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The Effect of Neonatal Intensive Care Unit Design on the Distance Walked by Nurses

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Abstract

Background: The intent of this paper is to compare the impact of neonatal intensive care unit (NICU) design upon nursing staff by investigating the number of footsteps walked per shift and complaints of physical distress following the relocation of a NICU from a traditional open-bay design, where many babies receive care in one large room, and a new single-family room NICU in which each baby receives care in a private room.

Methods and findings: Staff nurse and expanded role neonatal nurse practitioner volunteers wore a pedometer for twelve-hour shifts in the open bay and single-family room NICUs. Data were analyzed by the severity of the nursing caseload and by shift for nurses, and by shift for neonatal nurse practitioners. For staff nurses, there was a significant increase from 5689 steps/shift (4.50 km) in the open bay NICU to 6523 (5.16 km) steps in the single-room unit. No differences were found in comparisons by shift. Nurse practitioners had a significant increase from 4025 (3.19 km) to 5157 (4.09 km) steps per shift. The number of steps at night increased from 2385 to 5982 steps; however, this difference was not significant due to the small sample size. Comparisons of nursing surveys for items specifically related to work-related musculoskeletal disorders demonstrated no significant differences.

Conclusions: A statistically significant increase in footsteps per shift was found among neonatal nurses and neonatal nurse practitioners in the single-family room NICU as compared with the open bay facility. Although the results were statistically significant, the physical impact for distances walked were minimal. The number of steps in the single-family room NICU were ½ of the number reported for nurses on medical-surgical units. It should be emphasized that nursing administration anticipated the potential for the need for increased walking in the single-room NICU and additional support personnel were added to assist in supporting the nursing staff.

Keywords: NICU Design; NICU staffing; Walking; Pedometer measurements

Introduction

Nurses have cared for neonates and their families in large traditional open-bay (OPBY) neonatal intensive care units (NICU) for many years. New knowledge gained in the area of sensory development over the last 25 years [1,2] has resulted in neonatal nursing practice evolving from a focus of saving lives to one of providing appropriate infant stimulation and reducing environmental stress in an effort to optimize long-term neurodevelopmental outcomes [3,4]. The OPBY NICU was designed to allow nurses to be in close proximity of the babies for whom they were caring. The OPBY NICU presented challenges and limitations in the ability to control adverse environmental sensory stimuli such as noise, light, odor, lack of diurnal patterns and in providing a healing environment for infants, family, and staff [5,6]. The single-family room NICU (SFR NICU) was designed so that each neonate (or pair of neonates for twins) receives care in a separate room. This design has been successfully used to provide control over the environment for the fragile developing neonate [7,8].

Environmental re-design with the SFR NICU involves multifaceted changes for the neonatal nurse which are frequently overlooked [9]. Changes in the physical environment require integration with other work systems [10]. While the primary focus of the NICU is optimal infant care, it is important to be mindful of the physical geography and workflows that can support nurses in providing optimal care. The environment of their nurses may influence infant outcomes directly, or indirectly [11].

The purpose of this research was to quantitatively evaluate the distances walked, measured as footsteps taken, during a twelve-hour shift by staff nurses in two different types of NICU; an OPBY NICU built in the late 1970's, and a new SFR NICU which opened in 2006. The new SFR design resulted in an increase in area of the NICU from 2134 m² to 8230 m². Specifics of the nursery design, staffing and many aspects of care in these two units have been described in detail elsewhere [5,12-15].

Evaluation of distances walked by nurses is important because when nurses are required to walk greater distances it diminishes their time and ability to remain in close proximity to the infants in their care. This impacts their ability to observe the neonate and to assess the needs of the family. Consequently, these factors may impact the parent's ability to participate in family-centered care and can adversely affect their satisfaction with care. Hospital administrators must remain sensitive to the needs of nurses, which will ultimately impact care for infants and families [9].

