

Creating Naptime: An Overnight, Nonpharmacologic Intensive Care Unit Sleep Promotion Protocol

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Abstract

Introduction: Patients in the intensive care unit (ICU) have significantly disrupted sleep. Sleep disruption is believed to contribute to ICU delirium, and ICU delirium is associated with increased mortality. Experts recommend sleep promotion as a means of preventing or shortening the duration of delirium. ICU Sleep promotion protocols are highly complex and difficult to implement. Our objective is to describe the development, pilot implementation, and revision of a medical ICU sleep promotion protocol. **Methods:** *Naptime* is a clustered-care intervention that provides a rest period between 00:00 and 04:00. We used literature review, medical chart review, and stakeholder interviews to identify sources of overnight patient disturbance. With stakeholder input, we developed an initial protocol that we piloted on a small scale. Then, using protocol monitoring and stakeholder feedback, we revised *Naptime* and adapted it for unitwide implementation. **Results:** We identified sound, patient care, and patient anxiety as important sources of overnight disturbance. The pilot protocol altered the timing of routine care with a focus on medications and laboratory draws. During the pilot, there were frequent protocol violations for laboratory draws and for urgent care. Stakeholder feedback supported revision of the protocol with a focus on providing 60- to 120-minute rest periods interrupted by brief clusters of care between 00:00 and 04:00. **Discussion:** Four-hour blocks of rest may not be possible for all medical ICU patients, but interruptions can be minimized to a significant degree. Involvement of all stakeholders and frequent protocol reevaluation are needed for successful adoption of an overnight rest period.

Keywords

delirium, intensive care unit, sleep, circadian rhythm, clustered care

Introduction

There is growing awareness of the importance of sleep in the intensive care unit (ICU) (1, 2). Critically ill patients experience sleep loss, poor sleep quality, and circadian disruption (3-7). Sleep disruption may lead to delirium and persistent cognitive impairment after critical illness (8). Intensive care unit delirium is an independent predictor of mortality, increased length of stay, and postdischarge cognitive impairment (9-13).

Impediments to sleep in the ICU are multifactorial. It is informative to consider ICU sleep disruption within the construct of the Spielman's 3P model of insomnia or sleep disruption (Figure 1) (14). This model identifies predisposing, precipitating, and perpetuating factors. Of these factors, noise (eg, high sound), light, and in-room patient care activity are modifiable (15,16). Many studies demonstrate that average hospital and ICU sound levels are excessive and disruptive to patients (6,15,17-20). In

addition, abnormal light exposure, frequent use of continuous enteral feeding, and lack of physical activity predispose critically ill patients to circadian misalignment and amplitude loss which in turn contribute to further sleep disruption (21-23).

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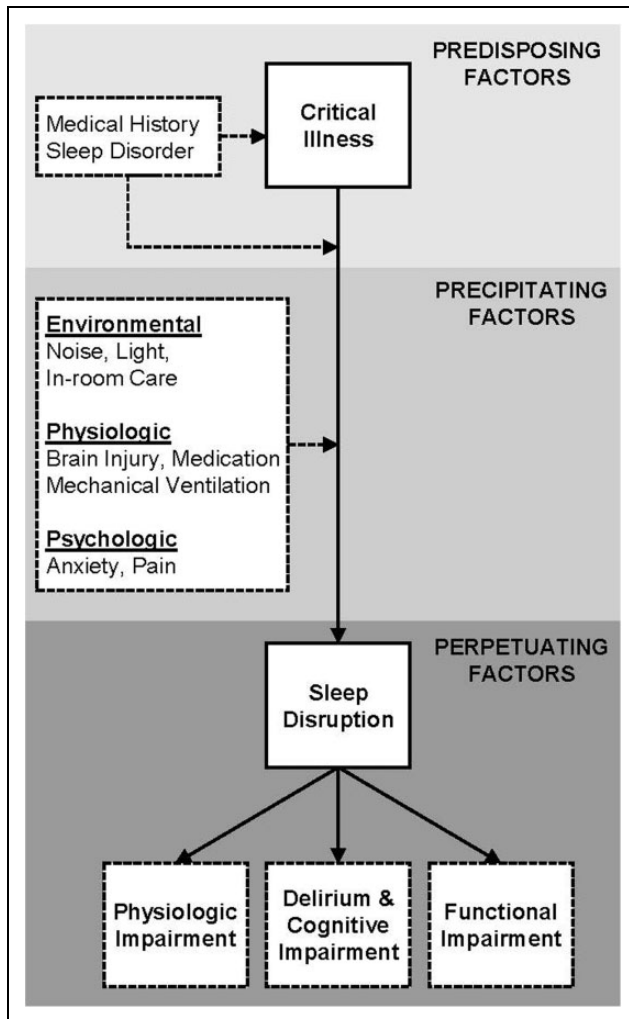


