RESEARCH ARTICLE

Reduced Overnight Vital Signs Improve Sleep in Hospitalized Children: A Nonrandomized Interventional Trial

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ABSTRACT

OBJECTIVE: This study sought to determine the change in sleep quality and duration among children hospitalized on acute care units when overnight vital signs (VS) monitoring is eliminated, compared with children who receive standard-of-care VS monitoring.

PATIENTS AND METHODS: This is a nonrandomized controlled study among children hospitalized on medical-surgical units (n = 109). The study intervention involved forgoing VS measurement at 0000 and 0400. The primary outcome was actigraphy-measured total sleep time, with secondary outcomes of actigraphy-measured wake status at midnight and 0700; actigraphy-measured and self-reported nocturnal wake frequency and duration; and self-reported total sleep time, restfulness upon waking, and sleep disturbances.

RESULTS: Actigraphy total sleep time in the intervention group was 49.2 minutes longer than in the control group ($P = .04$). Sleep efficiency, wake after sleep onset, and wake episodes were not different. There was also no difference in the number of children asleep at midnight, but more children in the intervention group were asleep at 0700 than in the control group (77% vs 55%, $P = .03$). Self-reported restfulness and sleep disturbances were also superior in the intervention group. There were no unplanned pediatric intensive care unit (ICU)/cardiac ICU transfers, rapid response activations, code sepsis alerts, or code blue events.

CONCLUSIONS: Forgoing overnight VS measurement among children hospitalized on medical-surgical units was associated with an increase in overnight sleep duration but did not decrease the overall number of nighttime interruptions or time awake during the night. VS measurement reduction was also safe and may be important for children to achieve adequate sleep in the hospital.

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Dr Bitterfeld conceptualized and designed the study, developed the data collection tool, led data collection, analysis, and interpretation, drafted the initial manuscript, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Ms Fraley contributed to the design of the study, recruited participants, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Ms Smith contributed to the design of the study, recruited participants, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Ms Mathias contributed to the design of the study, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Ms Peterson contributed to the design of the study, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Dr Cipriano contributed to the design of the study, contributed to interpretation of the data, critically reviewed and revised the manuscript, and approved the final manuscript as submitted. Deidentified individual participant data (including data dictionaries) will be made available, in addition to study protocols, the statistical analysis plan, and the informed consent form. The data will be made available upon publication to researchers who provide a methodologically sound proposal for use in achieving the goals of the approved proposal. Proposals should be submitted to Leandra.bitterfeld@imail.org.

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INTRODUCTION

Adequate sleep is vital for healing and optimal functioning, and sleep deprivation negatively impacts the body's breathing, circulation, immune system function, endocrine function, and metabolism.[1] A lack of sleep is also associated with diminished cognitive and emotional functioning,[2] an increase in self-reported pain, altered pain threshold,[3] and depressive symptoms.[4] Hospitalized children are at high risk for disturbed sleep and its physiological effects, given the high-sensory and unfamiliar nature of hospitals.

Overnight vital signs (VS) are measured every 4 hours on pediatric acute care units at many institutions, despite limited evidence supporting this practice.[5,6] Additionally, VS measurements are often ordered and collected without considering the patient's clinical status or the potential impact that they may have on sleep. Indeed, an observation study on a pediatric surgical unit found that approximately 60% of children had at least 1 abnormal overnight VS measurement, but only half of those abnormal overnight VS measurements were accompanied by additional clinical action. This suggests that only a minority of overnight VS measurements are paired with an adjustment in clinical care.[7] This practice is in direct contradiction to guidance from the American Academy of Nursing's Choosing Wisely Campaign, which states, "Don't wake the patient for routine care unless the patient's condition or care specifically requires it."[1]

This team's previously published scoping review[8] summarizes prior work in this area. Current research finds that VS checks and nursing cares are the most frequent cause of nighttime awakenings among hospitalized children.[9–12] Most studies investigating the impact of overnight VS on sleep are either observational studies or quality improvement projects, which focus on process measures rather than on patient-level outcomes.[8] Furthermore, few studies included sleep duration[13] or efficiency[14] as outcomes of reducing VS checks. Quality improvement initiatives do, however, demonstrate that a reduction in overnight VS monitoring is a safe intervention, with no escalations of care or code blue events when overnight VS checks were reduced.[13–17] This work suggests that reducing overnight VS checks may be a safe and effective intervention for improving sleep in hospitalized children.

This study sought to determine the change in sleep quality and duration among children hospitalized on acute care units when overnight VS monitoring is eliminated, compared with children who receive standard-of-care overnight VS monitoring.

