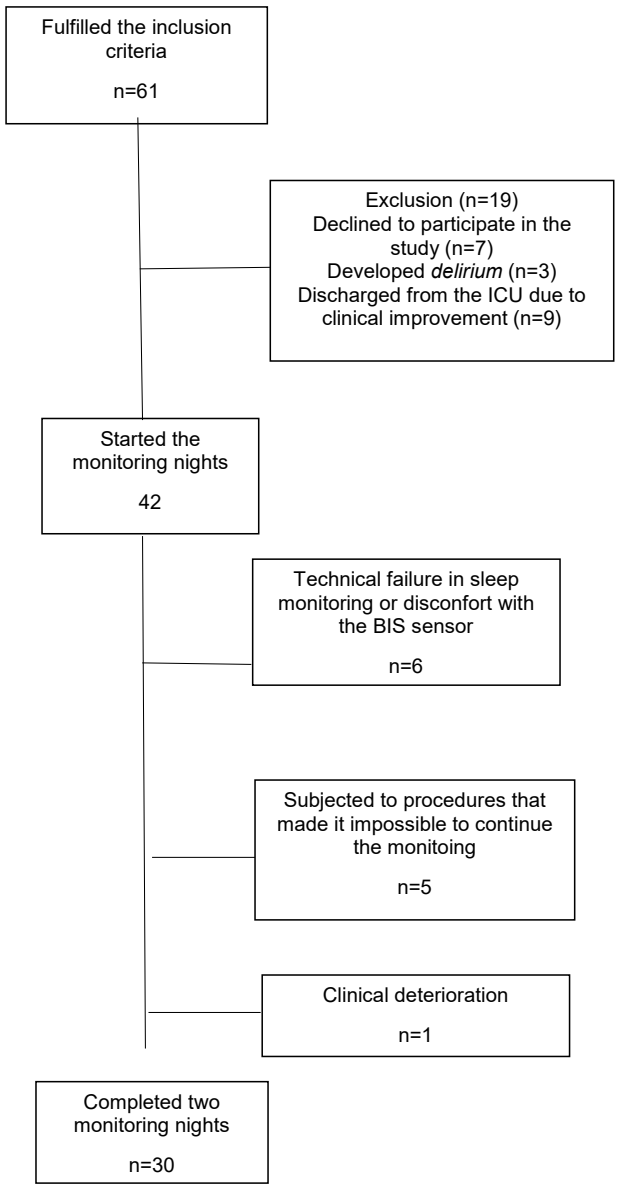

Figure 1: Flowchart of recruitment and inclusion of study participants.

Table 1: summarizes the characteristics of the study patients. The use of benzodiazepines among the patients in the sample was negligible.

Variable N = 30	First night	Second night
Age (years)[a]	66.5	(51-72)
White[b]	37	(90)
Mixed race[b]	3	(10)
Male[b]	17	(56.6)
APACHE II[c]	11,76 (4.3)	11,23 (4.4)
Current smoker[b]	3	(10)
Current drinker[b]	1	(3.3)
Use of invasive mechanical ventilation[b]	2	(6.6)
Use of noninvasive mechanical ventilation[b]	1	(3.3)
Use of tracheostomy[b]	1	(3.3)
Opiod dose[a]	0 (0-0.15)	0 (0-0.05)
Norepinephrine dose[a]	0.55 (0-0.2)	0 (0-0.05)
Reason for hospitalization:		
Gastrointestinal surgery[b]	13	(51.2)
Thoracic surgery[b]	5	(12.2)
Urological surgery[b]	4	(9.7)
Acute renal failure[b]	1	(2.4)
Sepsis[b]	1	(7.3)
Liver transplantation[b]	1	(2.4)
Oral and maxillofacial surgery[b]	2	(4.8)
Orthopedic surgery[b]	1	(2.4)
Leptospirosis[b]	1	(2.4)
Myasthenia gravis[b]	1	(2.4)

Table 2: shows the results of measurements of sleep, temperature, ambient sound pressure, ambient luminance and pain perception in both nights of observation.