The efficiency of work, the impact on work relationships and the ability to observe patients are important factors when considering a major change in NICU design, even within the same organization [16]. Significant portions of nurses' activities are dedicated to walking while searching for supplies, which detracts from time in providing care. Nurses in critical care units, require close proximity to enable a quick response to alarms, the ability to observe and care for infants and interact with families [9]. Walsh reported that nurses believed the SFR NICU was a physically difficult place to work and stated that extra walking increased difficulty in providing coverage [17]. Others have indicated that access to supplies and equipment is an additional challenge to nurses, and thus, both should be in close proximity to a nurse's patient care assignment [1]. Carlson, et al. reported that nurses specifically expressed concerns related to walking [18]. Shepley, et al. found that the walking increased in the SFR NICU, but travel per square foot of NICU area actually decreased [19].

Methods

Nurses and neonatal nurse practitioner (NNP) volunteers were asked to wear pedometers during twelve-hour work shifts in the OPBY NICU between November 2005 and June 2006. No data was collected for six months following the opening of the new SFR NICU to allow care practices to stabilize. Between November 2006 and June 2007, the same requests were made in the SFR NICU. Nurses were assigned to use pedometers by care role in the NICU during one week of each month of both study periods. Only nurses with patient care assignments were included. Levels of nursing assignments for this study were as follows: Level 1 nurses provided care for babies receiving enteral nutrition, Level 2 nurses provided care

for babies with intravenous lines and or requiring oxygen, Level 3 nurses provided care for babies on ventilator support. NNPs who worked days shifts rounded on a caseload of babies, attended deliveries, admitted new infants to the NICU and presented report at the end of the shift. One nurse practitioner worked the night shift and monitored all babies in the NICU and attended deliveries.

Participants were each trained in the use of the New Life Styles Digi-Walker SW-651 pedometer (New Life Styles, Inc., Lees Summit, MO) by one of the authors. All research involving the NICU environment discussed in this paper was reviewed and approved by Sanford and University of South Dakota Medical Center Institutional Review Committee. All participants signed consent for participation. All data regarding were entered into an Access Database (Microsoft Corp., Redmond, WA) using anonymous alphanumeric codes for participants. Statistical analysis was performed using non-paired t-test using SPSS v. 14 (SPSS, Inc., Chicago, IL).

Staff satisfaction for the two NICU facilities was evaluated in a separate study in which staff members were asked to complete a 103-item survey in both the OPBY and SFR NICU [12]. Due to the relevance of this information to this investigation, the results of two items indicating that the individual is concerned (7=most concerned, 1=least concerned) regarding musculoskeletal problems with the lower limbs and concerns related to musculoskeletal problems associated with the upper extremities or with the back are included in this report [12]. Non-parametric analysis was performed for these responses using SPSS software.

Results

Pedometer measurements

Pedometer measurements were available for a total of 63 twelve-hour shifts in the OPBY NICU and 85 shifts in the SFR NICU. Data were available for a total of 30 NNP shifts in the OPBY NICU and 26 in the SFR NICU. The mean (SEM) total number of steps per shift increased for the staff nurses from 5689 (274) to 6523 (256) steps ($p=0.03$). The mean total steps increased from 4025 (255) to 5157 (412) for NNPs ($p=0.02$, **Table 1**).

Table 1 Pedometer reading by role and shift in the open-bay and single-family room NICU.