METHODS

Study Design and Setting

This is a nonrandomized controlled study to evaluate the effect of forgoing overnight VS on sleep quality and duration. Participants were sequentially recruited, first into the control cohort and then into the experimental cohort. Sequential, rather than randomized, recruitment was chosen for 2 reasons. First, the study team felt that treatment adherence would be higher if nursing staff were tasked with consistent VS monitoring orders, rather than randomized orders. Second, we thought that sequential enrollment, with forgone VS monitoring ordered in the latter group, would ease implementation of practice change if warranted.

This study was conducted on medical-surgical units in a standalone tertiary care pediatric hospital in the western United States that has 280 total beds, 100 of which are medical-surgical beds, and sees approximately 14 000 admissions annually. All hospital rooms in the facility are private, with only 1 occupant per room. This study was approved by the hospital's institutional review board and registered with ClinicalTrials.gov (NCT06865781). It was conducted and reported according to the Transparent Reporting of Evaluations With Nonrandomized Designs (TREND) guidelines.[18]

Participants

Participants were children hospitalized on medical-surgical units, aged 1–18 years, with a Pediatric Early Warning Score ≤1 at 2000. Additionally, children had to be under the care of a pediatric hospitalist team, rather than a subspecialty team, and both the daytime attending hospitalist and bedside nurse needed to confirm that the child was appropriate for participation. Children were eligible for enrollment at any point during their hospital stay.

There were several medical exclusion criteria, which were developed and refined in discussion between the study team and hospitalist leaders. Additionally, children under the care of subspecialty and surgical teams were not included due to difficulty engaging these teams in eligibility screening. A full list of inclusion and exclusion criteria can be found in Table 1.

While we initially intended to enroll 80 children per group, enrollment targets were reduced due to limited project time and

TABLE 1. Participant Inclusion and Exclusion Criteria

Inclusion Criteria
Hospitalized on medical-surgical units
Aged 1–18 y
Pediatric Early Warning Score ≤1 at 2000
Parent/legal guardian present and willing to consent to study participation
Primary language of either English or Spanish
Under the care of a pediatric hospitalist team
Confirmed eligible by both the daytime attending hospitalist and bedside nurse
Exclusion Criteria
Preexisting diagnosis of hypertension, kidney disease, pulmonary hypertension, chronic lung disease, congenital heart disease causing cardiopulmonary compromise, obstructive sleep apnea, seizure disorder, and neuromuscular disability, unless explicitly approved and acknowledged by attending physician
Received intravenous immunoglobulin, intravenous magnesium, or continuous albuterol in the previous 24 h
Received opioids, benzodiazepines, or other sedating medications beyond home regimen in the previous 12 h
Require oxygen monitoring at home baseline
Requiring oxygen above baseline
Fever in the previous 24 h
Sepsis alert in the previous 72 h
Anaphylaxis within 24 h
Undergone surgery within 24 h

TABLE 2. Standard Overnight VS Monitoring Routines

VS Monitoring Routine	1900	2000	2100	2200	2300	0000	0100	0200	0300	0400	0500	0600	0700
VS with BP every 12 h		Temp, HR, SpO_2, RR, BP				Temp, HR, SpO_2, RR				Temp, HR, SpO_2, RR			
VS with BP every 4 h		Temp, HR, SpO_2, RR, BP				Temp, HR, SpO_2, RR, BP				Temp, HR, SpO_2, RR, BP			
Study intervention VS		Temp, HR, SpO_2, RR, BP											

Abbreviations: BP, blood pressure; HR, heart rate; RR, respiratory rate; SpO_2, oxygen saturation; Temp, temperature; VS, vital signs.

resources, resulting in a smaller final sample size. Notably, this health system had a planned electronic health record system transition that the study team anticipated would interfere with successful engagement of clinical staff in study conduct. Thus, we sought to conclude enrollment before this change. We determined that a sample size of 51 children in each group would allow for detection of a moderate effect size (Cohen $d = 0.50$, estimated 45- to 60-minute increase in sleep duration) with an α error probability of 0.05 and power of 80%.

Study Intervention

VS monitoring orders on these units consisted of measurement every 4 hours of temperature, heart rate (HR), respiratory rate (RR), and oxygen saturation (SpO_2). Blood pressure (BP) measurement orders were either every 4 hours or every 12 hours, and this VS measurement routine is conducted for the entirety of the hospital stay. The study intervention involves forgoing all VS measurements at 0000 or 0400, including continuous pulse oximetry and cardiac monitoring, to allow for a longer period of sleep uninterrupted by VS measurements (Table 2).

Recruitment and Study Conduct

Patients hospitalized on medical-surgical units were screened for inclusion and exclusion criteria by a study team member, who then shared information about potentially eligible children with their attending hospitalist for eligibility verification. Once children were deemed eligible by the attending hospitalist, study team members verified eligibility with the bedside nurse and approached eligible families for consent and enrollment.

