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Moving to a single patient room design: are there physical and psychological effects on the neonatal intensive care unit staff?

Abstract

Purpose: The purpose of this study was to quantify the physical and psychological changes in staff health after moving from an open bay (OB) Neonatal Intensive Care Unit (NICU) to a single patient room (SPR) design.

Subjects: 81 registered nurses, respiratory therapists, and neonatal nurse practitioners working in a 45 bed, regional referral, level IV NICU were recruited for the study. 59 participants completed all study activities.

Design: A pre-post experimental design was used.

Methods: The number of steps taken during a routine work shift were measured, for 3days, first in the OB NICU, and then in the SPR NICU, 3months after the move. Blood pressure and body weight were measured in both locations as a measure of physical health. Participants also completed a questionnaire to assess chronic health conditions, musculoskeletal health, and involvement in weight control and exercise programs. Mental health was measured before and after the move with the Psychiatric Symptoms Index (PSI), and a brief survey about perception of the work environment, including space, light, and noise.

Results: Participants walked, on average, nearly 900 steps more each day (just over 1/3 of a mile) in the SPR NICU (6082.41) than the OB NICU (5185.23), p=0.014; physiologic parameters were unchanged. Hypertension was identified in 2 participants previously unaware of the condition; there were no changes in musculoskeletal complaints. Mental health was unchanged despite a significant increase in satisfaction with the amount of work and personal space (p<0.001), noise level (p<0.001), and natural light (p<0.001), in the new SPR NICU compared to the traditional OB NICU. NICU staff had high levels of anxiety and depression; 32% reported symptoms associated with clinical depression.

Conclusions: New NICU designs and technological advances in monitoring and communication are thought to improve the quality of health care, family satisfaction and ease workflow burden for staff. There was a modest increase in the physical demands of the work environment in the SPR compared to OB NICU, which was neither beneficial nor harmful to staff's physical health. Despite increased satisfaction with the physical space, psychological health was unchanged, with a high proportion of staff reporting symptoms associated with anxiety and depression. Although redesigned NICUs are appreciated for their aesthetics, the new work environment may not contribute to improvement in staff mental health.

Keywords: mesh, intensive care, workflow, environment design, mental health, walking, nurses

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Abbreviations: NICU, neonatal intensive care unit; SPR, single patient rooms; ICU, intensive care unit; HADS, hospital anxiety and depression scale; OB, open bay

Introduction

Neonatal Intensive Care Unit (NICU) design has transitioned away from the traditional open bay (OB), multi-bed rooms to single patient rooms (SPR). The change in design is in response to evidence that preterm infants can be adversely affected by routine intensive care unit (ICU) care and benefit from a physical space that reduces stimuli yet supports their health care needs.[1]

In May of 2012, the OB NICU in our hospital moved to a SPR design in a newly built Children's Hospital. Although the number of beds remained the same, the NICU footprint changed from approximately 10,000 square feet to more than 28,000 square feet, necessitating a change in workflow for the staff. Given the increase in square footage, the required amount of walking for the staff, per shift, was expected to increase significantly. As a result, the NICU staff was anxious about the move to the unfamiliar environment and the potential increased physical demand required performing patient care duties.

To help decrease anxiety, hospital administration thought it was vital for the staff to be given sufficient time and education to transition safely and efficiently to the new hospital. To support the transition, staff received several required online educational programs which included the use of new equipment and a virtual tour of the NICU and the new hospital. When access to the hospital became available, the NICU staff participated in "day in the life" exercises where they practiced the new workflow including finding supplies and equipment and other daily activities. They were also sent on way-finding tours of the new unit as well as locations within the new hospital where patients may need to go for testing, such as the magnetic resonance imaging suite.

To assist in creating a productive workflow, several new technologies were implemented in the new building. These new technologies included a nurse-call system that eliminated the need for overhead pages and nurses walking to find other members of the healthcare team; hallway workstations that allowed nurses to remain within close proximity of their patients; an adjacent labor and delivery suite; refrigerators in each patient room for human milk and formula that eliminated the need for nurses to walk to a central nutrition location; medication storage in individual patient rooms; in-house mobile devices which allowed nurses to receive calls from within and outside the hospital; a real-time staff locating system; and patient monitor waveform displays located strategically within the unit for immediate and convenient viewing.