Figure 1. Model of intensive care unit sleep disruption based on Spielman's 3P model of sleep disruption (insomnia). Many of the listed precipitating factors are modifiable in the intensive care unit setting.

Current expert guidelines suggest sleep promotion for delirium prevention (1). One sleep-promoting intervention with noise reduction and clustering of care significantly reduced the incidence of delirium (24), and a meta-analysis of environmental interventions demonstrated improvement in sleep quantity and decreased sleep fragmentation (25).

To address the problem of ICU sleep disruption, we developed a multifaceted, nonpharmacologic sleep promotion intervention, *Naptime*, to provide patients with a period of rest from 00:00 to 04:00. The purpose of this article is to describe the development, implementation, and iterative revision of our protocol.

Materials and Methods

The pilot implementation of *Naptime* was registered with ClinicalTrials.gov (NCT03119207) and approved by our institution's Human Investigations Committee (HIC# 1112009428).

Setting

This project was conducted in the medical intensive care unit (MICU) of an academic tertiary medical center that admits over 3000 patients per year. Sepsis and acute respiratory failure are the most frequent reasons for admission. The patient–nurse ratio is 1:1 or 2:1. There is 24/7 attending physician staffing, with many admissions and discharges during the overnight period. The unit is rectangular with private, single-bed patient rooms on each of the four sides. In the center, there is a core of workstations, supply closets, and conference rooms (Figure 2). There is no central nursing station. Nurses work at standing-computer stations inside the patient room or at desks directly outside. No overhead paging is allowed on the unit. Our MICU Alarm Committee has modified alarm parameters and protocols to minimize nuisance alarms, limit signaling of alarms in other patient rooms, and promote rapid silencing of alarms. The MICU has no visiting hour restrictions, but visitors are not allowed to congregate in the unit hallways.

There is a hospital-wide quiet time protocol from 23:00 to 06:00 which includes dimming hallway lights and limiting overhead pages to cardiac arrest or fire announcements. On admission, patients receive a quiet pack including headphones, earplugs, and eye masks, and a brief explanation card which emphasizes the importance of sleep and requests that patients keep sound levels low overnight. The use of earplugs and eyes masks varies based on preference but can be effective for those who are comfortable using these devices (26). The institution-wide protocol includes changes in workflow by pharmacy, laboratory, information technology, and facility services. For example, under the hospital-wide protocol, in-room stocking of supplies, floor maintenance, and trash collection occur before 23:00 or after 05:00.

Stakeholder Inclusion

We recruited a diverse set of MICU stakeholders for all stages of protocol development. Stakeholders from hospital and unit leadership facilitated communication between our group and hospital-wide services (eg, pharmacy, laboratory, information technology, and facilities services). We recruited MICU clinical staff (physicians, nurses, respiratory therapists, pharmacists, and patient care assistants) to facilitate changes in direct care. Patient and visitor stakeholders provided insight into their needs. We also collaborated with special interest groups, including the ICU alarm, ICU infection control, and ICU skin care committees.