The first group of children enrolled were assigned to the control group, where no changes were made to the child's VS monitoring routine, and the bedside care team (registered nurse and patient care technician) was informed of the child's study participation. The second group of children were assigned to the intervention group and did not have any VS measurements taken at 0000 and 0400. The bedside care team was informed of the child's assignment to the intervention group, and orders were placed for no VS monitoring at 0000 or 0400 of the study night. The care team was also instructed that if a patient had a change in clinical status during the study period, or if a nurse/clinician had a concern about a patient's clinical status, the team should take VS measurements as the nurse/clinician felt appropriate, and the child would be removed from the study. During control group enrollment, it came to our attention that some study participants had no overnight VS monitoring ordered before enrollment. We did not want to disrupt care and elected to allocate these children to the intervention group ($n = 22$).

Control group enrollment occurred until the day that the revised sample size goal ($n = 51$) was met, and intervention group enrollment period commenced the following day. Control group enrollment occurred from June 2024 to January 2025, and intervention group enrollment occurred from January 2025 to May 2025.

The study duration was a single period of approximately 24 hours. Study staff completed the informed consent process with eligible children and their family. Then, children were fitted with the actigraphy watch and given the sleep diary and sleep survey with instructions to complete them the following morning. Study staff informed the family of group allocation to ensure that they were aware of the overnight care they would receive. Finally, the bedside team was informed of the child's participation in the study and group allocation. At the conclusion of the study, a study team member returned to collect the actigraphy watch and sleep diary and discuss with the bedside nurse any unanticipated events that occurred during the study period.

Data Collection and Measurement of Outcomes

We used multiple methods to measure sleep outcomes, with total sleep time measured by actigraphy as our primary measure (Micro Motionlogger [Ambulatory Monitoring Inc]) and the Sadeh algorithm, which has been validated in children aged 1–18 years against polysomnography.[19] Measurements gathered from the actigraphy watch were total sleep time, sleep efficiency (the percentage of total time in bed actually spent asleep),[20,21] the number of wake episodes during the sleep period, time awake during the sleep period, and the child's wake status at 2200, midnight, and 0700.

Additionally, a patient-reported sleep diary and the Patient-Reported Outcomes Measurement Information System (PROMIS) 8-item Pediatric Sleep Disturbance survey were administered to children aged 8 years and older. Children less than 8 years old did not complete subjective sleep measures, as these tools are not validated for younger age groups. Furthermore, we were concerned about parents' ability to complete these tools consistently and reliably because parents do not always spend the night in the hospital room and may not wake up every time their child does. The sleep diary was modified from the National Sleep Foundation's diary,[22] which was

developed in collaboration with insomnia experts and potential users. Children (with help from a caregiver, if needed) recorded the time they fell asleep, the time they woke up, the number of times they were woken up during the night, and the total number of minutes they were awake during the night. Additionally, they recorded whether they felt rested, somewhat rested, or tired upon waking. The PROMIS 8-item Pediatric Sleep Disturbance survey is reverse scored on a scale of 8 to 40, with lower score indicating better sleep and less sleep disturbance. The scale has demonstrated validity and reliability in children with and without neurodevelopmental disorders.[23] All study materials were available in English and Spanish.

Safety measures were monitored during the study and for an additional 24 hours after study completion and included any unnoticed, clinically significant change in clinical status (measured as an unplanned transfer to the pediatric intensive care unit [PICU] or cardiac intensive care unit [CICU]) and any rapid response activations, code sepsis alerts, or code blue events. The instance of any of the above events was communicated to the study team via the attending hospitalist and confirmed via chart review.

Additional demographic and hospital stay data were gathered from the participant's electronic medical record, including age, gender, primary diagnosis at time of enrollment, length of stay, and time from study enrollment to discharge. We retrospectively collected the number of VS readings, BP readings, and nighttime care activities received on the study night (1900–0700), which were toileting events, medication administration, intravenous line flushes, blood draws for laboratory tests, starting/stopping of tube feedings, and any other diagnostic procedures or care activities. A VS reading was considered as a set consisting of temperature, HR, SpO_2, and RR, although incomplete VS measurement sets were also counted as an occurrence. While several nighttime care activities may have been completed during a single room entry, we were unable to discern this through chart review. Thus, each care activity was counted separately and then added for a total number of nighttime care activities.