There were also other significant differences to the work environment including increased natural light throughout the NICU, a quiet space for staff, and lounges for parents and staff, away from, but adjacent to the clinical area.

As staff was eager to quantify the change in workflow, we designed a study to measure the steps taken during a typical NICU shift before and after the move to the new SPR NICU. Our primary interest however was in measuring the health benefits, both physical and psychological, associated with increased daily exercise, if it existed. We were also interested in what difference the change in environment might have on staff mental health as the lack of space and natural light in the old NICU were frequent complaints.

Methods

Nurses, respiratory therapists, and nurse practitioners working more than part-time were enrolled in the study prior to the move to the new SPR NICU location. The NICU is a level IV perinatal center with 45 acute beds that admits more than 730 medical and surgical patients each year. Using a quasi-experimental design, participants were asked to wear a pedometer for 3 consecutive work days, first in the OB NICU 2months prior to the move and again in the new SPR NICU. No additional daily duties were required for bedside staff in preparation for the move. Staff picked up a pedometer (Oregon Scientific PE 320) at the beginning of the shift and returned it to the investigators at the end of the shift. Measurements in the SPR NICU were taken 3months after the move to allow staff to acclimate to the new surroundings.

To evaluate the potential health benefits from increased exercise in the new NICU (if any existed), blood pressure and body weight were measured at the beginning of the study in the OB unit and again after the study resumed in the SPR NICU. Care was taken to perform the measurements at the same time of day for each shift. Blood pressure was recorded using a North American Healthcare TV3649 Wristech monitor. Weight was recorded on the Tanita BWB 800AS Digital Medical Scale; participants were allowed to opt-out of weight measurements and still participate in the study. Participants also completed a brief health questionnaire assessing chronic health conditions, musculoskeletal health, use of weight control and exercise programs outside of work, mental health, and satisfaction with the NICU environment.

The Psychiatric Symptoms Index (PSI) was used to assess mental health. The PSI is a 29 item self-report instrument that measures four primary symptom dimensions: depression, anxiety, anger, and cognitive disturbance. The Index distinguishes those with high versus low symptomatology associated with psychopathology. Participants were asked to indicate how frequently they were bothered by each symptom on a 4 point Likert scale, ranging from 0 (never) to 3 (very often). The index yields a total score as well as scores for each of the 4 subscales. Norms are available from an urban, non-patient population of 2299 households.[2]

Internal consistency, as measured by Cronbach's alpha for the normative sample is 0.91 for the total score and ranges from 0.77 to 0.85 for each of the 4 subscales.

The study was approved by the Institutional Review Board; written informed consent was obtained from participants.

Data were analyzed with descriptive statistics and paired t-tests, for continuous data. Using paired statistics allows each staff member to serve as their own control so that for any given participant work duties and the duration of the shift worked were similar. A multivariable model was used to identify independent predictors of the number of steps taken per shift.

Results

Eighty-one NICU staff enrolled in the study including registered nurses respiratory therapists, and nurse practitioners. Complete data were available for 59/81 (73%) enrollees. Demographic and health characteristics of the participants are shown in Table 1. As expected the majority of participants were female, registered nurses. The proportion of staff reporting chronic health conditions was similar to the rates for women living in the United States, as reported in U.S. Department of Health and Human Services, *Women's Health USA* 2011, with the exception of two conditions: Asthma was 2.5 times more frequent among NICU staff (23.7%) than the national rate (9.2%), and hypertension was lower (13.6%) than the national rate (30%) for women over 18years of age.[3]

Table 1 Demographic characteristics, chronic health conditions and health behaviors of participants