Identification of Sources of Disturbance

During the first stage, we conducted a literature review via PubMed to generate a list of factors that may contribute to sleep disruption. We used the search terms “intensive care unit” and “critical care” combined with “sleep,” “rest,” “disruption,” “disturbance,” “sound,” “noise,” “light,” “lux,”

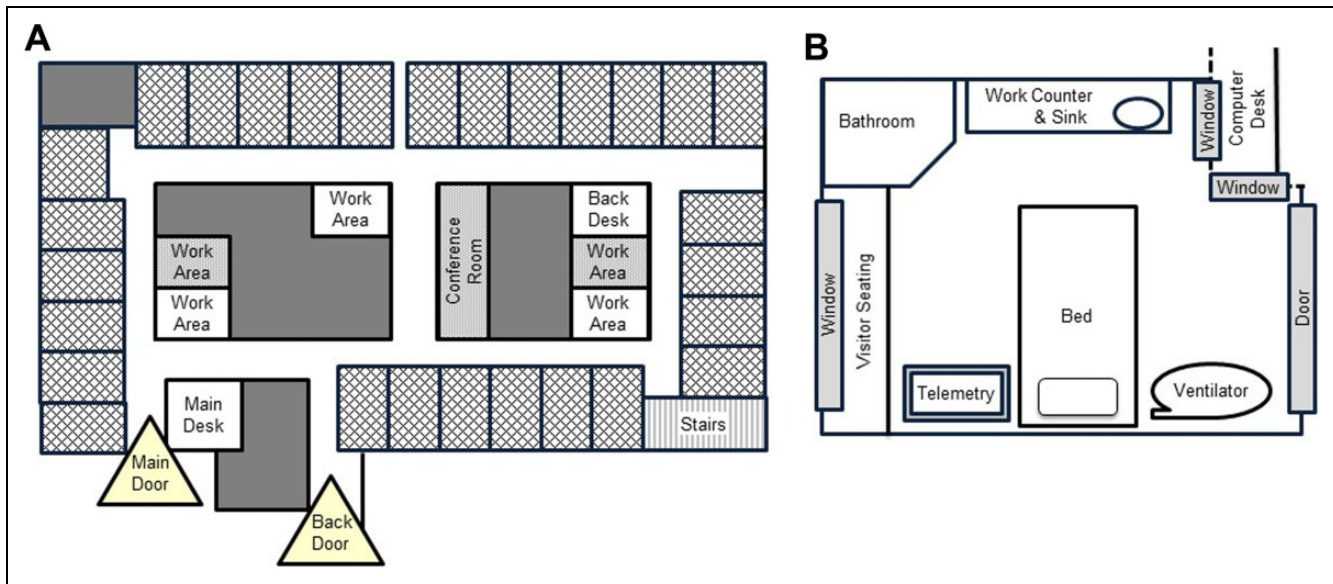


Figure 2. A, Medical intensive care unit floor plan. Cross-hatched rectangles around the perimeter are patient rooms. Unlabeled gray areas are offices or closed supply closets. Open (white) and closed (gray) work areas, a closed conference room, stairs, and unit doors are located as indicated. B, Patient room floor plan. Standard furniture and common clinical equipment are located as indicated. The door is sliding glass. Interior windows allow monitoring from hallway computer desk. There is a large exterior window in every patient room.

“nocturnal care interactions,” and “nocturnal nursing interactions.” We identified a set of relevant articles in English. We discussed the resulting list of factors with stakeholders and addressed these factors in our protocol per stakeholder recommendation.

We abstracted overnight care activities from the electronic medical record (EMR) to understand workflow. We conducted interviews with physicians, nurses, patient care assistants, and respiratory therapists who worked nights and with patients regarding sources of sleep disturbance (27). We also met with the MICU pharmacists to discuss medications that require frequent dosing or long run times to determine ways to avoid disturbance due to medication administration.

Protocol Development and Pilot Implementation

We used the data obtained in the first phase to develop a protocol. We selected 00:00 to 04:00 as the *Naptime* period to include most patients’ sleep midpoint (28). With the support of our stakeholders, we delineated 4 categories of care activities: (1) untimed, (2) timed outside of *Naptime*, (3) time critical within *Naptime*, and (4) urgent or emergent (Table 1). We also developed care protocols to mitigate the disturbances that we identified (Table 2). The bedside nurse served as the gatekeeper to minimize in-room disturbance levels between 00:00 and 04:00. Emergency interventions were not limited or altered.

