Night-time Screen Media Use in the Pediatric Intensive Care Unit

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Abstract
This prospective observational study quantified screen media use within the night-time pre-sleep period in a pediatric intensive care unit and postulated possible implications. Seventy-five patients between the ages of newborn to 19 years old were observed 5 evenings per week for 3 weeks. Trained observers documented the patient’s screen use, type of screen used, screen engagement, sleep state, light level, and parental presence. Patients in the ICU had an average 65 minutes of screen media use, per evening. The total screen media use averaged 59 minutes for the 0 to 18-month age group; 83 minutes for the 18 to 24-month age group; 66 minutes for 2 to 6 year olds; 72 minutes for 6 to 13 year olds; and 74 minutes for those above 13. This research demonstrates that children are engaging in more screen time during the night hours than is recommended by the AAP.

Keywords
critical care, sleep, screen time, intensive care units, pediatrics, hospital

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Introduction
The hospital and the intensive care unit (ICU) settings have a number of disruptive environmental factors that likely result in suboptimal sleep health; moreover, there is limited research to meaningfully inform change on this matter. Additionally, increased screen time has been shown to be adversely associated with sleep health in non-hospitalized children, primarily via delay in sleep onset and reduced sleep duration. Given what is known about sleep hygiene in healthy pediatric populations there is reason to explore whether screen time in intensive care unit impacts not only sleep but also, physical health and recovery. In this prospective observational study, we aimed to quantify screen use within the night-time pre-sleep period in the pediatric intensive care unit and to postulate possible implications.

Background
Short-term consequences correlated with lack of sleep in childhood include increased risk for injury¹ as well as of externalizing disorders, attention problems, and mood disorders.²,³ Sleep problems in childhood predict higher levels of anxiety, depression and aggression in adolescence.⁴ The impacts of sleep disturbances in childhood have long-term negative impacts on school performance and weight management.⁵,⁶ Given the myriad environmental disruptions within the hospital setting; it is highly suspected that sleep is compromised among patients. Inadequate sleep has been associated with a weakened immune system and decreased cognitive functioning.⁷,⁸ This maybe especially crucial in critically ill children for whom disease severity accentuates potential vulnerabilities.

Research conducted in the last few decades provided insights into the relationship between screen time and sleep. Having a television in a child’s room has consistently been associated with poorer sleep quality

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and quantity. It has become apparent that this correlation extends to any screen use in a child’s bedroom, primarily though to be due to delayed onset of sleep post-media use. The detrimental impact of night-time screen use on sleep is thought to be due in part to over-stimulation immediately before trying to engage in a restful state.

Literature, conducted with healthy pediatric populations, has shown that increased screen use is associated with mood disorders, obesity, disordered sleep, learning impairments, and delayed development. Access to screens do have some benefits; video calling has enabled communication between young children and traveling parents or extended family. Screens serve as medium to children’s literature and educational materials that may not otherwise be accessible. These benefits of screen time are primarily present when the child is actively engaging with the screen in the presence of a supportive caregiver.

The American Academy of Pediatrics (AAP) have released guidelines that discourage television or video viewing before the age of 2 years, suggesting instead that parents focus on interactive play to foster appropriate child development (APA, 2016). Furthermore, the AAP has discouraged the use of “background screen-time” and recommends that screens be turned off if children are not actively engaging with them (APA, 2016). They have also suggested that pediatricians discuss screen-based media with families and encourage minimal screen exposure. Despite these recommendations, hospitals continue to increase the availability of screens with limited guidelines on its use.

Children who spend time in the hospital are at a unique risk given that their medical condition; and risks associated with the hospital environment that may negatively alter their typical neurodevelopmental trajectory. For hospitalized children, watching various forms of screen media has become a common activity, especially when adult interaction is limited. Screen media may be used as a diversion activity in hospitals, reducing anxiety during distressing medical procedures, providing music therapy, or to give a child a sense of comfort and familiarity. While it is accepted that screen use may have a positive use as a short-term distraction modality, prolonged use has been shown to have negative developmental implications. Currently, it’s unclear what the implications of pre-sleep screen use in pediatric patients are in terms of sleep hygiene, risk of delirium, or clinical course.