Statistical Analysis

As previously described, children recruited during the control group phase with no overnight VS monitoring ordered at the time of enrollment were allocated to the intervention group. First, data distributions were assessed for skewness to evaluate normality before analysis. Control and intervention group characteristics were reported as mean and SD for continuous variables and counts and percentages for categorical variables. Outcomes were compared using an independent-samples *t* test for continuous variables or a χ^2 test for categorical variables. This same analysis was rerun, excluding children without overnight VS measurement ordered before enrollment, to assess the potential impact of patient acuity on between-group differences. Missing data were handled using pairwise deletion to maximize data points available in this relatively small sample, and a description of missing data can be found in Supplemental Table 1. All statistical tests were run using SPSS version 30.0.0 (IBM), and the sample size estimate was calculated using G*Power version 3.1.9.7.

RESULTS

Patient Demographics

A total of 123 children were enrolled, and the recruitment flow diagram can be found in Figure 1. Children were excluded after enrollment because they were discharged before the study night (n = 7), met exclusion criteria after enrollment and before the study night (n = 6), or declined participation after completing the consent process (n = 1). No children were excluded due to unanticipated overnight events. The final sample consisted of 53 children in the control group and 56 children in the intervention group. Participants in the control and intervention groups were similar in terms of age, gender, and primary language spoken. Children ranged in age from 1 to 18 years in the control group and 1 to 17 years in the intervention group. The primary diagnoses of the 2 groups were mostly similar, with the exception of more children with an endocrine diagnosis in the intervention group and more children with a gastrointestinal diagnosis in the control group. This difference was largely driven by children admitted with either a new diagnosis of type 1 diabetes (not in diabetic ketoacidosis) or cystic fibrosis management, who often do not have overnight VS monitoring ordered and thus were allocated to the intervention group. Children in both groups had an overall length of stay of approximately 5 days (control group range, 1–20 days; intervention group range, 1–32 days) and were enrolled in the study approximately 2.5 days before discharge (Table 3).

VS Monitoring Frequency and Sleep Outcomes

In the control group, most children (89%) had BP measurements ordered every 12 hours, rather than every 4 hours, at the time of enrollment. During the study period, most control group children (90%) had 3 sets of VS measurements taken overnight, and the remaining had 2 (8%) or 5 (2%) sets of VS measurements taken, demonstrating high adherence to the standard-of-care VS monitoring. Children in the intervention group had fewer overnight VS measurements than the control group. In the intervention group, 91% of children had only 1 set of VS measurements taken, again demonstrating high adherence to the intervention protocol. The number of other overnight care activities did not significantly differ between the 2 groups (Table 3).

Among the actigraphy measures, total sleep time in the intervention group was, on average, 49.2 minutes longer than in the control group ($P = .04$). Sleep efficiency ($P = .83$), wake after sleep onset ($P = .94$), and wake episodes were not different ($P = .79$). There was no difference in the number of children asleep at 2200 ($P = .98$) or midnight ($P = .51$) between the groups, but more children in the intervention group were asleep at 0700 than in the control group (77% vs 55%, $P = .03$).

Conversely, sleep diary measures demonstrated no difference in total sleep time ($P = .46$) but fewer wake episodes in the intervention group ($P = .005$). While not statistically significant, sleep diaries