We conducted a pilot test of the protocol from August 2013 until June 2014. We implemented the protocol for individual patients, and research staff provided one-on-

one coaching to the bedside nurses. We did not alter clinical staffing for the protocol. Patients underwent the *Naptime* protocol every night of their MICU stay. During the day, medications, diagnostic imaging, laboratory draws, and care orders were reviewed and retimed by the principal investigator (M.P.K.) in conjunction with the primary team. The overnight nurse and physician discussed and retimed any newly ordered medications, imaging, or laboratory draws. The nurse prevented other nonurgent room visits on an as-needed basis.

To assist with pilot protocol implementation and standardization, we developed a checklist of care activities that should be completed before *Naptime* (Supplement 1). We also monitored adverse events (eg, unintended device removal, fall, or unexpected death) during *Naptime*.

Adaptation for Unitwide Implementation

We elicited challenges or violations to the protocol by staff. The bedside nurse completed a confidential survey (Supplement 2) to identify the frequency and reason for *Naptime* interruptions. We reviewed the medical record for the occurrence of medication administration, diagnostic imaging, or laboratory draws. We repeated meetings with stakeholders. To facilitate future monitoring, we developed automated reporting of overnight blood draws, medication administration, and radiologic studies in the EMR. Based on this feedback, we adapted the *Naptime* protocol for unitwide implementation and launched the protocol in March of 2017. The details of the protocol are reported below.

Table 1. Categorization of Bedside Care Activities.

Activity Type	Common Activity Examples
Restricted 00:00 to 04:00	
Not timed	<ul style="list-style-type: none"> Bathing and linen changes Wound care and dressing changes Bedside supplies, trash, laundry, and cleaning Visitors
Timed and can be rescheduled	<ul style="list-style-type: none"> Routine or nonurgent laboratory or diagnostic studies Routine procedures Scheduled and as-needed medications with dose intervals greater than 4 hours Routine mechanical ventilator checks Routine patient assessment (ie, RASS, GCS, pain, CAM-ICU) Routine physician exam ("prerounding")
Permitted 00:00 to 04:00	
Time sensitive or frequent (cluster as possible)	<ul style="list-style-type: none"> Urgent laboratory or diagnostic studies Urgent procedures Urgent medications, continuous medications, or medications with dose intervals less than 4 hours Urgent ventilator checks Blood pressure monitoring every 15 to 60 minutes Patient turns every 2 hours for non-self-turning patients Point-of-care glucose monitoring per patient need if on insulin drip Neurologic checks per patient need Alarm response Patient call response
Emergency care	<ul style="list-style-type: none"> All emergent care required by the patient

Abbreviations: CAM-ICU, confusion assessment method for the intensive care unit; GCS, Glasgow Coma Scale; RASS, Richmond Agitation and Sedation Scale.

Results

Sources of Disturbance

Major themes from the literature review included disturbance from the following: staff and visitor voices, general sound, sound from alarms, sound from carts or moving equipment, room maintenance, skin care and bathing, laboratory draws, medication administration, frequent overnight care, pain, and anxiety or sadness (selected articles 15,16,19,29,30). Review of the medical record revealed that

laboratory draws, diagnostic imaging, medication administration, transfusions, skin and wound care, dressing changes, and procedures related to intravenous access frequently occurred overnight. Baseline analysis of unitwide practice revealed that 10.5% of blood transfusions, 8.7% of diagnostic imaging, 27.0% of laboratory draws, and 9.2% of medications occurred between 00:00 and 04:00. Stakeholder interviews are reported in detail elsewhere (27). Briefly, both staff and patients identified environmental factors in sleep disruption; however, patients also identified emotions and a need for reassurance as major factors in sleep disruption.

Naptime Pilot Implementation

We piloted *Naptime* with 26 patients. The mean patient age was 62.3 years (standard deviation [SD] = 16.3). Acute Physiology and Chronic Health Evaluation II mean was 18.9 (SD 6.3); 25% of patients had sepsis, 28% had acute respiratory failure, 34% were intubated, and 74% were on vasopressors. Mean length of stay was 4.1 (SD 2.9) days. The primary team and bedside nurse agreed with *Naptime* enrollment in all cases. Daytime medical record review most frequently resulted in an adjustment in the timing of routine medications (42% of patients, not including piperacillin-tazobactam or insulin), piperacillin-tazobactam (31%), insulin sliding scale (38%), and ventilator checks (34%). Laboratory draws frequently occurred during the *Naptime* protocol; the median number of laboratory draws for *Naptime* patients was 1 with an interquartile range of 0 to 3.

