



# NURSES' PERCEPTIONS OF PEDIATRIC INTENSIVE CARE UNIT ENVIRONMENT AND WORK EXPERIENCE AFTER TRANSITION TO SINGLE-PATIENT ROOMS

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**Background** The architectural design of the pediatric intensive care unit may play a major role in optimizing the environment to promote patients' sleep while improving stress levels and the work experience of critical care nurses.

**Objectives** To examine changes in nurses' perceptions of the environment of a pediatric critical care unit for promotion of patients' sleep and the nurses' work experience after a transition from multipatient rooms to single-patient rooms.

**Methods** A cross-sectional survey of nurses was conducted before and after the move to a new hospital building in which all rooms in the pediatric critical care unit were single-patient rooms.

**Results** Nurses reported that compared with multipatient rooms, single-patient private rooms were more conducive to patients sleeping well at night and promoted a more normal sleep-wake cycle ( $P < .001$ ). Monitors/alarms and staff conversations were the biggest factors that adversely influenced the environment for sleep promotion in both settings. Nurses were less annoyed by noise in single-patient rooms (33%) than in multipatient rooms (79%;  $P < .001$ ) and reported improved exposure to sunlight.

**Conclusions** Use of single-patient rooms rather than multipatient rooms improved nurses' perceptions of the pediatric intensive care unit environment for promoting patients' sleep and the nurses' own work experience. (*American Journal of Critical Care*. 2016;25:e98-e107)

Every year in the United States, more than 250 000 children are admitted to a pediatric intensive care unit (PICU).<sup>1</sup> The chaotic PICU environment, including constant sound and bright light, exposes critically ill children to multiple risk factors that can fragment sleep during the hospital stay.<sup>2</sup> Sleep is a basic human need and is integral to normal neurodevelopment in healthy children. In children with critical illness, sleep may play an even more important role in recovery.<sup>3</sup> Several studies<sup>4-6</sup> have indicated that both adult and pediatric ICU patients experience disturbances in circadian rhythm and decreases in slow-wave sleep. Although critically ill patients have multiple risk factors for sleep fragmentation, the most modifiable is the external environment, because sound and light levels play a key role in sleep-wake homeostasis.<sup>2,4-7</sup>

Disturbances in sleep continuity may be associated with an increased risk for delirium in patients admitted to the ICU.<sup>8-11</sup> Critical illness implies the need for invasive medical instrumentation and frequent interruptions for nursing care and monitoring. However, modifying the external environment can help optimize the sleep experience and potentially decrease a child's sedation needs during mechanical ventilation. A lack of natural sunlight and of periodicity in light-dark exposure can lead to adverse effects on circadian rhythms and sleep architecture.<sup>12</sup> Constant loud and sudden sounds interrupt sleep, increase sedation needs, and affect physiological parameters such as heart rate and respiratory rate.<sup>13</sup>

In addition to potential benefits for patients, modifying the external environment to promote sleep for patients may also have favorable effects on nurses' stress and job satisfaction.<sup>14-16</sup> Caring for critically ill children and their families has a strong emotional impact. Nursing has been well-established as a stressful profession, and studies of ICU nurses have shown that work satisfaction and stress levels are strongly correlated.<sup>17</sup> Higher light levels during the day, achieved via exposure to natural sunlight, are integral to human health.<sup>18</sup>

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Outside the health care environment, previous studies<sup>16,19</sup> have indicated that the presence of windows and sunlight improves job satisfaction. Furthermore, sound levels in most ICUs are universally higher than those recommended by the World Health Organization.<sup>2,13,20-24</sup> Noisy work environments in both PICUs and adult ICUs contribute to higher heart rates, fatigue, and annoyance among nurses.<sup>15,25</sup>

Most PICUs internationally have a layout with multipatient rooms, which, although convenient for the workflow of daily patient care, may not be conducive for sleep continuity or the preservation of circadian rhythm.<sup>26</sup> Since the 1990s, hospital designs have been shifting from multipatient to single-patient room configurations.