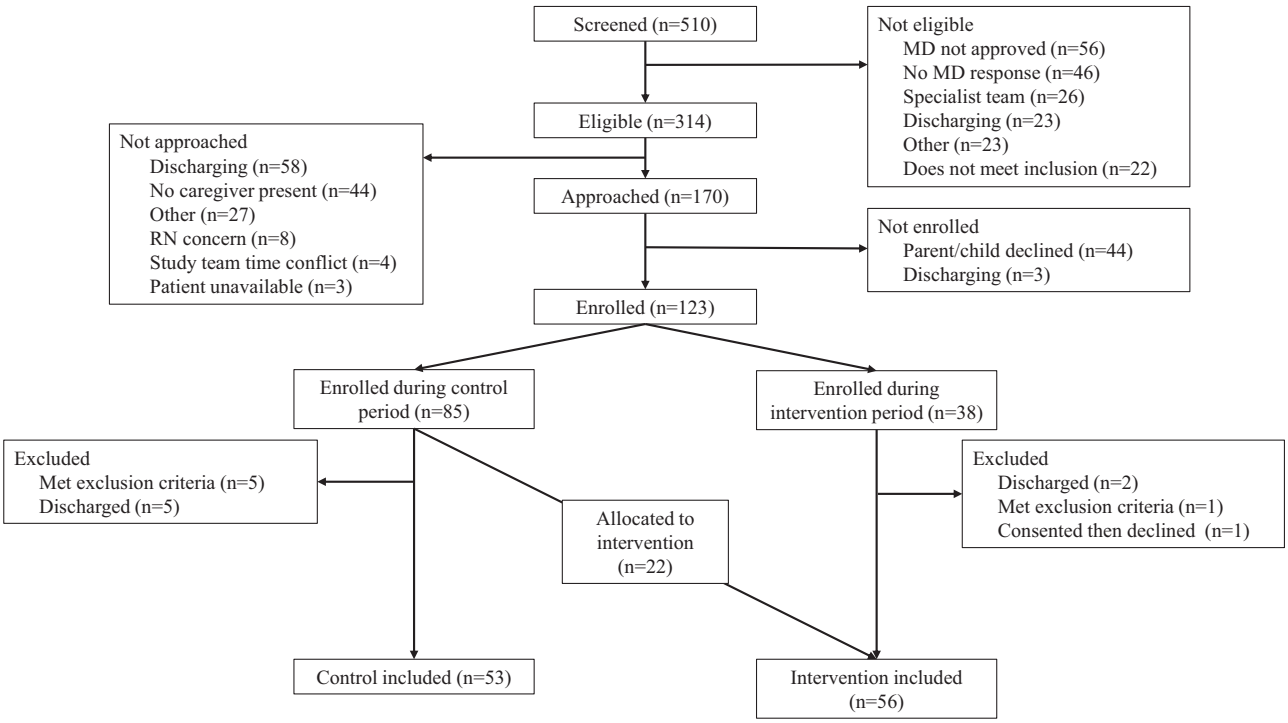

FIGURE 1. Participant flow diagram.
Abbreviation: RN, registered nurse.

showed less perceived time awake during the night in the intervention group ($P = .08$). Additionally, the intervention group reported feeling "tired" upon wakening less often ($P = .04$), and scores on the sleep disturbance survey were lower, indicating fewer disturbances and superior sleep ($P = .03$; Table 4).

Safety Outcomes

There were no unplanned PICU/CICU transfers, rapid response activations, code sepsis alerts, or code blue events among any study participants. A single participant discharged from the hospital the morning after study participation and returned to the emergency department that afternoon due to parental concern for patient pallor/poor perfusion. A code sepsis was called for low body temperature, but it was ultimately attributed to environmental exposure, and the patient was determined to not be experiencing sepsis.

Acuity-Controlled Subanalysis

As previously discussed, children without overnight VS monitoring ordered at the time of enrollment were all allocated to the intervention group. These children may have had lower acuity than those with overnight VS monitoring ordered, potentially confounding the noted difference in sleep quality. To assess this, we reran our analysis excluding children without overnight VS monitoring ordered before enrollment, which serves as a proxy measure of acuity. In this analysis, we find similar differences between groups, suggesting that the differences between the control and intervention group may have been somewhat, but not entirely, mediated by patient acuity. This analysis can be found in Supplemental Table 1.

DISCUSSION

This is the first study among a cohort of hospitalized children to use a control group design to understand the measurable impact of forgone overnight VS monitoring on sleep quality and duration. We found that children who did not have VS measured overnight slept longer than children who had VS measurements taken every 4 hours throughout the night. Consequently, these children were also more likely to wake up feeling rested. Almost half of the control group reported feeling tired upon wakening, while less than 20% of the intervention group reported the same. Sleep quality was also better in the intervention group, with sleep disturbance scores approximately 19% lower than in the control group. We also found that a higher number of children were asleep at 0700 in the intervention group than in the control group. Anecdotally, nighttime nursing care is more likely to occur in the late evening hours, shortly after shift change, rather than in the early morning hours. Therefore, we hypothesize that although children in the 2 groups had an overall similar number of nighttime care needs, children who did not have overnight VS monitoring—especially early in the morning, when care tasks are less frequent and shift change is occurring—were able to sleep longer into the morning than children who were awoken for VS monitoring around 0400. These findings suggest that

TABLE 3. Participant Demographics and Hospital Stay Characteristics

Participant Demographics	Control Group (n = 53)	Intervention Group (n = 56)	*P* Value
Age, mean (SD), y	10.8 (5.5)	9.8 (4.5)	.29
Gender, n (%)			.57
Male	24 (45)	27 (48)	
Female	28 (53)	29 (52)	
Other	1 (2)	0 (0)	
Primary language spoken, n (%)			.59
English	52 (98)	54 (96)	
Spanish	1 (2)	2 (4)	
Admitting diagnosis, n (%)			
Cardiovascular	0 (0)	0 (0)	
Gastrointestinal	20 (38)	7 (13)	.002
Endocrine	3 (6)	27 (48)	<.001
Infection	13 (25)	11 (20)	.54
Musculoskeletal	1 (2)	1 (2)	.97
Neurological	2 (4)	0 (0)	.14
Psychiatric/behavioral health	8 (15)	5 (9)	.32
Dermatologic	4 (8)	1 (2)	.15
Respiratory	1 (2)	2 (4)	.59
Surgical	1 (2)	0 (0)	.30
Other	0 (0)	2 (4)	.17
Hospital stay characteristics, mean (SD)			
Length of stay, d	5.3 (3.9)	4.9 (4.9)	.68
Time from study enrollment to discharge, d	2.5 (2.0)	2.3 (3.2)	.77
Overnight VS readings (HR, temp, RR, SpO_2)	3.0 (0.4)	1.0 (0.4)	<.001
Overnight BP readings	1.4 (0.9)	1.1 (0.4)	.02
Other overnight care activities	6.8 (3.4)	6.0 (2.7)	.29