We collected 24 post-*Naptime* surveys from bedside nurses. Survey responses indicated the following estimates of the number room entries: "None" 8%, "1-2 times" 21%, "3-4 times" 38%, and "5 or more times" 33%. Urgent or time critical care was the most frequently cited reason for room entrance (58%). Care activities that required room entrance included monitoring of continuous hemodialysis, titration of vasopressors, position changes, and agitated delirium. Only 8% of respondents indicated that there was not enough time outside of *Naptime* to conduct routine care. Discussion with stakeholders revealed persistent beliefs that routine daily laboratory draws are needed at 02:00 to allow time for electrolyte repletion before the change of shift. There was also concern that day shift caregivers would be frustrated if certain tasks (eg, bathing) did not occur overnight. There were no adverse events related to the *Naptime* protocol.

Unitwide Adaptation

The number of protocol violations during the *Naptime* pilot suggests that an uninterrupted 4-hour period is not achievable for a significant proportion of patients. We adapted the protocol to emphasize alternate strategies to cluster care and minimize disturbance so that patients have at least 60 to 120 minutes at a time for rest. For the unitwide protocol, the

Table 2. Summary of Naptime Protocol Elements.

Institution level	<ul style="list-style-type: none"> • Hospital-wide quiet time protocol and quiet pack • Overhead pages only for life-threatening emergencies • Coordination of pharmacy, laboratory medicine, information technology, and facilities services
Unit level	<ul style="list-style-type: none"> • Leadership Support • Visitor policies and encouragement of family members to rest at home • Provider meetings in closed work spaces • No unit level overhead paging • Alarm policies and work groups • Restriction of main ICU door use
Bedside	<ul style="list-style-type: none"> • Leadership support • Closed door and curtains • Dimmed lights • Signal to sleep • Daytime wake protocol
Direct care	<ul style="list-style-type: none"> • Care clustered and disturbance minimized during room entrances • Medications scheduled outside of <i>Naptime</i> • Continuous infusions use higher volumes or higher concentrations • Routine labs or diagnostic testing at 04:00 or later • Ventilator checks and suctioning before and after <i>Naptime</i> • Skin care, wound care, and line checks before <i>Naptime</i> • Positioning disturbance minimized with “pillow pull”
Challenging cases	<ul style="list-style-type: none"> • Facilities and supplies outside of <i>Naptime</i> • Minimize collateral disturbance for medical emergencies • Cluster care for high-intensity patients to achieve rest blocks of 60 to 120 minutes • Cluster and prioritize in-room care for overnight admissions. • Encourage patients in challenging rooms to utilize ear plugs or eye masks

Abbreviation: ICU, intensive care unit.

nurse remains the gatekeeper for preventing in-room activity during *Naptime*. For unitwide implementation, we identified nurse champions, created educational materials, and held in-service meetings to publicize protocol relaunch. Caregiver education focused on laboratory draw practices and acceptance of delaying nonurgent care activities to times outside of *Naptime*.

Unitwide Protocol

Clinical staff complete routine nighttime care before midnight. The care that must occur during *Naptime* is clustered to decrease the number of room entrances; caregivers use flashlights, nightlights, and low voices to minimize the light and sound associated with care that occurs during *Naptime*. At the start of *Naptime*, the nurse dims or turns off lights and

closes the window curtain, the door curtain, and the room door. We suggest a small opening in the door curtain to allow viewing of the head of the bed, the ventilator, and the telemetry monitor. We encourage patients to turn televisions off or use headphones. We have a policy against turning the television on for unresponsive patients or in empty rooms. Our protocol also includes keeping window shades up during the day to promote wakefulness. Although heart rate and oximetry are continuous on our unit, we turn telemetry alarms to a minimum volume inside the patient room. We complete temperature checks before *Naptime*. Blood pressure monitoring occurs no more frequently than every 60 minutes if clinically allowable.

We also ask the bedside nurse to provide a verbal “signal to sleep.” This signal lets the patient know that they have time to sleep for a few hours and explains the ongoing remote monitoring. This explanation reassures patients that they are safe and that we are continuing to take care of them. Nurses ask the patients if they have toileting, pain, or other needs and assure that the call bell is within reach. Nurses provide a similar signal for unresponsive or sedated patients that is adapted to their abilities.