To our knowledge, only 1 study has been done on the effects of screen time in hospitalized children. In this study, parents reported their children engaging in significantly more screen time (beyond AAP recommendations) in the hospital setting compared to home use. While this study demonstrated the significant role of screen use within the hospital environment, it did not address screen use during the evening to night hours nor in the ICU setting.

Given this limited research, the focus of the current work is to quantify screen use in children in the critical care unit in the night-time pre-sleep hours and potential associations for further study.

Study Design and Methods

Observation of patients in the combined 24-bed pediatric intensive care unit (PICU) and cardiovascular intensive care unit (CVICU) at an urban academic Children’s Hospital took place over the course of a 3-week period (5 days per week). Participants were observed every 15 minutes from 8 pm to midnight accounting for 17 observation points over the 4.25-hour night-time period. All patients from newborn to 19 years of age were screened for inclusion. Patients who were anesthetized, on paralytics, on significant life support modalities (ECMO, HFOV, on 2 or more pressors), under end of life care or to be transferred out of the unit were excluded. There was no direct contact with patients, families, or health care providers as to not confound results. This study was approved by the University BLINDED Institutional Review Board (approval number: FWA00000312).

Patients were observed in their rooms either through an open door or a window in the hallway looking into the room. Independent trained observers documented the patient’s sleep state, screen use, type of screen use, screen engagement, light level and parental presence. This data was collected using a Red Cap survey tool.

The sleep state was documented as awake, asleep, or unknown. Screen use, type of screen, and level of screen engagement was noted. The patient was recorded as actively engaged with the screen, if they maintained direct eye-contact with the screen for greater than 60 seconds during each 15-minute interval. The presence of light was noted (excluding minor sources from monitors or night lights) and the general source of this light (in the front of the room, in the back of the room, or both). The presence of audible sound in the patient’s room and the source of the sound (talking, music, or screen media) was recorded. The trained observers also documented if a family member was present inside the patient’s room and if the family member was actively engaged with the patient. Direct family engagement was defined as family members in physical contact with, standing bedside, making eye contact, or talking to the patient.
Demographic data including current age, gender, current diagnosis, reason for admission to the PICU, and length of stay were also collected from the electronic medical record (EPIC).

**Statistical Methods**

Time in an observed state was estimated by assuming that each observation represented a 15-minute span. Total time in a state (per patient per day) was thus calculated by multiplying the number of observations of the state by 15 minutes (0.25 hours). Seventeen potential observations (including endpoints 8 PM to midnight) resulted in 4.25-hours observed time per day. Missing observations were not counted for any state.

Descriptive statistics for patient demographics, length of hospital stay, and observation surveys were generated. Comparisons of time in states estimates across age groups were made by ANOVA tests. Comparisons of time in states estimates between genders were made with t-tests. Associations between estimated time in observed states or other numeric values (ie, age, etc.) were estimated by Pearson’s correlation coefficient.

All analyses were conducted with R (version 4.0.2). No multiple comparison p-value adjustments were made.

**Results**

**Descriptive Statistics**

Our sample included 75 hospitalized children ranging from newborn to 19 years (Mean = 6.40 years, Standard Deviation = 6.42 years, 46.6% female). Over the 3-week collection period, 4539 eligible patient observations occurred. There was an average of 267 observation points collected per day, with an average daily census of 17.8 participants. Observations could not be undertaken in 11% of encounters due to patient exclusion or a loss of direct patient visualization due to procedures, care interventions, or privacy curtains. The participant’s length of stay in the PICU and CVICU ranged from 1 to 137.5 days (Mean = 10.65, Median = 2.84, SD = 21.85). Demographic characteristics of participants are outlined in Table 1.

**Association Between Screen Media Use and Age**

On average, children staying in the ICU have 65-minutes of screen media use, per evening study period. The total screen media use averaged 59-minutes in the 0 to 18 month age group; 83-minutes for the 18 to 24 month age group; 66-minutes for the 2 to 6 year group; 72-minutes for 6 to 13 years; and 74-minutes for the above 13 (Table 2). Interestingly, some screens were left on after the patients had fallen asleep and were clearly not actively engaged with screen media (see Figure 1). This was especially prominent in the 0 to 18 months old age group, in whom screens were on for 24.74% despite a documented sleep state in at least 78.70% of the observation points.

