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PRACTICE REFLECTION

Do not disturb: Use of wearable biosensor technology to minimize sleep disruptions in patients with hematological malignancies

by Natalie D. Iannucci and Charlene H. Chu

ABSTRACT

Patients with hematological malignancies frequently suffer from sleep disruptions during hospitalization, primarily due to frequent night-time interventions such as vital signs monitoring, which occurs at least three times during the night shift. Consequently, the sleep of these patients is interrupted each time a nurse checks their vitals. Minimizing disturbances to sleep in cancer patients is essential, as poor sleep quality has been associated with poorer responses to treatment and reduced overall survival (Strøm et al., 2022).

This paper proposes the use of wearable biosensor technology over night in the inpatient setting to monitor patients' vital signs remotely and, thus, minimize disruptions to their sleep. The importance of improving sleep in this patient population and the potential for use of this technology necessitates further research on the analytical and clinical validity of wearable biosensors for use with hospitalized malignant hematology patients. The paper concludes with future recommendations and implications of this technology for the nursing profession.

AUTHOR NOTES

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INTRODUCTION

The circadian sleep-wake cycle plays a vital role in human health, specifically in regulating the immune system and in metabolizing energy (Zhou et al., 2022). Sleep is essential for long-term health, as processes such as DNA repair and production of melatonin, an antioxidant, occur during this time (Zhou et al., 2022). Therefore, frequent sleep interruptions downregulate these processes and negatively impact health (Jaime et al., 2022). Sleep deprivation is a significant stressor for hospitalized cancer patients (Abuatiq et al., 2020), as evidenced by a recent study where 92.6% of cancer patients reported experiencing nighttime sleep interruptions during hospitalization (Jaime et al., 2022). This paper proposes wearable biosensor technology (WBT) as a promising digital health solution to reduce sleep disruptions from vital sign monitoring in hospitalized malignant hematology (MH) patients. A background description on the issue of sleep disruption for this patient population is provided first. Subsequently, the paper describes how WBT can improve patients' sleep and health outcomes. The paper concludes with recommendations for research, nursing education, and nursing practice.

SLEEP DISRUPTIONS FOR MALIGNANT HEMATOLOGY INPATIENTS

Poor sleep quality, attributed to symptoms of the disease, side-effects of treatments, and other stressors, is a common problem for cancer patients (Divani et al., 2022). A systematic review found that sleep disturbances during cancer treatment correlated with poorer response to treatment and reduced overall survival (Strøm et al., 2022). In MH inpatient units, there are frequent disruptions to patients' sleep, as they require monitoring of vital signs at least every four hours due to their high risk for infection and other complications (Kroloff et al., 2022). For acutely ill patients and those receiving highly reactive treatments, the frequency of vital signs monitoring is increased (Tonino et al., 2019). From first-hand experience working as a nurse on an MH unit, nurses must wake patients to measure their vital signs at midnight and at 4 a.m. In addition, these patients are disrupted at 10 p.m. and 6 a.m. for scheduled medications and between 5 a.m. and 6 a.m. for blood work. These interruptions occur every night while the patient is hospitalized, resulting in no more than four consecutive hours of uninterrupted sleep. Studies demonstrate that consistent poor sleep quality can increase stress responses, cause mental health issues, and increase the risk of metabolic abnormalities (Chaudhry et al., 2020; Ritmala-Castren et al., 2021). Despite these adverse effects, the nursing tasks must be completed as scheduled to ensure subsequent care is not delayed and to prevent negative patient outcomes. Therefore, innovative technologies are urgently

needed to facilitate the completion of these tasks, while minimizing sleep disruptions.

WEARABLE BIOSENSOR TECHNOLOGY

Technological advancements to reduce patients' sleep disruptions are already being discussed in other hospital wards (Jaime et al., 2022). For example, there are recommendations for remote monitoring systems in the intensive care unit that will notify nurses when infusion pumps and monitors need to be checked, reducing the prevalence of loud alarms sounding in patient rooms (Jaime et al., 2022). A similar application of remote monitoring technology, Wearable Biosensor Technology (WBT), can be used in the MH inpatient unit to reduce sleep interruptions. WBT can continuously monitor health parameters unobtrusively with minimal disruption to the patient, and transmit data to remote locations (Bian et al., 2020; Canali et al., 2022) through Bluetooth and other network systems (Tonino et al., 2019). The type and placement of WBT devices depends on the measurements being made, ensuring accuracy and operational robustness (Bian et al., 2020; Ha et al., 2019). Depending on the type of WBT, various vital signs can be measured (Haveman et al., 2021; Tonino et al., 2019).