Pharmacy protocols schedule routine medications outside of *Naptime*. Medications that require administration every 6 hours are given at 05:00, 11:00, 17:00, and 23:00. With the support and input of our pharmacy department, the EMR prevents inadvertent overnight medication scheduling via system defaults which offer a “now” dose and then automatically schedules medications during appropriate daytime periods. If needed, the bedside nurse can also change medication timing without physician approval. Inhaled medications that are “as needed” or “standing” are administered under an institutional protocol that prevents waking the patient. Exceptions are allowed for patients requiring continuous or frequent dosing of inhaled medications.

Infused medications are a major source of disruption due to intravenous pump beeping. Beeping from continuous infusions can be minimized with the strategic use of bag sizes and concentrations that ensure sufficient supply for the entire or at least one-half of the rest period. Routine tubing changes needed for continuous infusions occur outside of *Naptime*. Difficult medications with frequent dosing or long run times (eg, piperacillin–tazobactam) cause disruption. We minimize disruption by starting infusions at midnight and maximizing run time; in many cases, a 4-hour run time can be used to avoid starts or stops during 00:00 to 04:00.

Routine laboratory draws occur after 04:00. This avoids disturbance related to phlebotomy and disturbance for nonurgent electrolyte repletion or transfusion. Patients requiring frequent laboratory monitoring every 4 to 6 hours have their presleep laboratory draws ordered “stat” at 22:00; adjustments or changes can be made before midnight. For every 6-hour fingersticks, our protocol suggests a 05:00, 11:00, 17:00, and 23:00 schedule.

Ventilated patients must have a ventilator check at least every 8 hours by a respiratory therapist; we complete this

check before *Naptime* for stable patients. Also, ventilator alarm settings can be optimized to prevent nuisance alarms, and ventilator screens can be positioned to be visible through the glass wall for out-of-room monitoring. For most patients, suctioning can be timed just before and after *Naptime*. Patients who require suctioning more frequently are suctioned a minimum number of times during *Naptime*, and we cluster the suctioning with other necessary care.

Position changes are required every 2 hours for immobile patients. We position patients on their side with pillows for support at 00:00. At 02:00, the nurse pulls the pillows out from under the patient which allows the patient to roll onto their back and change position. We believe that this “pillow pull” position change is the least disturbing during the rest period. We cluster other care needed during *Naptime* with this position change. We complete routine wound care, dressing changes, and monitoring of central lines outside of *Naptime*.

Challenging Cases

Naptime does not change the timing of urgent or emergent patient care. During emergencies, we mitigate disruption to adjacent patient rooms by closing doors and preventing staff and family from congregating outside the patient’s room. As noted above, some patients have frequent or time-intensive care needs that prevent a continuous 4-hour rest period. Examples include patients in the prone position, patients supported by continuous renal replacement, and patients who have unstable ventilator or vasopressor needs. Our protocol describes strategies for these patients to cluster interventions that could provide shorter blocks of rest (eg, minutes) between 00:00 and 04:00. As mentioned above, the 02:00 position change is often used as a time point to deliver a cluster of care to patients.

Finally, overnight admissions are frequent, disruptive to the patient, and disruptive to patients in adjacent rooms. Our protocol suggests a coordinated examination by all members of the medical team, immediate laboratory draws, rapid completion of any diagnostic work or procedures, and clustering of in-room care. We delay any care per *Naptime* protocol if it is safe for the patient. Overnight discharges are also very disturbing to patients. We continue to work with our hospital-wide bed management teams to avoid transfers between 00:00 and 04:00.

Discussion

Implementing *Naptime* presented challenges related to the complexity of care in the MICU. Nonurgent laboratory draws and urgent or time critical care were the most frequent reasons for protocol violation. Furthermore, pilot implementation suggested that an uninterrupted 4-hour period is not achievable for a significant proportion of patients. Based on our pilot, we adapted the protocol to emphasize alternate strategies to cluster care and minimize disturbance so that

most patients have at least 60 to 120 minutes at a time for rest. The protocol must adapt to the individual patient and individual ICU needs. Although we have identified and addressed many sources of overnight disturbance, ICU sleep promotion requires vigilance for new sources of disturbance and frequent protocol adjustment.