In acute care, compared with multipatient rooms, single-patient rooms are associated with lower rates of medical errors, increased control of room light and temperature, lower sound levels, and even decreased prevalence of delirium.<sup>27</sup> Moreover, patients and their families prefer the private-room design.<sup>28</sup> Publications on pediatric ICUs have largely focused on the design of neonatal ICUs; the heterogeneous population of PICUs (patients 0-21 years old) and the impact of PICU design has not been investigated.<sup>29-31</sup> Compounding the challenges of caring for critically ill children are the vastly different neurodevelopmental needs of PICU patients. The same nurse, for example, may be assigned to care for both a 1-month-old infant and a 16-year-old adolescent on the same shift.

The primary objective of our study was to examine changes in nurses' perceptions of the PICU environment with the transition from an ICU with multipatient rooms to a unit with single-patient rooms. Specifically, we sought to examine the effect

Changing the unit's environment to promote patients' sleep may also lessen nurses' stress and improve job satisfaction.

of having all private rooms on a nurse's ability to control the external environment in a way that optimizes sleep for critically ill children and the effect of this change in environment on the nurses' perception of their own work experience. We hypothesized that a private-room setting would improve a nurse's ability to control the external environment in ways that would promote sleep in patients, decrease nurses' stress, and enhance the overall work experience.

## Methods

A cross-sectional survey study was conducted during a transition of the PICU from multipatient to single-patient rooms. The original PICU was a 32-bed unit with 4 private rooms and 4 semiprivate rooms; the remainder of the unit consisted of several beds in larger rooms. All of the private and semiprivate rooms had 1 window with shades, whereas the large multibed rooms had 1 window for 4 beds.

Nurses' stations were located in open spaces within the patient care areas. The current PICU is a 40-bed unit with all private rooms and a window in each room. Each room includes lighting on dimmer switches and a movable boom that allows for patients to be positioned in any direction (facing window, nurses' station, or wall). The new unit also has a sliding door

that can be incrementally opened. In the original PICU, the door was either closed or open completely.

After receiving approval from the institutional review board, we electronically mailed a survey to all PICU nurses 12 weeks before and 12 weeks after the PICU transition. We informed all participants that individual responses would remain confidential and assigned each respondent a numeric identifier to allow matching of before and after surveys. To minimize reporting bias, we did not inform respondents about the follow-up survey at the time of the first survey. The survey was pilot tested among a committee of nurses in the PICU for feedback on the clarity of the questions and the survey interface. The final survey (see Appendix) consisted of 20 questions divided into perceptions of the PICU sound and lighting environment for patient care and perceptions of the environment for the nurses' personal work experience. Questions were closed-ended and multiple-choice, and a 5-point Likert scale was used. Respondents were also asked to provide any specific comments or additional information in free-text form.

Responses were collected by using Survey Monkey. McNemar  $\chi^2$  tests were used to compare responses to the questions on perceptions about the sleep environment and work experience before and after the move to the PICU with single-patient rooms. All tests were 2-tailed, and  $P \leq .05$  was considered statistically significant. The data were analyzed by using Stata 12 software (StataCorp).

## Results

### Demographics

Demographic data of respondents are summarized in Table 1. A total of 83% of nurses (100/120) completed the pretransition questionnaire, and of these respondents, 90 completed the posttransition survey (75% overall response rate). The majority of the 90 respondents (63%) were 21 to 29 years old, and 99% of the respondents (89/90) were women. Among the respondents, 43% had 1 to 3 years of work experience in the PICU; 41% had more than 3 years. The mean percentages of the nurses' work time spent on day shifts, night shifts, and administrative/education duties were 49%, 45%, and 6%, respectively.

### Perceptions of Sleep Environment: Sound and Light

As shown in Table 2, nurses reported that single-patient private rooms were overall more conducive than multipatient rooms to patients sleeping well at night and to promoting a normal sleep-wake cycle ( $P < .001$ ). More nurses agreed that they had increased control of light and sound for sleep promotion during both day and night in single-patient rooms ( $P < .001$ ) than they did with multipatient rooms. However, in both the single-patient and the multipatient rooms, monitors and alarms were the greatest factor that affected sound levels during the day and night. Conversations between clinical staff were the second most commonly reported factor that affected sound exposure in both layouts, although this factor was cited less often after the move to single-patient rooms. With respect to light exposure, in both layouts, the most important factor cited for increasing light at night was safety. Other factors included requirements of the charge nurse or unit culture to keep the lights on. Patient care was also a persistent reason for increased light exposure at night in both PICU layouts.