**Screen Media Use During the Night-time Time Period**

On average, screen media was observed to be turned on for 28.48% of the total observation points. When participants presented as awake, screen media use was turned on in 56.50% of observations. When the study participants were asleep (in 66.84% of the total observation periods), screen media was left on in 21.74% of the time. Figure 2 shows the proportion of participants asleep, those with screen on, and those awake and actively engaged with screens. 89.57% of the screen use was from hospital provided televisions, while the other 10.43% were screens given to children by their caregivers such as tablets, phones, or computers.

| Table 1. Descriptive Demographic Data Summary of Participants (n=75). |
|---------------------------|---------------------------|
| Total participants        | 75 (100%)                 |
| Age (years), y            |                           |
| 0-1.5                     | 27 (36.0%)                |
| 1.5-2                     | 4 (5.3%)                  |
| 2-6                       | 12 (16.0%)                |
| 6-13                      | 13 (17.3%)                |
| 13 and up                 | 19 (25.3%)                |
| Gender                    |                           |
| Male                      | 40 (53.0%)                |
| Female                    | 35 (47.0%)                |
| Race/ethnicity            |                           |
| Asian                     | 6 (8.0%)                  |
| Black                     | 16 (21.3%)                |
| Hispanic                  | 5 (6.7%)                  |
| American Indian or Alaskan Native | 4 (5.3%)                |
| Caucasian                 | 43 (57.3%)                |
| Pacific Islander          | 0 (0.0%)                  |
| Did not say               | 5 (6.7%)                  |
| Other                     | 0 (0.0%)                  |
| Mean length of stay       | 10.65 days (±21.85)       |
| Median length of stay     | 2.84 days (1.66, 9.15)    |
| Average age               | 6.4 years (± 6.42)        |
Table 2. Average Screen Time and Active Screen Time for Participant Age Groups (n=75).

| Age (years) | Average screen time per night (minutes) | Average active screen time per night (minutes) | Estimated daily active screen use (minutes) |
|-------------|----------------------------------------|-----------------------------------------------|-------------------------------------------|
| 0-1.5       | 59                                     | 13                                            | 73                                        |
| 1.5-2       | 83                                     | 18                                            | 102                                       |
| 2-6         | 66                                     | 20                                            | 113                                       |
| 6-13        | 72                                     | 46                                            | 260                                       |
| 13 and up   | 74                                     | 43                                            | 243                                       |
| Average     | 65                                     | 23                                            | 158                                       |

Figure 1. Proportion of participants asleep, with screen median on, and actively engaging in screen media during the observational period by age group.
Association Between Active Screen Media Use and Age

When screens were on, they were actively watched in 34.05% of total observation points. Within the 4.25 hour observation period, actively watched screen media use averaged 13-minutes in the 0 to 18 month age group; 18-minutes in the 18 to 24 month age group; 20-minutes in the 2 to 6 year group; 46-minutes in the 6 to 13 year group; and 43-minutes for those above 13 years ($P < .001$ for all groups). On average, children staying in the PICU had 23-minutes of active screen media use, per the 4.25 hour night-time period.

Associations Between Light Presence Inside Participant’s Rooms and Sleep

33.95% of the observations demonstrated had 1 significant source of light. Patients presented asleep while having a significant source of light inside the room 34.18% of the time. As shown in Figure 3, the proportion of patients with a source of light in the...
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Room decreased from an estimated 48% to 24% over the observation period. This demonstrates a significant amount of light pollution occurring after patients have fallen asleep.

**Associations Between Sound Presence Inside Participant’s Rooms and Sleep**

During this study, sound (deemed easily audible by observer in the hallway) was noted in the participant’s rooms 38.3% of the observation points. When participants presented as asleep, sound was present in 37.9% of observations. Sound originated from technology (59.9%), from people (31.5%), and from both technology and people in 7.9% of the observations.

**Associations Between Screen Media Use and Parental Presence**

Parental or family presence in the room during the observation point had a weak but significant correlation with observed screen use. \( r = .174, P = .004 \).

**Associations Between Screen Media Use and Parental Engagement**

The presence of engaged family members had a weak but significant correlation with screen use. \( r = .182, P = .003 \).

**Associations Between Screen Media Use and Gender**

Male patients tended to have screens on more per day than female patients. \( P = .031 \).