There is a gap between the perceived importance of sleep and the implementation of sleep promotion protocols (2,31). This protocol conflicts with ICU culture and practice on many levels. Because of this, we have involved stakeholders, recruited nurse champions, and garnered the support of hospital and ICU leadership. We are leveraging successful ICU tools such as checklists to facilitate workflow. Future directions include consulting with implementation experts to facilitate long-term maintenance and expansion of the protocol beyond our MICU.

Ultimately, changes to ICU staffing models may be needed to allow a greater amount of work to be done outside of the *Naptime*. Also, there is little focus on changing unit or building design or altering building materials to minimize patient disturbance. To justify modifications to the physical structure of the ICU, we need to demonstrate patient benefit. We are currently monitoring environmental disturbance levels, patient sleep, delirium incidence, and patient and staff satisfaction to document the benefit of *Naptime*.

Conclusions

There are many obstacles to sleep in the ICU. As the pressure to shorten inpatient admissions has increased, workflow and system defaults have evolved with little regard for patient sleep. Each hospital environment may have unique challenges, but many of the outlined solutions will have relevance to other ICUs. Notably, the involvement of broad stakeholders to identify sources of disturbance in an individual ICU will improve the design and implementation of a rest period such as *Naptime*. Finally, sleep improvement protocols require monitoring, a mechanism for stakeholder feedback, and iteration to maintain effectiveness over time. We believe that the wide dissemination of sleep promotion interventions will positively impact outcomes in critically ill patients.

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Supplemental Material

Supplemental material for this article is available online.