### Perceptions of Annoyance and Stress

Nurses were significantly less annoyed ( $P < .001$ ) by sound in the unit with all private rooms (33%) than in the unit with multipatient rooms (79%; see Figure). In addition, sound contributed significantly less ( $P < .001$ ) to the stress levels of nurses in the

A survey focused on nurses' perceptions of the PICU sound and lighting environment and their own work experience.

We would like to ask you a few questions about your perceptions of the light and noise environment in the ICU that you currently work in. Your completion of this survey or questionnaire will serve as your consent to be in this research study. The survey should take no more than 10 minutes to complete. Thank you! If you have any questions, please feel free to email \_\_\_\_\_

**1. Which of the following ICUs do you work in?**

- CSICU (Cardiac surgical ICU)
- PICU (Pediatric ICU)

**2. How many years have you worked in this ICU?**

- <1
- 1-3
- 4-6
- 6-10
- >10

**3. Approximately what percentage of your time at work is spent in the following capacities?  
Numbers should add up to 100.**

Clinical: day shifts

Clinical: night shifts

Education/administration

**4. Which category below includes your age in years?**

- 21-29
- 30-39
- 40-49
- 50-59
- 60 or older

### ICU environment and patient care

Now we would like you to answer some questions about the ICU environment in which you work.

**5. I feel that the current layout of our ICU is conducive to my patients sleeping well at NIGHT.**

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

**6. I am able to manipulate the environment in our ICU to promote sleep through light and noise control.**

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

**7. The layout of our ICU promotes a normal sleep-wake cycle (awake during the day, asleep at night)**

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

**8. I feel like I have control over the amount of NOISE that my patients are exposed to during the daytime.**

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the day shift

**9. I feel that I have control over the amount of NOISE that my patients are exposed to during the nighttime.**

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work night shift

*Continued*

10. Factors that MOST COMMONLY affect the noise my patients are exposed to in the DAYTIME are . . . please rank from 1 to 6 (1 = most, 6 = least). If you don't work the day shift, you may skip this question.

	1	2	3	4	5	6
Monitors/alarms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocera <sup>®</sup> /overhead announcements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visitors' voices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voices of clinical staff (physicians, nurses, RTs)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Everyday maintenance activity (eg, cleaning floors)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other patients in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. Factors that MOST COMMONLY affect the noise my patients are exposed to in the DAYTIME are . . . please rank from 1 to 6 (1 = most, 6 = least). If you don't work the day shift, you may skip this question.

	1	2	3	4	5	6
Monitors/alarms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Vocera <sup>®</sup> /overhead announcements	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visitors' voices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Voices of clinical staff (physicians, nurses, RTs)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Everyday maintenance activity (eg, cleaning floors)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other patients in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. I feel my patients would benefit from exposure to sunlight during the daytime.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the day shift

13. I feel like I have control over my patients' exposure to light in the daytime.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the day shift

14. I feel like I have control over my patients' exposure to light in the nighttime.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the night shift

15. Factors that most commonly ADVERSELY affect my control of LIGHT that my patients are exposed to at night include . . . Please rank the following from 1 to 6 (1 = affects the most, 6 = affects the least).

	1	2	3	4	5	6
Charge nurse or unit requirement to keep lights on	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inability to control window shades or lack of windows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safety issues (need to have lights on to continuously assess the patient)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inability to dim lights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visitors' demands	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other patients in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Patient care/nursing interventions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

16. Please provide any other comments/thoughts about the ICU environment in which you work and how it affects the noise and light your patients are exposed to and patients' sleep quality (ie, other barriers).

### Your work environment

The next few questions are about your perceptions of the work environment in your ICU.

17. I often feel annoyed by the noise in our ICU.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Continued

18. The noise I am exposed to during a routine shift in the ICU adds to my stress level at work.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the day shift

19. I wish our unit were quieter overall.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

20. I wish I had more exposure to sunlight during the day in our ICU.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree
- I don't work the day shift

21. Please feel free to provide any other comments regarding the ICU environment and how it affects your work experience.

**Appendix Continued**

Abbreviation: RT, respiratory therapist.