Abbreviations: BP, blood pressure; HR, heart rate; RR, respiratory rate; SpO_2, oxygen saturation; temp, temperature; VS, vital signs.

TABLE 4. Sleep Outcomes

Sleep Outcome	Control Group	Intervention Group	*P*
Actigraphy measures	N = 47	N = 48	
Total sleep time, mean (SD), min	411.7 (115.3)	460.9 (117.2)	.04
Sleep efficiency, mean (SD), %	89.3 (6.5)	89.6 (7.0)	.83
Wake after sleep onset, mean (SD), min	52.1 (35.7)	52.7 (36.9)	.94
Wake episodes count, mean (SD)	14.4 (7.4)	14.8 (8.3)	.79
Asleep at 2200—yes, n (%)	10 (21)	10 (21)	.96
Asleep at midnight—yes, n (%)	37 (79)	35 (73)	.51
Asleep at 0700—yes, n (%)	26 (55)	37 (77)	.03
Sleep diary measures (>8 y old)	N = 35	N = 35	
Total sleep time, mean (SD), min	506.9 (146.8)	528.9 (95.5)	.46
Wake after sleep onset, mean (SD), min	38.6 (62.2)	17.5 (24.2)	.07
Wake episodes count, mean (SD)	3.0 (1.7)	1.9 (1.4)	.005
Self-reported rest upon wakening, n (%)			.04
Rested	9 (26)	15 (44)	
Somewhat rested	10 (29)	14 (40)	
Tired	16 (46)	6 (17)	
PROMIS Sleep Disturbance measure (>8 y old)	N = 35	N = 36	
Sleep Disturbance Survey score, mean (SD)	20.9 (8.1)	16.9 (6.8)	.03

Abbreviation: PROMIS, Patient-Reported Outcomes Measurement Information System.

reducing overnight VS monitoring may be an effective strategy for improving sleep for children hospitalized on medical-surgical units.

Another notable finding is the discordance between results from actigraphy data and sleep diaries. We saw that children in both groups appeared to overestimate the time they slept and underestimate the times that they were awake during the night, which are results similar to those of prior studies comparing actigraphy with sleep diary measures in children both in[24] and out[25] of hospitals. Sleep diaries are a common tool for measuring sleep[8] and are undoubtedly easier and cheaper to administer than actigraphy devices. However, researchers using sleep dairies as their primary measure of sleep duration among hospitalized children should interpret such data in the context of these known limitations.

Nighttime sleep recommendations for children aged 1 to 18 years range from 8 to 12 hours,[26] and neither study group met these recommendations. In this sample, most children were asleep by midnight (76%), but only 21% were asleep at 2200. This lack of sleep in the late evening shortens overall sleep time significantly, considering that morning clinical care starts around 0700. Interventions targeting hospital sleep improvement should not only reduce nighttime interruptions but also promote evening sleep routines and bedtimes.

Forgoing VS monitoring is not an appropriate intervention for all children hospitalized on medical-surgical units, and we estimate that on any given night, only 10% to 20% of hospitalized children met the inclusion criteria. To ensure safety for the enrolled children, we carefully crafted a list of exclusion criteria with input from pediatric hospitalists and nursing staff and verified appropriateness for enrollment with physicians and bedside nurses, because children's health status and medical stability can change from day to day. Interventions that reduce VS monitoring will likely require an individual approach rather than attempts to identify cohorts based on diagnosis, medical complexity, or length of stay. We propose that care teams consider daily discussions of the necessity of overnight VS measurement during multidisciplinary rounds to tailor a routine that maximizes both sleep and safety. This strategy has been used to reduce the number of central line days[27] and trialed in reducing the number of overnight VS measurements.[28] Such an approach may be

effective in reducing unnecessary overnight VS measurements, and sustainment likely depends on active communication between all members of the care team, but particularly clinicians and bedside nursing staff.