Machine learning can detect abnormalities from the continuous vital signs data, such as early signs of sepsis, without disrupting the patient's sleep. This unobtrusive and accurate data collection can facilitate the prompt initiation of antibiotics, potentially resulting in reduced hospital stays and fewer readmissions compared to traditional monitoring methods (Downey et al., 2018).

WBT has mostly been tested in outpatient settings with calls for more research regarding its use in the inpatient setting (Haveman et al., 2021). Most of the research available on WBT tests its validity, usability, and wearability (Haveman et al., 2021; Tonino et al., 2019). Nurses in a study by Kooij et al. (2022), noted that excessive sweating and skin irritation may influence the usability of the devices, which are important considerations for the MH population. Feasibility studies that assessed patients' experiences using WBT for greater than 12 hours, whether in hospital or at home, reported no issues with wearability (Miller et al., 2021; Tonino et al., 2019). These studies highlight that patients found the use of these devices to be comfortable and that they did not interrupt their sleep (Miller et al., 2021; Tonino et al., 2019).

RECOMMENDATIONS AND IMPLICATIONS FOR NURSING

Research

Research indicates that nurses have identified issues with the quality of the network connection in relation to the use of WBT (Tonino et al., 2019). An important next step is for the MH healthcare team to collaborate with the wearables engineering team to validate the technology in relation to the patient care needs of MH inpatients and ensure adequate network connection. A study should be conducted to assess the benefits of minimizing sleep disruptions in this high-risk population, as well as verifying the health outcome benefits reported by Downey et al. (2018). Lastly, organizational guidelines must be developed to support safe and effective application of WBT with this patient population, including ethical, privacy, security, and confidentiality implications (Registered Nurses' Association of Ontario, 2024).

Nursing Education

Nursing education needs to keep pace with new developments in health technologies. Nursing students need to be exposed to digital health technologies and informed on the ways they will shape their future healthcare practices (Dykes & Chu, 2021; Kleib et al., 2022). The nursing profession is also confronting significant gaps in knowledge when it comes to technology that is powered by artificial intelligence, like WBT (Ronquillo et al., 2021). Specifically, for these wearables, nursing informatics education is needed to ensure that nurses can integrate the technology while maintaining their own clinical judgement.

Nursing Practice

The nursing role in the implementation of WBT includes being involved from design and implementation to evaluation to address the needs and inefficiencies in patient care and ensure technologies are appropriately deployed (Chu et al., 2022). The nurses' role, including advance practice nurses, involves training to ensure staff understand the functionality, benefits, and limitations of the devices. Nurses will need training on how to use the technology and how to identify and report functional and patient-specific issues such as system malfunctions and reactions to the device (Miller et al., 2021). They will also need expertise in interpreting the data generated by WBT and integrating this information into their clinical decision-making (Chu et al., 2022). Nurses will play a pivotal role in educating patients about WBT and addressing any concerns to ensure patient comfort and compliance. Lastly, the evaluation of the technology should include the perspectives of nurses to gain a full understanding of WBT's effects on workflow in the MH units.

CONCLUSION

WBT is a promising solution to minimize sleep disruptions for hospitalized cancer patients. Given the need for frequent monitoring due to the immunosuppressive states of these patients, WBT provides a means to unobtrusively track vital signs, thereby minimizing night-time awakenings and promoting better sleep quality. This technology has the potential to improve patient outcomes by enabling early detection of complications and timely interventions, while also enhancing the efficiency of nursing workflows. The successful implementation of WBT will rely heavily on the involvement of nurses in all phases. The benefits of this technology, if proven clinically valid in this context, can not only improve cancer patients' sleep, but also significantly enhance their experience in the hospital.

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