Demographic Characteristics	N %
Ageaa mean (95% CI)	39 (36,42)
Sex (female)	56 (94.5%)
Raceb	
White	49 (83%)
African American	3 (6.8%)
Asian	2 (5.4%)
Other	1 (3.1%)
Profession	
Nurse	53 (89.8%)
Respiratory therapist	3 (5.1%)
Nurse practitioner	3 (5.1%)
Shift worked, days	41 (69.5%)
Chronic Health Conditions	
Hypertension	8 (13.6%)
Asthma	14 (23.7%)
Heart disease	3 (5.1%)
Diabetes	1 (1.7%)
Arthritis	6 (10.2%)
Varicose veins	6 (10.2)
Health Behaviors	
Smokes cigarettes	1 (1.7%)
Wears support stockings	14 (23.7%)
Weight reduction program participation	14 (23.7%)
Fitness program involvement	20 (33.9%)
Exercises 1-2 hours per week or less outside of work	34 (57.6%)
Sleeps 7 hours or less per night	48 (81.4%)

a[3] refused to answer

b[1] refused to answer

Chronic health conditions did not change over the course of the study (data available but not shown), except 2 study participants were diagnosed with hypertension and placed on medication by their primary care physician after high blood pressure readings were noted during the study. As expected, fewer staff reported smoking and more reported participation in fitness programs than the national rate for women, of 22.7% and 14.7% respectively.[3] The use of weight reduction programs, fitness activities, and sleep habits changed for only one participant over the course of the study (data are shown for the first survey only).

As seen in Table 2, participants walked, on average, nearly 900 steps more each day in the SPR NICU than the former OB NICU; physiologic parameters were unchanged. Although the day shift walked more, on average, than the night shift (mean (95% CI): 913 (106, 1720) vs. 417 (887, 1720)), the variability in the number of steps taken was great and so the difference was not statistically significant. In a multiple variable regression model, neither age, race, weight, chronic condition, PSI score, musculoskeletal pain, the shift worked, amount of sleep, nor participation in a fitness program, were independently related to the change in steps taken in the SPR.

Table 2 Change in the number of steps taken each day and physiological measures

	OB	SPR	Difference	p-value
Steps	5185.23	6082.41	897.18 (187.18, 1607.19)	0.014
Systolic blood pressure	118.6	117.66	-0.95 (-3.27, 5.17)	0.65
Weighta	151.14	151.38	0.24 (-2.20, 1.73)	0.81

Data are displayed as mean difference (95% confidence interval)

[a]Weight, n=42

Musculoskeletal pain was a significant problem for NICU staff but the proportion of staff reporting back and lower extremity pain did not differ significantly after the change in work environment for most conditions (Table 3). For those reporting pain, the intensity changed very little with participants reporting an increase or decrease of 1 point, on average, on a 10 point scale (data available but not shown) after the move to the SPR.

Table 3 Proportion of participants reporting musculoskeletal pain and lower leg fatigue and edema

	OB	SPR	p-value
Back pain	14 (24%)	13 (22%)	1
Hip pain	4 (7%)	6 (10%)	0.74
Upper leg pain	4 (7%)	1(2%)	0.36
Lower leg pain	5 (8.5%)	5(8.5%)	1
Knee pain	11 (19%)	14(24%)	0.65
Ankle pain	2 (3.4%)	1(1.7%)	1
Foot pain	5 (8.5%)	7(11.9%)	0.76
Heal pain	5 (8.5%)	8(13.6%)	0.56
Leg fatigue	9 (15.3%)	6(10.2%)	0.52
Leg edema	3 (5.0%)	7(12%)	0.32

The staff was significantly more satisfied with the physical environment of the SPR NICU compared to the OB NICU, as shown in Table 4.

Participants' mental health scores were unchanged after the move to the SPR. As seen in Table 5, there was no change in the Psychiatric Symptoms Index total score or scores for each of the subscales. Scores were however, markedly above the PSI normative sample from an urban adult population.2 Seventy five percent of participants scored above the normative sample mean on the cognitive disturbance subscale; 56% and 52.5% scored above the normative sample mean on the anxiety and depression subscales, respectively. Thirty two percent of participants scored greater than 20 on the PSI, a score highly related to clinical depression.