Limitations

This study has some limitations. While we used a control group design, we did not randomize participants. The enrollment strategy used may have introduced selection or temporal bias to our sample, as the hospitalized patient population changes throughout the year. In particular, the winter season brings higher admission rates overall due to increases in seasonal respiratory viral infections. Our control-to-intervention enrollment transition occurred in January, meaning the winter season was split between the 2 groups, presumably limiting temporal differences between them.

Additionally, neither the bedside staff nor the participants were blinded. This may have introduced some reporting bias by participants. Additionally, bedside staff may have modified overnight care delivery, knowing that the child was enrolled in the study. It is possible that they were more intentional about grouping interventions or completing patient care early in the night, especially among intervention group participants. We think this risk is present but small, considering that several other overnight care tasks were similar between the 2 groups, although our measurement of overnight care activity frequency does not allow us to definitively measure the number of overnight room entries.

It is also possible that unobserved variables are confounding the difference between groups, although we collected several clinical variables to interrogate this risk. Our data on VS measurement and nighttime disruptions were gathered via retrospective chart review; thus, the accuracy of these data depends on accurate charting by bedside caregivers. Finally, this was a relatively small sample, and most outcomes' results were below the target sample size due to missing data elements, which limits our ability to detect smaller than moderate differences between groups.

CONCLUSION

Forgoing overnight VS monitoring among children hospitalized on medical-surgical units is associated with an increase in overnight sleep duration by almost an hour, as well as subjective reports of patients feeling better rested, but did not decrease the overall number of nighttime interruptions or time awake during the night. VS monitoring reduction was also safe, with no escalations of care in our sample. Reducing overnight VS monitoring may be an important component of a sleep preservation bundle to achieve sleep duration that meets professional recommendations while children are in the hospital, although larger studies across multiple institutions are needed to validate these findings.

ABBREVIATIONS

BP: blood pressure
CICU: cardiac intensive care unit
HR: heart rate
PICU: pediatric intensive care unit
PROMIS: Patient-Reported Outcomes Measurement Information System
RR: respiratory rate
SpO_2: oxygen saturation
VS: vital signs

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REFERENCES

1. American Academy of Nursing announced engagement in National Choosing Wisely Campaign. *Nurs Outlook*. 2015;63(1):96–98. PubMed doi: 10.1016/j.outlook.2014.12.017
2. Vriend J, Davidson F, Rusak B, Corkum P. Emotional and cognitive impact of sleep restriction in children. *Sleep Med Clin*. 2015;10(2):107–115. PubMed doi: 10.1016/j.jsmc.2015.02.009
3. Schrimpf M, Liegl G, Boeckle M, Leitner A, Geisler P, Pieh C. The effect of sleep deprivation on pain perception in healthy subjects: a meta-analysis. *Sleep Med*. 2015;16(11):1313–1320. PubMed doi: 10.1016/j.sleep.2015.07.022
4. Hillman DR. Sleep loss in the hospitalized patient and its influence on recovery from illness and operation. *Anesth Analg*. 2021;132(5):1314–1320. PubMed doi: 10.1213/ANE.0000000000005323
5. Mann DL. Q4 vital signs: can machine learning protect patients from the machinery of modern medicine? *JACC Basic Transl Sci*. 2019;4(3):468–469. PubMed doi: 10.1016/j.jacbts.2019.05.002

6. Orlov NM, Arora VM. Things We Do For No Reason™: routine overnight vital sign checks. *J Hosp Med.* 2020;15(5):272–274. PubMed doi: 10.12788/jhm.3442

7. Brown M, Moreci R, Megison H, et al. Routine overnight assessments in stable pediatric surgery patients: a critical reconsideration. *J Pediatr Surg.* 2025;60(4):162201. PubMed doi: 10.1016/j.jpedsurg.2025.162201

8. Bitterfeld L, Mathias J, Waldron BP, Kranz C. Understanding the effects of overnight vital signs monitoring on sleep duration and disruptions in hospitalized children: a scoping review. *J Pediatr Nurs.* 2023;73:e10–e18. PubMed doi: 10.1016/j.pedn.2023.07.002

9. Crawford S, Utt A, Beebe C, et al. Quality of sleep in a pediatric hospital: A descriptive study based on an assessment of interruptions, perceptions, and the environment. *J Nurs Adm.* 2019;49(5):273–279. PubMed doi: 10.1097/NNA.0000000000000750

10. Herbert AR, de Lima J, Fitzgerald DA, Seton C, Waters KA, Collins JJ. Exploratory study of sleeping patterns in children admitted to hospital. *J Paediatr Child Health.* 2014;50(8):632–638. PubMed doi: 10.1111/jpc.12617

11. Meltzer LJ, Montgomery-Downs HE, Insana SP, Walsh CM. Use of actigraphy for assessment in pediatric sleep research. *Sleep Med Rev.* 2012;16(5):463–475. PubMed doi: 10.1016/j.smrv.2011.10.002