Role	Open-Bay			Single-Family Room		
	N	Mean	SEM	N	Mean	SEM
All Nurses	63	5689 (4.50)	274	85	6523 (5.16)	256
Level 1						
-Day	5	7064 (5.58)	873	18	7734 (6.12)	569
-Night	3	5234 (4.14)	1061	3	6893 (5.46)	758
Level 2						
-Day	17	6726 (5.33)	428	14	7092 (5.62)	511

-Night	8	6075 (4.81)	535	11	5287 (4.18)	612
Level 3						
-Day	17	5716 (4.52)	582	10	6685 (5.29)	701
-Night	12	3533 (2.78)	455	17	5402 (4.28)	456
All NNP	30	4025 (3.19)	255	26	5157(4.09)	412
NNP -Day	22	4566 (3.60)	248	14	4303 (3.40)	518
NNP -Night	6	2385 (1.88)	318	8	5982 (4.73)	752
Levels of Nursing Care: Level 1 receiving enteral nutrition; Level 2 intravenous lines and/or requiring oxygen; Level 3 ventilator support (estimated distance in km); p<0.05 in bold italics; NNP: Neonatal Nurse Practitioners						

Data were reviewed for staff nurses and NNPs for day and night 12-hour shifts and by the two facilities. None of the differences were statistically significant. The mean total steps per shift for nurses by level of care provided and shift are also in **Table 1**. There was a dramatic increase in the pedometer measurements for NNPs working the night shift. This increase is likely due to a markedly increased distance from the NICU to the delivery rooms in the SFR NICU. In all other categories, pedometer measurements were greater during day shifts than at night and were generally greater in the SFR NICU than the OPBY NICU during comparable shifts.

Survey responses

Surveys forms were distributed to 104 nurses in the OPBY NICU and 117 in the SFR NICU. There were 59 (56%) and 63 (53%) responses respectively. The concern among the nursing staff regarding musculoskeletal problems of the lower extremities had a lower median score of 3 (less concern) in the SFR NICU compared with 4 in the OPBY NICU; however, the difference was not significant. Similarly, no significant differences were found in the responses to questions regarding musculoskeletal problems associated with the upper extremities or associated with the back [12].

Discussion

The increase in walking experienced by staff in the SFR NICU was modest. Multiplying the number of footsteps by 0.79 meters/step and dividing by 1000 m/km, yields the distances listed in the **Table 1**, ranging from 1.88 km to 6.12 km per 12-hour shift. Most of the differences between the two facilities were approximately 0.8 km/shift, with the exception of the night shift Nurse Practitioners who had an increase of 2.85 km per 12-hour shift. This is likely due to a marked increase in the distance from the SFR NICU to labor and delivery floor. Additionally, the distance walked to assess individual infants during the night would have been much greater in the SFR NICU.

In the new SFR NICU, staff nurses and NNPs walked more per 12-hour shift. In spite of increased steps per shift, nursing staff did not report increased concern regarding musculoskeletal problems associated with their upper extremities, lower extremities or back.

Welton, et al. performed similar pedometer measurements for medical-surgical nurses. He estimated that nurses walked an average of 8,747 steps or 6.60 km during a typical 12-hour shift [20]. Day shift nurses walked significantly more than night nurses with a mean of 6.8 versus 6.4 km. These data indicate that although NICU nurses walk significantly more in the SFR NICU, the distances are not excessive when compared with other typical hospital nurses.

The Boekelheide SFR NICU was constructed to provide a developmentally appropriate, family-centered NICU, complying with Recommended Standards for Newborn ICU Design [6]. Nursing administration anticipated that operational systems and workflows would need to be redesigned for the SFR NICU to support nursing staff. New staffing patterns were needed to eliminate issues caused by the increased area of the unit, separation of nurses from their assigned cases and isolation of nurses from their colleagues. At the beginning of planning, multi-disciplinary teams were formed which included parent representatives, nurses, neonatal nurse practitioners, physicians, pharmacists, respiratory therapists, therapists, and support staff. Careful thought was given to the location of supplies, operational changes, equipment, processes, and technology in the new NICU. Additional support staff were hired and trained before the SFR NICU opened. These are outlined in **Table 2**.

Table 2 Additional SFR NICU positions supporting nurses.