<sup>a</sup> Hands-free wireless communication device.

unit with single-patient rooms (44%) than in the unit with multipatient rooms (90%), and the percentage of nurses in the unit with single-patient rooms (27%) who desired a quieter unit differed significantly ( $P < .001$ ) from the percentage in the unit with multipatient rooms (89%). Finally, the percentage of nurses in the new unit (50%) who desired more sunlight exposure differed significantly ( $P < .001$ ) from the percentage in the old unit (95%). Table 3 gives free-text responses from PICU nurses that summarize common themes that were present after the move to single-patient rooms.

**Discussion**

In this cross-sectional survey study of PICU nurses, a change from multipatient rooms to single-patient rooms improved nurses' perceptions of the PICU environment for sleep promotion, particularly optimization of sound and lighting. Additionally, nurses reported feeling significantly less stress and annoyance as a result of the PICU environment after a transition to the unit with single-patient rooms. To our knowledge, this study is the first in which investigators considered the role of PICU architectural design on nurses' perceptions of the patient care and work environment. In addition to results suggesting that single-patient rooms have benefits for promoting patients' sleep and decreasing nurses' stress, we identified issues for ongoing

**Table 1**  
Demographics of pediatric intensive care unit nurses who responded

Characteristic	% of Nurses
Years of experience	
< 1	16
1-3	43
4-6	11
7-10	11
> 10	19
Age range, y	
21-29	63
30-39	18
40-49	16
50-59	3

improvement that must be addressed beyond a change in PICU design.

Not surprisingly, in the new PICU, as in the old PICU, monitors and alarms persisted as the most important factor affecting sound levels in the unit during the day and night. The next most important factor was conversations among clinical staff. Private rooms provide a level of protection from general ICU sounds only. Although alarms are a necessary part of ICU care to anticipate and manage acute changes in a child's clinical condition, evidence is increasing to support technological and institutional