12. Stremler R, Micsinszki S, Adams S, Parshuram C, Pullenayegum E, Weiss SK. Objective sleep characteristics and factors associated with sleep duration and waking during pediatric hospitalization. *JAMA Netw Open.* 2021;4(4):e213924. PubMed doi: 10.1001/jamanetworkopen.2021.3924

13. Cook DJ, Arora VM, Chamberlain M, et al. Improving hospitalized children's sleep by reducing excessive overnight blood pressure monitoring. *Pediatrics.* 2020;146(3):e20192217. PubMed doi: 10.1542/peds.2019-2217

14. Daniel LC, Venella KL, Woodard K, et al. Can extending time between vital sign checks improve sleep in hematopoietic stem cell transplant patients? Testing feasibility, acceptability, and preliminary efficacy. *Pediatr Blood Cancer.* 2024;71(4):e30832. PubMed doi: 10.1002/pbc.30832

15. Lee CC, Savage NM, Wilson EK, et al. Sleeping safely! A quality improvement project to minimize nighttime interruptions without compromising patient care. *Pediatr Qual Saf.* 2021;6(3):e404. PubMed doi: 10.1097/pq9.0000000000000404

16. Lin HM, Macias C, McGee C, et al. "Help me sleep": A quality initiative to reduce overnight vital signs. *Hosp Pediatr.* 2022;12(2):142–147. PubMed doi: 10.1542/hpeds.2021-006250

17. Glover B, Bederman L, Orenstein E, et al. Quasi-experimental, nonrandomized initiative to minimize sleep disruptions among hospitalized children. *Pediatr Qual Saf.* 2023;8(4):e666. doi: 10.1097/pq9.0000000000000666

18. Des Jarlais DC, Lyles C, Crepaz N;TREND Group. Improving the reporting quality of nonrandomized evaluations of behavioral and public health interventions: the TREND statement. *Am J Public Health.* 2004;94(3):361–366. PubMed doi: 10.2105/AJPH.94.3.361

19. Meltzer LJ, Walsh CM, Traylor J, Westin AM. Direct comparison of two new actigraphs and polysomnography in children and adolescents. *Sleep (Basel).* 2012;35(1):159–166. PubMed doi: 10.5665/sleep.1608

20. Shrivastava D, Jung S, Saadat M, Sirohi R, Crewson K. How to interpret the results of a sleep study. *J Community Hosp Intern Med Perspect.* 2014;4(5):24983. PubMed doi: 10.3402/jchimp.v4.24983

21. Kohyama J. Which is more important for health: sleep quantity or sleep quality? *Children (Basel).* 2021;8(7):542. PubMed doi: 10.3390/children8070542

22. Carney CE, Buysse DJ, Ancoli-Israel S, et al. The consensus sleep diary: standardizing prospective sleep self-monitoring. *Sleep (Basel).* 2012;35(2):287–302. PubMed doi: 10.5665/sleep.1642

23. Meltzer LJ, Forrest CB, de la Motte A, Bevans KB. Clinical validity of the PROMIS pediatric sleep measures across populations of children with chronic illnesses and neurodevelopment disorders. *J Pediatr Psychol.* 2020;45(3):319–327. PubMed doi: 10.1093/jpepsy/jsz088

24. van Rijssen IM, Hulst RY, Gorter JW, et al. Device-based and subjective measurements of sleep in children with cerebral palsy: a comparison of sleep diary, actigraphy, and bed sensor data. *J Clin Sleep Med.* 2023;19(1):35–43. PubMed doi: 10.5664/jcsm.10246

25. Short MA, Gradisar M, Lack LC, Wright H, Carskadon MA. The discrepancy between actigraphic and sleep diary measures of sleep in adolescents. *Sleep Med.* 2012;13(4):378–384. PubMed doi: 10.1016/j.sleep.2011.11.005

26. Paruthi S, Brooks LJ, D'Ambrosio C, et al. Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for healthy children: methodology and discussion. *J Clin Sleep Med.* 2016;12(11):1549–1561. PubMed doi: 10.5664/jcsm.6288

27. Beville ASM, Heipel D, Vanhoozer G, Bailey P. Reducing central line associated bloodstream infections (CLABSIs) by reducing central line days. *Curr Infect Dis Rep.* 2021;23(12):23. PubMed doi: 10.1007/s11908-021-00767-w

28. McDaniel LM, Benjamin H, Carlin K, Desai AD, Ralston SL. Improving sleep by minimizing unnecessary overnight vital signs in hospitalized patients. *Hosp Pediatr.* 2025;15(5):387–397. PubMed doi: 10.1542/hpeds.2024-008105