Materials management coordinator (MMC, New Positions)
- Monitors and adjusts unit supply levels based on census
- Monitors condition of equipment
- Orders and tracks new equipment
- Organizes and monitors supply rooms
- Resource for nurses for equipment
- Set up of rooms for new admissions
- Assist with delivering supplies to patient rooms
Receptionist (New Positions)
- Monitors locked guest entrance to the NICU and admits parents and visitors
- Takes and maintains photo identification of parents and visitors

- Provides an overview of the new parents
- Maintains health screening questionnaires for visitors
Health Unit Coordinators (HUC, Additional Positions)
- Programs pagers linked to patient monitors and nurse call system
- Programs monitors for nursing care groups
Patient Service Representatives (PSR, Additional Positions)
- Clean equipment
- Deliver supplies to patient rooms
- Stock unit supplies
- Set up rooms for new admissions

Activities involving equipment represent a significant drain on the typical day of a nurse [12]. Equipment access, storage, design, and function were identified as major issues to problems [21]. To address some of these problems in our SFR NICU, a Materials Management Coordinator (MMC) position was created one year before opening the new SFR NICU. This individual consolidated and organized many tasks that in the past were not assigned to a specific role and were performed by nurses in the unit. The person in this role is now responsible for the quality, quantity, and location of material resources.

Equipment and supplies were carefully considered with a focus of keeping the nurse close to their patient assignment. Bedside supply carts were purchased and the location of equipment in them standardized and labeled. Supplies are delivered to the rooms daily by ancillary staff (MMC). Carts equipped for admissions and procedures, and boxes for supplies needed when infants are taken off the unit were designed to allow quick access to supplies. Decentralized supply cabinets for frequently used supplies were also created in each work zone. Refrigerators were placed in each room for the storage of breast milk and formula. Specialty formulas, which require mixing, are prepared each day by dietary staff in a nutrition room in the NICU and are delivered to patient rooms. Pyxis medication supply stations (Cardinal Health, San Diego, CA) were placed in each nursing work area.

New technology was added and communication technology was upgraded. These included expanded cardio-respiratory monitor features, a nurse call system, and pagers. Patient monitors are capable of displaying two imbedded windows, to allow nurses to see monitors of the other infants assigned to him/her. Nurses are assigned in care groups of two or three providing care for neonates. The monitors of each care group are programmed to activate pop-up screens in each room when any of the monitors in a care group alarm. Monitor alarms are directed to the primary nurse and her buddy's pagers. NICU staff members were already using wireless phones in the OPBY NICU. All members of the healthcare team used wireless telephones to facilitate communication. Nurses-to-parent communication is facilitated by nurses writing their name and phone number on a white board in their baby's room. Portable phones are located in each room. Parents are encouraged to call the nurse's phone if they have a non-emergent need or question.

Computers were placed in each patient room, with additional wireless computers on portable stands for nurse practitioner and physician use. Subsequently, these computers were used for medical and nursing documentation in the electronic medical record.

In the transition to the new SFR NICU, if the nursing director had not taken the area and geography of the new facility into consideration in planning for nursing and support staff coverage, the required walking distances could have been much greater. The increased distance walked by nurses and other care providers, staffing patterns and staff turnover need to be explored further [16].

There were limitations in this investigation. Data were obtained from volunteers rather than all nurses in the NICU. Footsteps are a surrogate measure of distance walked and indirectly measure some of the energy a nurse work expends during a shift in the NICU. The questionnaire used is also subject to the limitation of willingness of the nursing staff to honestly respond to survey items. Non-the-less, we feel that this research is one of the few objective evaluations performed to date of the change in walking and physical complaints in the SFR NICU compared with the OPBY NICU.

Conclusion

In a comparison of pedometer measurements of distances walked by staff nurses and NNPs in a traditional OPBY and a new SFR NICU, both groups walked more in the SFR NICU. Analysis by shift and nurse role did not show statistically significant differences within groups; however, mean values for pedometer measurements were generally greater on day shifts and greater for all shifts in the new SFR NICU without an increase in physical complaints. These findings were achieved through administrative attention to the layout of the NICU, consideration of operational details, the application of available technology and the addition of non-professional support staff to control excess walking and help to keep nurses closer to neonates and parents for whom they care.