**Table 2**  
Nursing perceptions of the pediatric intensive care unit environment (n=90)

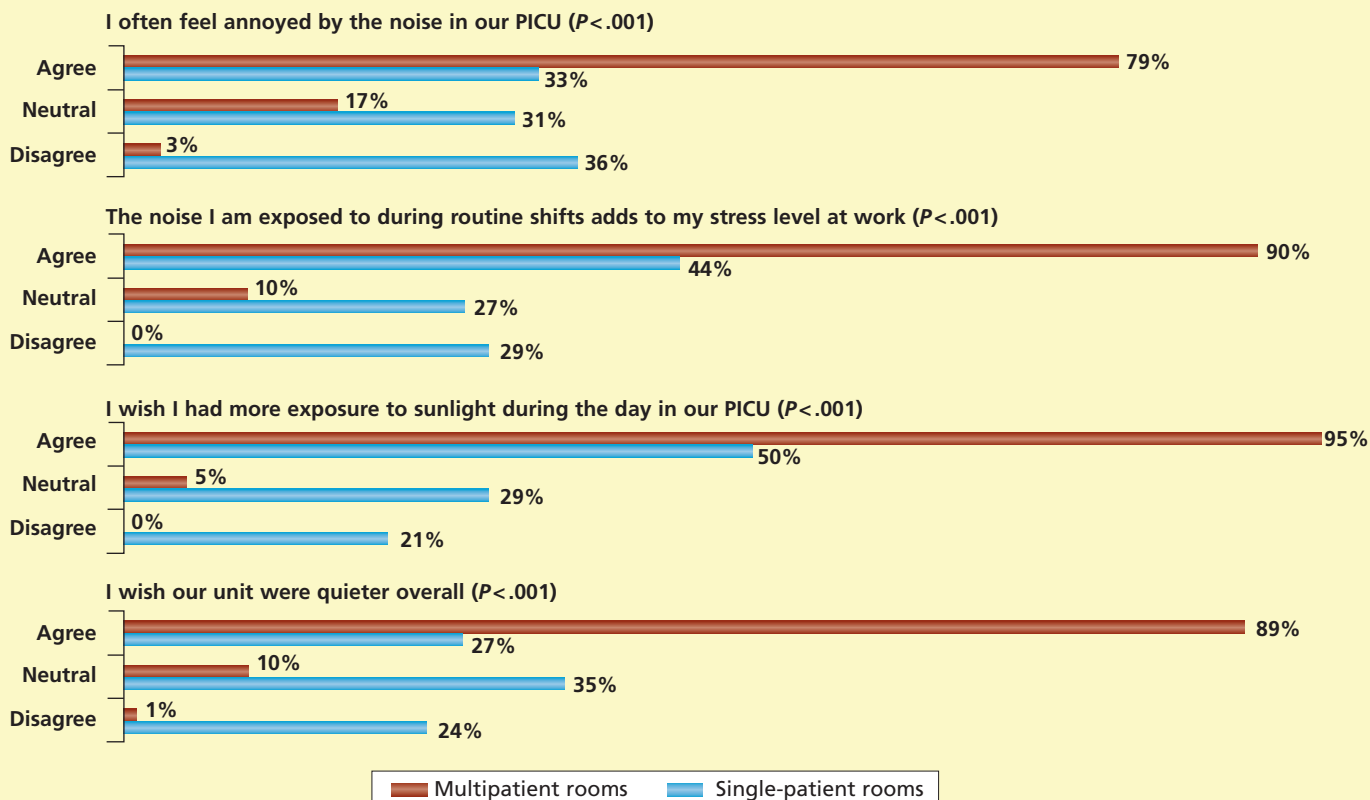
Unit	% of Respondents		P
	Open layout	Private rooms	
Our current unit layout promotes a normal sleep-wake cycle			<.001
Agree	0	62	
Disagree	95	6	
Neutral	5	32	
I am able to manipulate the unit's environment to promote sleep			<.001
Agree	17	88	
Disagree	72	4	
Neutral	11	8	
The factor that most affects <b>daytime</b> noise exposure for patients is			.001
Monitors/alarms	52	61	
Vocera <sup>a</sup> /overhead announcements	13	5	
Visitors' voices	4	6	
Voices of clinical staff	25	16	
Everyday maintenance activity	1	12	
Other patients in the room	5	0	
The factor that most affects <b>nighttime</b> noise exposure for patients is			<.001
Monitors/alarms	46	70	
Vocera <sup>a</sup> /overhead announcements	8	3	
Visitors' voices	4	4	
Voices of clinical staff	27	17	
Everyday maintenance activity	5	5	
Other patients in the room	11	0	
I feel I have control over my patients' exposure to light in the <b>daytime</b>			<.001
Agree	13	58	
Disagree	58	7	
Neutral	13	11	
I don't work the day shift	16	24	
I feel I have control over my patients' exposure to light in the <b>nighttime</b>			<.001
Agree	13	57	
Disagree	52	11	
Neutral	25	20	
I don't work the night shift	10	12	
The factor that most affects <b>nighttime</b> light exposure for patients is			.001
Charge nurse/unit requirement to keep lights on	25	28	
Inability to control shades/lack of windows	12	2	
Safety issues (need to assess patient frequently)	45	59	
Inability to dim lights	11	0	
Visitors' demands	1	1	
Other patients in the room	1	0	
Patient care/nursing interventions	5	9	

<sup>a</sup> Hands-free wireless communication device.

culture changes to minimize false alarms and alarm fatigue.<sup>32</sup> Electronic sounds from intermittent alarms led to the most arousals from sleep in studies of healthy volunteers in simulated ICU environments.<sup>33</sup> Therefore, quality improvement initiatives to individualize alarm thresholds and minimize false alarms are crucial to optimize the balance between patient safety and a healing ICU environment, while simultaneously decreasing nurses' stress.<sup>34-37</sup> Similarly, the institution of nighttime quiet hours both in patient rooms and general areas can change culture and minimize sound due to staff conversations,

enabling adherence to recommendations<sup>2</sup> of the World Health Organization that sound levels should be no more than 30 dB at night. However, current evidence suggests that most PICUs internationally do not have either noise or light optimization protocols in place for sleep promotion.<sup>26</sup>

Another important issue raised by the questionnaire was the struggle between optimizing patient safety and promoting sleep. Dimming lights in the rooms of the most critically ill children may not be feasible because staff need to make continual visual assessments of the patients and provide frequent care.