Table 4 Change in satisfaction with NICU environment

How Would You Rate The Follow Environmental Factors In The NICU?	OB	SPR	Difference	P value
Noise Level	3.69	2.64	-1.05 (-1.35, -0.75)	<0.001
Condition of Staff Lounges	3.78	2.14	-1.64 (-1.92, -1.36)	<0.001
Presence of Natural Light	4.19	1.53	-2.66 (-2.9, -2.35)	<0.001
Charting Space	2.92	1.86	-1.05 (-1.33, -0.77)	<0.001
Amount of Personal Space	3.41	2.05	-1.36 (-1.64, -1.07)	<0.001

Likert scale 1-5, very satisfied to very dissatisfied; lower scores indicate greater satisfaction.

Table 5 Difference in scores on the Psychiatric Symptoms Index (PSI)

	OB	SPR	Difference	P value	Normative sample scores
PSI total score	14.45+10.84	15.22+12.02	0.77+8.75	0.5	10.5+10.7
Cognitive disturbance subscale	23.16+16.31	20.34+17.32	14.02	0.2	12.4+16.2
Anxiety subscale	13.10+12.24	13.20+12.66	0.10+9.42	0.93	7.0+11.3
Depression subscale	13.61+12.58	14.30+14.91	0.68+11.53	0.65	10.4+(13.5
Anger subscale	15.09+ 4.35	17.53+17.08	2.44+12.59	0.15	18.4+17.4

Likert Scale, 0-3 never to very often; higher scores indicate greater symptomatology. Data are displayed as mean ± SD to facilitate comparison to normative sample scores

Discussion

Workflow changed as a result of moving from an OB NICU to a SPR NICU. NICU staff walked, on average, nearly a half mile more per shift. Although walking is the most common form of physical activity for women and has proven health benefits, there was no significant difference in the participants' systolic blood pressure or body weight with increased walking at work. Musculoskeletal complaints were similar before and after the move, and mental health was unchanged, despite a significant increase in exercise and satisfaction with natural light and personal space.[4]

Nurse expectation that the new space would be more physically demanding was not unfounded. In a previous study by Helseth et al.,[5] walking increased for nurses from 5700 steps per shift in an OB NICU to 6500 steps in a SPR NICU; our results were similar. Walsh et al.,[6] found that nursing staff believed that SPRs were more physically demanding because of increased walking. Despite the increased walking per shift, the distance measured by NICU nurses is much less than the 8,747 steps reported for nurses on a standard medical-surgical unit per 12-hour shift. Although there was no measurable change in blood pressure or body weight in our study, the increase in walking per day may have beneficial health effects over time. In a literature review, Golay et al.,[7] demonstrated improved health through small lifestyle changes such as 15minutes of increased exercise per day with

respect to diabetes risk, and cardiovascular health. Individuals that walk more than 5000 steps per day also have lower cardiometabolic risk factors.[8]

Excessive walking can cause increased fatigue, pain, edema, and aggravate underlying orthopedic problems in the lower extremities.[4] In our study musculoskeletal pain was a significant problem for NICU staff in general both in the OB and SPR NICU; however there was no significant difference in reported complaints between the NICU designs. A review of the literature on walking found reduced symptoms of musculoskeletal disorders.[9] A study by Chiu and Wang found differences in shoes and wearing compression hosiery reduced muscle fatigue in the calf, lower back pain, knee pain and heel pressure, and reduced ankle discomfort.[10] We did not consider shoe choice in our study; only 14 participants reported wearing support stockings.

Hypertension remains a significant health problem in the United States. The prevalence of hypertension among adults in the United States is 30%.[4] Among those with uncontrolled hypertension; nearly 40% are unaware of their hypertension,4 as was the case for 2 enrollees placed on an anti-hypertensive medication as a result of participation in our study. A simple periodic blood pressure screening of NICU nurses during work hours could improve the health of the nursing work force.

The NICU staff was significantly more satisfied with the amount of personal space, noise level and natural light in the new SPR NICU compared to the traditional OB NICU. The traditional OB NICU had very little space to accommodate the patients, medical equipment, families, and staff within the same environment; as a result the space was cramped and noisy with noise level exceeding the recommended level for high-risk infants.[11] The new SPR unit was developed with sound reduction in mind: sound-absorbing ceiling tiles, sound dispersers suspended from the ceiling to intercept sound as it travels down the hallway, and rubberized floors were installed to decrease the noise caused by walking and moving equipment throughout the unit. Sound-absorbing surface materials also improves speech intelligibility of people nearby and the speech privacy for people at a distance, by reducing reverberation.[12] In addition, the overhead paging system in the OB unit was replaced with in-house mobile devices.