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References

1. Graven S, Browne J (2008) Sensory development in the fetus, neonate, and infant: introduction and overview. *Newborn Infant Nurs Rev* 8: 169-172.

2. Als H (1982) Towards a synactive theory of development; promise for the assessment and support of infant individuality. *Infant Ment Health J* 3: 229-243.
3. Als H, Duffy FH, McAnulty GB, Rivkin MJ, Vajapeyam S, et al. (2004) Early experience alters brain function and structure. *Pediatrics* 113: 846-857.
4. Als H, Gilkerson L (1997) The role of relationship-based developmentally supportive newborn intensive care in strengthening outcome of preterm infants. *Semin Perinatol* 21: 178-189.
5. Stevens DC, Khan MA, Munson DP, Reid EJ, Helseth CC, et al. (2007) The impact of architectural design upon the environmental sound and light exposure of neonates who require intensive care: an evaluation of the Boekelheide neonatal intensive care nursery. *J Perinatol* 27: S20-28.
6. White RD, Smith JA, Shepley MM (2013) Recommended standards for newborn ICU design (8thedn.) *J Perinatol* 33: S2-S16.
7. White R, Whitman T (1992) Design of ICUs. *Pediatrics* 89: 1267.
8. White R (2003) Individual rooms in the NICU: An evolving concept. *J Perinatol* 23: S22-S24.
9. Shepley MM (2004) Evidence-based design for infants and staff in the neonatal intensive care unit. *Clin Perinatol* 31: 299-311.
10. Gurses AP, Carayon C (2007) Performance obstacles of intensive care nurses. *Nurs Res* 56: 185-194.
11. Harris DD, Shepley MM, Kolberg KJS, Harrell JW (2006) The impact of single family room design on patients and caregivers: Executive summary. *J Perinatol* 26: S38-S48.
12. Stevens DC, Helseth CC, Khan MA, Munson DP, Smith TJ (2010) Neonatal intensive care nursery staff perceive enhanced workplace quality with the single-family room design. *J Perinatol* 30: 352-358.
13. Stevens D, Thompson PA, Helseth CC, Pottala JV, Khan MA, et al. (2011) A comparison of outcomes of care in an open-bay and single-family room neonatal intensive care facility. *J Neonatal Perinatal Med* 4: 189-200.
14. Stevens DC, Thompson PA, Helseth CC, Hsu B, Khan MA, et al. (2014) A comparison of the direct cost of care in an open-bay versus single-room neonatal intensive care unit. *J Perinatol* 34: 830-835.
15. Stevens D, Munson DP, Khan MA (2016) The single-family room neonatal intensive care environment. *NeoReviews* 17: e687-e696.
16. Floyd AM (2005) Challenging designs of neonatal intensive care units. *Crit Care Nurse* 25: 59-66.
17. Walsh WF, McCullough KL, White RD (2006) Room for improvement: Nurses' perceptions of providing care in a single room newborn intensive care setting. *Adv Neonatal Care* 6: 261-270.
18. Carlson B, Walsh S, Wergin T, Schwarzkopf K, Ecklund S (2006) Challenges in design and transition to a private room model in the neonatal intensive care unit. *Adv Neonatal Care* 6: 271-280.
19. Shepley MM (2002) Predesign and post-occupancy analysis of staff behavior in a neonatal intensive care unit. *Children's Health Care* 31: 237-253.
20. Welton JM, Decker M, Adam J, Zone-Smith L (2006) How far do nurses walk? *Medsurg Nursing* 15: 213-216.
21. Gibbons C, Geller S, Glatz E (1998) Biomedical equipment in the neonatal intensive care unit: is it a stressor? *J Perinatal Neo Nurs* 12: 63-67.