**Associations Between Screen Media Use and Length of Participant’s Hospitalization**

In this study, the average length of hospitalization for the participants was 10.6 days (255.5 hours). The length of the hospitalization stay did not have an impact on screen use. \( r = .033, P = .628 \).

**Discussion**

The primary objective of this study was to quantify screen time use in pediatric ICU patients during the night-time hours. Our findings suggest that screen use is an intrusive element in the pre-sleep inpatient environment; patients had an estimated average of 65-minutes of screen media use and an estimated average of 23 minutes of actively engaged screen media use per the 4.25 hour night-time period. From this data, it is apparent that hospitalized children have screen viewing integrated into their bedtime routine.

This increased amount of pre-sleep screen media use may be related to the patients’ increased access. Population based studies have indicated that approximately 65% of
American children have a television or screen in their bedroom.\textsuperscript{26} In the observed pediatric intensive unit, each room is equipped with its own television set. Sixty-five percent of the observed screen use was without active attention on the screen, often while participants were asleep. This background screen use was especially prominent in the younger population from 0 to 18 months old. This population was observed to be asleep for 78% of the total observation points and had an estimated average of 59 minutes of screen use during the observational period (Figure 1). It’s important to also consider the health consequences of the sound and light disturbances from this screen use, as it can interfere with the child’s duration and quality of sleep. As sleep has positive effects on immune system functioning and mood regulation, background screen use may have negative implications on the healing and recovery process.\textsuperscript{7,23}

During the 4.25-hour collection period, the average amount of screen time for young children exceeded the daily AAP guidelines. AAP recommends that children under the age of 18 months avoid nearly all screen media other than video-chatting with relatives; and for children 18 to 24 months to have less than an hour of parent guided quality screen time.\textsuperscript{18} For children 2 to 5 screen use should be limited to 1 hour of high quality programing. In this study, we extrapolated active engaged screen use over the observation period into an estimate of screen time in a 24-hour period (Table 2). This yielded an estimated 73-minutes for the 0 to 18 month age group, to 243 minutes in the above 13 age group. The duration of active engaged screen use as well as the exposure to background screen time are areas of concern and suggest that the in-patient hospital environment is not conducive to following evidence-based developmental guidelines.

Patients presented asleep while having a significant source of light inside the room 34.18% of the time and a significant source of sound (as audible from the hallway) in 37.9% of observations. Although actual lumen and decibel levels were not measured and is a limitation of this study, we may still infer impact on sleep. Research has shown that light pollution at night can disturb circadian rhythm and suppress melatonin.\textsuperscript{19} Combating ICU sleep disturbances will require the elimination of unnecessary noise and light (including screen use), consolidating patient care rounds at night and using other sleep aids like eye masks, white noise machines, or curtains.\textsuperscript{24}

**Limitations**

Other limitations of this study include 11% of the observation points could not be made due to loss of visualization of the patient for privacy and or procedures. Further, due to the short nature of the observations, the amount of active screen engagement is a limited inference.

**Implications**

Given what is known regarding the importance of sleep and the detrimental impacts of excessive screen time, our findings suggest that there are avenues for improvement. Creating an optimal inpatient environment for pediatric patients will require multidisciplinary engagement from child family life, nursing, physiotherapy and even design staff. An educational program, for both caregivers and parents, to increase awareness regarding the negative implications of disturbing sleep with light, noise, or screen use may be warranted. As future research develops, hospitals may also consider moving toward programing that promotes healthy sleep routines.

**Conclusion**

Overall this research demonstrates that children are engaging in more screen time during the night hours than is recommended by the AAP for healthy development. Ultimately, further research will be necessary to understand implications of hospital screen use in relation to sleep quality, sedative use, recovery, and delirium risk. This information serves as an additional point of reference as hospitals work toward creating a healthy environment conducive to healing and growth particularly for their vulnerable, young patients.

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**Author Contributions**

AS: Contributed to conception and design; Contributed to analysis and interpretation; Drafted manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. AW: Contributed to acquisition and interpretation; Drafted the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. MGH: Contributed to acquisition and interpretation; Critically revised the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. SJM: Contributed to conception and design; Contributed to analysis and interpretation; Drafted manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy. AM: Contributed to conception and design; Contributed to analysis and interpretation; Drafted the manuscript; Gave final approval; Agrees to be accountable for all aspects of work ensuring integrity and accuracy.
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