Variable	**First night**	**Second night**
Sleep parameters (BIS)		
Total volume [a]	2541 (1684-5233)	2028 (1102-4517)
Total time [a]	177 (124-273)	170 (77-258)
Continuous volume [a]	2130 (1300-3932)	1565 (757-3996)
Continuous time [a]	138 (65-224)	113 (32-225)
Deep volume [a]	0	0
Deep time [a]	0	0
Latency [a]	-	109
Perceived sleep quality (RCSQ)[b]	53.5 (24.6)	48.7 (29.8)
Environmental temperature [b]	22.1 (1.5)	22.7 (1.7)
Environmental sound pressure level (LAEq) [a]	57 (55.4-59.3)	57 (56-59)
Environmental luminance [a]	7409 (1635-15391)	26926 (9232-55762)*
Perceived pain [a]	0.35 (0-3.1)	0 (0-3.1)

[a] Values expressed as median (25-75% percentiles), [b] Values expressed as mean (standard deviation). Sleep time and latency expressed in minutes; sleep volume expressed in (BIS units below 80) x time; LAEq = equivalent continuous noise level (in decibels, A-weighted); ambient luminance expressed in Lux.

*p<0.001.

Measurements using the BIS showed that this group of individuals had reduced total sleep time in both nights of observation (medians of 170 and 177 minutes), without reaching deep sleep.

Bathing nights were associated with greater light exposure (Z = -3.652; p<0.001). Figure 2 shows the boxplots of the luminance measured on observation nights – all nights; first thirds, second thirds and third thirds of the nights. The higher environmental light exposures in nights with bed baths occurred mainly in the first thirds of those nights.

The medians of bath water temperature, bath duration and heat input in the bath were, respectively, 39.5ºC, 32.5 minutes and 1250ºC *versus* minutes.

The medians of post-bath distal-proximal gradient of temperature, average oscillation of temperature of sensors 1+2 and average oscillation of temperature of sensor 3 were, respectively, .035ºC, .87ºC and -.25ºC.

Table 3: shows the correlations between bath, skin temperature and sleep parameters on the second night of observation.

	Total volume	**Total time**	**Continuous volume**	**Continuous time**	**Deep volume**	**Deep time**	**Latency**
Distal-proximal gradient	-.17	-.14	-.2	-.19	-.22	-.22	-.3
Water temperature	.2	.24	.2	.22	.11	.12	.36
Duration of bath	.05	.07	.04	.07	.06	.07	-.1
Heat exposure on bath	.12	.17	.12	.16	.09	.1	-.03
Average oscillation sensors 1+2	.12	.15	.12	.15	-.06	-.08	-.1
Average oscillation sensor 3	.37*	.16	.36*	.25	.2	.18	-.05

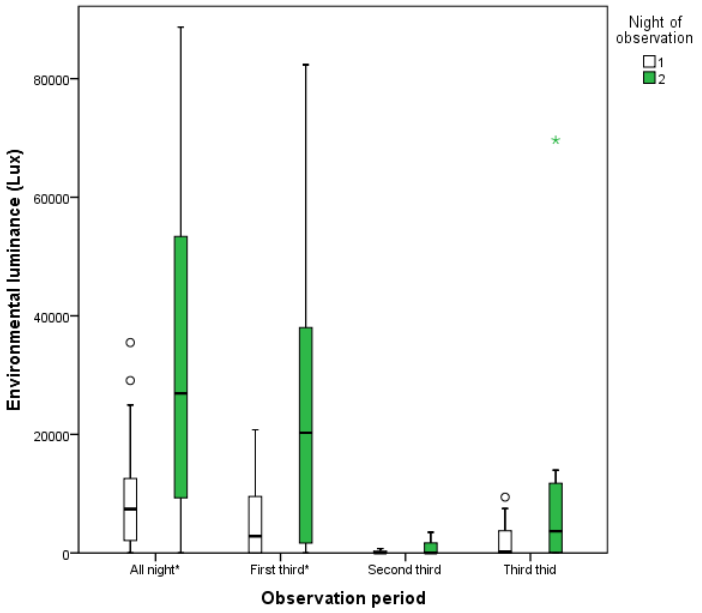

Figure 2: Boxplots of the luminances measured on the nights of observation – whole nights, first third, second third and third third of the night.

*p<.01.