The presence of windows in the workplace and access to daylight has been linked to increased satisfaction with the work environment.[13] Studies have shown that there are physical and psychological benefits of natural lighting including reducing depression, heart rate regulation, improving alertness, cognition, and mood.[14,13] Increased natural lighting was incorporated in the SPR NICU design by locating windows throughout the unit, including patient rooms and staff lounges. Windows also allow contact with the outside living environment, which has been found to be an important psychological benefit for workers.[15]

Despite greater satisfaction with the new work environment and increased exercise, participants did not have improved mental health, as measured by the PSI. The high stress work environment and moral distress experienced by ICU nurses contributes to poor mental health and the high level of burnout reported by hospital nurses.[16,17] Evidence of increased risk of anxiety and depression has been reported for pediatric and critical care nurses. Mealer et al.,[18] found that among ICU nurses, 18% reported anxiety and 12% reported depression, as measured by the Hospital Anxiety and Depression Scale (HADS). Jasper et al.,[19] reported that 10% of ICU nurses had symptoms indicating anxiety and depression and scored significantly higher on the HADS depression subscale than healthy controls in the general population.[18] In a study by Letvak, 18% of hospital nurses had depressive symptoms.[19] A larger proportion of our study participants reported symptoms associated with anxiety and depression than in these studies, which is a cause for concern; our results are similar to the proportion of Japanese nurses (31%) reported to be affected.[20]

Recent work has shown that system factors beyond patient care may play a significant role in nurses' health. The Nurses' Health Cohort found working environments associated with demanding jobs and little control and social support in their work places negatively affected nurses' functional health status.21 A high effort-reward imbalance (the balance of job demands with compensation, work esteem, and job security) is associated with poorer mental health in nurses.[18,20] Given the present economy and increased demand on healthcare workers our results may not be surprising. Additional work is underway to understand if institutional factors such as perceived support by administration and communication patterns within the NICU contribute to the high level of anxiety and depression seen in this study. As better mental health is related to improved job satisfaction and less burnout among nurses, and to improved patient satisfaction with health care, which is now a publically reported quality of care metric, addressing the mental health of the nursing workforce is critical.

Many changes took place as a result of the transition from the OB NICU to the SPR rooms which may have affected the study results. As staff is assigned parking garages throughout the campus, the move to the new Children's Hospital may have brought some staff closer to their parking space, decreasing the total amount of steps taken during the work day. We did not measure the number of steps to and from the garage. Simply wearing a pedometer has been shown to increase the number of steps taken but it may take more than 2500 extra steps each day to lower body weight and blood pressure.[8] An unexpected change was the social isolation nurses feel in the SPR environment, which was anecdotally reported to the investigators. Nurses reported feeling uneasy as a result of being unaware of what is happening throughout the NICU, and of feeling "trapped" by difficult family members without having colleagues nearby to observe interactions and help alleviate tension when needed. These unintended consequences need further investigation and may adversely affect nurses' mental health.

Conclusion

Single patient room NICU designs may increase the physical demand on the staff but does not result in increased physical complaints or improved physiologic indices. Psychological distress however maybe be increased by perceived social isolation. An increase in personal and work space, exposure to natural light and reduced work noise, did not contribute to improvement in staff mental health. Anxiety, depression, and cognitive disturbance (trouble concentrating, difficulty making decisions), were significant problems for study participants. These psychological symptoms may be related to moral distress due to the suffering of patients and families in an ICU, or institutional factors such as work shift requirements, salary support, professional recognition, or both. Neither of these categories of work stressors will likely be alleviated by NICU design. Hospitals that are renovating or building new NICUs, may wish to spend time identifying factors related to staff dissatisfaction and address these issues prior to occupying a new space.

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Conflicts of interest

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