**Figure** Comparison of nurses' views on work environment in single-patient vs multipatient rooms.

**Table 3**  
Free-text responses summarizing common themes after move to all private rooms

Please provide any other comments/thoughts about the PICU environment in which you work and how it affects patients' sleep-wake cycles and your work experience.

In the new unit, even with the door closed and curtains pulled, you can hear conversations being held outside of the room.

We should admit every child facing toward the window to optimize light.

As a unit, we are still not tuned into the amount of light, both natural or otherwise, that a patient should be exposed to; same goes for noise, because it was never a choice until now. A new culture needs to be created.

Parents present barriers as they often prefer shades down during the day to catch up on their own sleep, so need to educate them as well regarding the importance of sunlight exposure for their child.

The new unit has significantly improved the amount of noise in the unit at all hours, but staff get comfortable and forget how much noise they are making outside the rooms, particularly at night.

The environment is much easier to control in the new unit, but it is still the most critically ill children that need the lights on and have constant alarms from pumps/monitors/etc.

We need to be sure cares are grouped carefully to optimize sleep-wake cycles.

The stress level from noise in our ICU has decreased by about 80% in the new unit . . . it is the single, most impressive improvement in the entire unit.

I feel as if I'm using fewer PRN sedative medications due to decreased noise.

I am able to concentrate on my patients and provide better care, families are less stressed.

Having windows in every room has helped dramatically for patients, families and nurses—nothing beats a beautiful sunrise in the window after a chaotic night shift.

Abbreviations: ICU, intensive care unit; PICU, pediatric ICU; PRN, as needed.



Even with the ability to increase sunlight exposure during the day or dim lights at night, the preferences of patients' family members and staff personnel can be major obstacles to lighting optimization. Nevertheless, our results enabled physician and nurse leaders to identify areas for culture change and the need to create specific patient criteria for which noise and lighting protocols should be used.

Finally, making the transition to single-patient rooms improved PICU nurses' perceptions of the work environment and decreased job stress. Mealer et al<sup>38</sup> found that 20% to 30% of adult ICU nurses had indications of posttraumatic stress disorder because of the nurses' work, significantly higher than the lifetime prevalence of 6.8% among the US general population. PICU nurses spend their entire shift at the bedside of critically ill children, a situation that has great psychological impact and that increases the risk for associated traumatic stress.<sup>17,38</sup> In a study<sup>39</sup> of pediatric acute care nurses, 21% of survey respondents had strong signs and symptoms of posttraumatic stress disorder that were also associated with comorbid symptoms of anxiety, depression, and burnout. Younger ICU nurses (20-29 years old), the most highly represented demographic in our PICU, have reported higher job stress levels in previous studies<sup>40,41</sup> than did their older and more experienced colleagues. Therefore, the architectural design of an ICU where nurses care for critically ill children may have important implications for nurse retention and wellness.<sup>42</sup> Sound levels are known to increase stress and annoyance levels among nurses in the ICU environment.<sup>15,43</sup> Sunlight exposure during the day optimizes circadian rhythms for nurses who are frequently moving between day shifts and night shifts and also improves mood and energy.<sup>44</sup> Thus, having the ability and control to minimize noise and increase their own sunlight exposure during the day was beneficial to nurses' perceptions of the work environment.

This single-center study has limitations. First, perceptions of the environment may have been affected by anticipation and completion of the change in PICUs. That is, the new building and environment in general might have worsened perceptions of the old unit. Second, the ages and experience levels of the nurses who responded were quite heterogeneous, although this heterogeneity is generalizable to the majority of adult and pediatric ICUs. Third, the survey that we disseminated was not a previously validated tool. Finally, we do not have quantitative data on sound and light levels to correlate the change in perceptions with actual changes in sound and light levels before and after the move.

In summary, a PICU with single-patient private rooms led to improved perceptions of the patient environment for sleep promotion and decreased stress levels among PICU nurses. As more ICUs shift their architectural designs to the use of single-patient rooms, continuing to focus on issues that are not completely addressed by a new design is important. These issues include patient alarms, staff conversations, and the perception that an optimized sleep environment may detract from patients' safety. Future quality improvement and research initiatives should systematically address methods to optimize sound and light in the ICU environment so that patients can benefit from optimized sleep continuity and staff can work in an ICU that promotes a healing environment.

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