References

- Barr J, Fraser GL, Puntillo K, Ely EW, Gélinas C, Dasta JF, et al. Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in the intensive care unit. *Crit Care Med*. 2013;41:263-306.
- Kamdar BB, Knauert MP, Jones SF, Parsons EC, Parthasarathy S, Pisani MA, et al. Perceptions and practices regarding sleep in the intensive care unit. A survey of 1,223 critical care providers. *Ann Am Thorac Soc*. 2016;13:1370-7.
- Knauert MP, Haspel JA, Pisani MA. Sleep loss and circadian rhythm disruption in the intensive care unit. *Clin Chest Med*. 2015;36:419-29.
- Knauert MP, Yaggi HK, Redeker NS, Murphy TE, Araujo KL, Pisani MA. Feasibility study of unattended polysomnography in medical intensive care unit patients. *Heart Lung*. 2014;43:445-52.
- Cooper AB, Thornley KS, Young GB, Slutsky AS, Stewart TE, Hanly PJ. Sleep in critically ill patients requiring mechanical ventilation. *Chest*. 2000;117:809-18.
- Freedman NS, Gazendam J, Levan L, Pack AI, Schwab RJ. Abnormal sleep/wake cycles and the effect of environmental noise on sleep disruption in the intensive care unit. *Am J Respir Crit Care Med*. 2001;163:451-7.
- Elliott R, McKinley S, Cistulli P, Fien M. Characterisation of sleep in intensive care using 24-hour polysomnography: an observational study. *Crit Care*. 2013;17:R46.
- Weinhouse GL, Schwab RJ, Watson PL, Patil N, Vaccaro B, Pandharipande P, et al. Bench-to-bedside review: delirium in ICU patients – importance of sleep deprivation. *Crit Care*. 2009;13:234.
- Jackson JC, Gordon SM, Hart RP, Hopkins RO, Ely EW. The association between delirium and cognitive decline: a review of the empirical literature. *Neuropsychol Rev*. 2004;14:87-98.
- Milbrandt EB, Deppen S, Harrison PL, Shintani AK, Speroff T, Stiles RA, et al. Costs associated with delirium in mechanically ventilated patients. *Crit Care Med*. 2004;32:955-62.
- Ouimet S, Kavanagh BP, Gottfried SB, Skrobik Y. Incidence, risk factors and consequences of ICU delirium. *Intensive Care Med*. 2007;33:66-73.
- Pisani MA, Kong SY, Kasl SV, Murphy TE, Araujo KL, Van Ness PH. Days of delirium are associated with 1-year mortality in an older intensive care unit population. *Am J Respir Crit Care Med*. 2009;180:1092-7.
- Thomason JW, Shintani A, Peterson JF, Pun BT, Jackson JC, Ely EW. Intensive care unit delirium is an independent predictor of longer hospital stay: a prospective analysis of 261 non-ventilated patients. *Crit Care*. 2005;9:R375-81.
- Spielman A, Glovinsky P. In: Hauri P, ed. *Case Studies in Insomnia*. New York, NY: Plenum Medical Book; 1991.
- Tamburri LM, DiBrienza R, Zozula R, Redeker NS. Nocturnal care interactions with patients in critical care units. *Am J Crit Care*. 2004;13:102-13.
- Le A, Friese RS, Hsu CH, Wynne JL, Rhee P, O'Keefe T. Sleep disruptions and nocturnal nursing interactions in the intensive care unit. *J Surg Res*. 2012;177:310-4.
- Knauert M, Jeon S, Murphy TE, Yaggi HK, Pisani MA, Redeker NS. Comparing average levels and peak occurrence of overnight sound in the medical intensive care unit on A-weighted and C-weighted decibel scales. *J Crit Care*. 2016;36:1-7.
- Darbyshire JL, Young JD. An investigation of sound levels on intensive care units with reference to the WHO guidelines. *Crit Care*. 2013;17:R187.
- Gabor JY, Cooper AB, Crombach SA, Lee B, Kadikar N, Bettger HE, et al. Contribution of the intensive care unit environment to sleep disruption in mechanically ventilated patients and healthy subjects. *Am J Respir Crit Care Med*. 2003;167:708-15.
- Tembo AC, Parker V, Higgins I. The experience of sleep deprivation in intensive care patients: findings from a larger hermeneutic phenomenological study. *Intensive Crit Care Nurs*. 2013;29:310-6.
- Duffy JF, Czeisler CA. Effect of light on human circadian physiology. *Sleep Med Clin*. 2009;4:165-77.
- Edwards BJ, Reilly T, Waterhouse J. Zeitgeber-effects of exercise on human circadian rhythms: what are alternative approaches to investigating the existence of a phase-response curve to exercise? *Biol Rhythm Res*. 2009;40:53-69.
- Jiang P, Turek FW. Timing of meals: when is as critical as what and how much. *Am J Physiol Endocrinol Metab*. 2017;312:E369-80.
- Kamdar BB, King LM, Collop NA, Sakamuri S, Colantuoni E, Neufeld KJ, et al. The effect of a quality improvement intervention on perceived sleep quality and cognition in a medical ICU. *Crit Care Med*. 2013;41:800-9.
- Poongkunran C, John SG, Kannan AS, Shetty S, Bime C, Parthasarathy S. A meta-analysis of sleep-promoting interventions during critical illness. *Am J Med*. 2015;128:1126-37.e1.
- Kamdar BB, Yang J, King LM, Neufeld KJ, Bienvenu OJ, Rowden AM, et al. Developing, implementing, and evaluating a multifaceted quality improvement intervention to promote sleep in an ICU. *Am J Med Qual*. 2014;29:546-54.
- Ding Q, Redeker NS, Pisani MA, Yaggi HK, Knauert MP. Factors influencing patients' sleep in the intensive care unit: perceptions of patients and clinical staff. *Am J Crit Care*. 2017;26:278-86.
- Kryger MH, Roth T, Dement WC. *Principles and practice of sleep medicine*. 6th ed. Philadelphia, PA: Elsevier; 2017:1730.
- Xie H, Kang J, Mills GH. Clinical review: the impact of noise on patients' sleep and the effectiveness of noise reduction strategies in intensive care units. *Crit Care*. 2009;13:208.
- Little A, Ethier C, Ayas N, Thanachayanont T, Jiang D, Mehta S. A patient survey of sleep quality in the Intensive Care Unit. *Minerva Anesthesiol*. 2012;78:406-14.

31. Knauert MP, Kamdar BB, Sleep in the ICUTF. Reply: sleep in the intensive care unit is a priority. *Ann Am Thorac Soc.* 2016; 13:1868-9.

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