Spearman's rank coefficient showed moderate correlations between epigastric temperature oscillation with bathing (sensor 3), total sleep volume (ρ = .37; p<.05) and continuous sleep volume (ρ = .36; p<.05). Simple linear regression showed that epigastric temperature neither predicts total sleep volume [F (1, 28) = 3.794,

p=.062; R^2 = .12] nor continuous sleep volume [F (1, 28) = 3.689, p=.065; R^2 = .11].

Discussion

In low-severity, lucid, critically ill adult patients, there are no differences in sleep between nights with and without bed baths. In this same population, bed baths performed in the early evening are associated with increased exposure to light; and post-bath skin temperature of the epigastric region correlates with volume of sleep but does not predict it.

Bed bath performed in the ICU was not able to promote passive body heating and stimulate sleep in this population. Despite the temperature of the water used for bathing in this study (median of 39.5ºC) being only slightly lower than the routinely used in passive body heating techniques (40-42ºC), the bed bath, with sprinkling, allows greater convective loss of heat across the skin surface than immersion baths routinely used for passive body warming [8,11,17].

In bathing nights, there was greater exposure to light – particularly in the first hours of observation (Figure 2), probably because of prolonged manipulation by the nursing staff during the bath. This procedure, in spite of not being associated with a higher level of environmental sound pressure when compared to the first night of observation (Table 2), may have somewhat stimulated the patients, overcoming the potential sleep stimulus provided by the application of heat to the skin observed in environments with less stimuli [15,31]. In addition, more intense and prolonged exposure to light during bathing may have inhibited melatonin secretion [32] and compromised subsequent sleep.

We recorded high noise levels on observation nights (57 dB of median LAEq), well above the 35dB recommended by the World Health Organization [33]. Although intuitively expected, we did not observe higher levels of ambient sound pressure on bed bath nights.

We did not observe differences between observation nights in ambient temperature, perceived pain levels, clinical severity of illness, nor in analgesic and norepinephrine doses used. Although the study included individuals who underwent major surgery, the reported pain intensity was low. The authors believe that this occurred because the inclusion in the study of patients undergoing surgical procedures occurred only on the day after the surgical intervention, which made adequate analgesia possible earlier.

Despite the use of sedatives being common in the ICU, practically no individual received benzodiazepines on the monitoring days. The authors believe that the lack of prescription of this class of drugs in the monitored individuals was due to the characteristics of the ICU that housed the study (predominantly surgical, without chronically ill patients) and the tendency of the assistant team to avoid, as far as possible, the use of benzodiazepines as part of delirium prevention measures.

Although the correlation observed between the oscillation of epigastric temperature during bathing and the volume of sleep corroborates previous experimental findings, in which the manipulation of trunk temperature stimulated sleep [8-11] in this study the oscillation of epigastric temperature during bathing does not predict sleep. Despite being documented in the laboratory, according to the authors' knowledge, this correlation had never been demonstrated in the ICU routine.

This is the only study which the authors are aware of investigating the potential of bed bath as a non-pharmacological strategy to stimulate sleep in the ICU, but some limitations should be considered. In this study we did not monitor core temperature, which may have made it difficult to assess the real impact of passive body heating promoted by the bed bath. Although part of the sleep of critically ill patients occurs during the day [34,35], we only monitored the night period; there were losses to follow-up due to displacement or discomfort with the sensor; and these results are valid for lucid patients and those with diseases of low or moderate severity. Although this selection limited the generalizability of the results, it ensured the reliability of the measurements, as the assessment of sleep in agitated, clinically unstable or sedated patients is unfeasible or, at best, biased [36].

Conclusion

In low-severity, lucid, critically ill adult patients, there are no differences in sleep between nights with and without bed baths. In this same population, bed baths performed in the early evening are associated with increased exposure to light; and post-bath skin temperature of the epigastric region correlates with volume of sleep but does not predict it.

More studies are needed to clarify the impacts that skin temperature manipulation and environmental factors have on the sleep of critically ill patients.

This study was carried out in compliance with the 1975 Declaration of Helsinki (revised in 2000), having been approved by the Research Ethics Committee of the institution (registration number 83082118.7.0000.0096) and registered in the Brazilian Registry of Clinical Trials (RBR-2ss28r) on June 20th, 2018.

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