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Title: NICU nurses' stress and work environment in an open-ward

compared to a combined pod and single-family room design

Running head: NICU design

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Abbreviations:

NICU: Neonatal Intensive Care Unit

SFR: Single family Room

OW: Open ward

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Abstract

Background: The architectural design of a Neonatal Intensive Care Unit (NICU) may affect the quality of the work environment for nurses, yet few studies have been conducted using reliable and valid measures. Recent studies have suggested some drawbacks of single-family rooms (SFRs) for both infants and parents. Research is needed to explore nurses' work environment in units combining pods and SFRs.

Purpose: To compare NICU nurses' work stress, satisfaction, obstacles, support, team effectiveness, ability to provide family-centered care, and satisfaction with noise, light and sightlines in an open ward (OW) to a new unit of pods and SFRs.

Methods: A pre-post occupancy study was conducted in a level 3 unit before and after transitioning to a new unit of 6-bed pods and SFRs.

Results: There were no significant differences in nurse stress, satisfaction, support from colleagues, perceptions of team effectiveness and ability to provide family-centered care between the OW and the pod/SFR unit. Organizational obstacles, such as difficulties obtaining information from colleagues, were significantly lower in the pod/SFR. In contrast, environmental and technology obstacles were greater in the new pod/SFR unit.

Implications for practice: Some specific aspects of the pod/SFR unit are optimal for NICU nurses, while other aspects of the OW are perceived more favourably.

Implications for research: Studies are needed to examine the isolation the nurses may experience in SFR units, as well as strategies to reduce isolation.

Keywords: NICU, design, nurses, stress, support, job satisfaction, family-centered care

Introduction

The architectural design of a Neonatal Intensive Care Unit (NICU) may affect the physical and psychological health of newborns, their parents, and also nursing staff.[1] Open wards (OW) or bays contain many incubators in one large space and this design enables nurses to readily monitor fragile newborns. A pod design (i.e., a cluster of 4 to 10 incubators in one space) can offer more control than an OW over environmental factors, such as noise, that may affect the well-being of infants, staff and parents. However, like the OW, several infants and their parents share space. Single patient or family rooms (SFRs) may allow greater control over the environment and greater privacy. In North America, there has been a boom in new NICU construction as well as the renovation of existing units,[2] while in developing countries, new units are being constructed where none existed. NICU construction and renovation are expensive.[3] The trend in architectural design has been to replace OWs with units of SFRs.[4, 5]

Despite extensive debate, relatively few systematic studies examine how design configuration relates to the well-being of nurses.[6-8] While some studies examine one or more units before, and after, a transition to a new unit with a different architectural design; others compare units at one hospital with one type of design to a unit at another hospital with a differing design. The quality of existing studies is often weak as sample sizes are small, participation rates low, attrition a problem, and the validity and reliability of study measures unknown.[8-14] A review of studies conducted between 2001 to 2011 concluded that communication and interaction among staff and the ability to monitor multiple infants simultaneously were considered by staff to be better in OW NICUs compared to SFRs.[6] A recent survey of NICU nurses before and after their move to a new SFR unit from an OW found that nurses' reported that their ability to control

their workspace, privacy, teamwork and family-centered care were better in the SFR unit, and there were fewer work interruptions.[15]

A previous study that utilized valid and reliable measures, albeit with a small number of participants per group (e.g., 16 - 22), compared three groups of nurses: a group at hospital 1 who transitioned from an OW to a unit of only SFRs; a second group at hospital 2 who transitioned from an OW to a combined OW/SFR unit but worked in the SFR area exclusively, and a third group from hospital 2 who worked exclusively in that unit's OW. Post-occupancy, overall stress was lowest for nurses working in SFRs at hospital 1; and was significantly lower for nurses working in hospital 2's SFR area compared to nurses in hospital 2's OW.[16] The same pattern of findings was observed for job satisfaction: satisfaction was greatest for nurses working at hospital 1 (only SFRs), compared to hospital 2's SFRs and hospital 2's OW. In sum, these results suggest overall that a SFR design may be less stressful and more satisfying to work in than an OW for NICU nurses. However, these findings may reflect other differences between these hospitals other than design.

There is some evidence that nurses' perceptions may change over time after moving to a new unit. Three months post-transition, nurses found a new SFR unit more stressful compared to their previous OW.[8] However, 18 months post-transition, perceptions of the SFR unit were more favourable, yet still not as positive as the OW. Others too have found that nurses' perceptions are most favorable soon after the move but level off over time in the new design.[15] Others also noted an improvement in perception of teamwork 1 to 8 months post-occupancy.[14] These data point to the importance of assessing nurses after they have time to adjust to the new design. Indeed, architectural research recommends that post-occupancy assessments be conducted at least one year after the transition.[16]

Early in 2016, the OW of a Canadian urban level 3 NICU moved to a new unit with both pods and SFRs in a newly constructed critical care wing. They were supported by a project management team from their organization which provided logistical, clinical and moving planning. This event provided an opportunity to conduct a study to examine the effect of design on nurse well-being. This study improved upon previous work by using reliable and valid measures of the constructs of interest and including a sufficient number of participants. The purpose of our study was to compare nurses' job stress, work obstacles, ability to provide family-centered care, work satisfaction, satisfaction with noise and light in their unit, team effectiveness and support in the OW to the pod/SFR. Specifically, based on past research that showed the impact of NICU design on nurses stress as well as on their perceptions of key elements of their work environment (such as communication with colleagues and team effectiveness, ability to provide family-centered care and overall satisfaction)[6, 8, 10-15] we hypothesized that nurses would report lower job stress, fewer obstacles to providing care, greater ability to provide family-centered care, and greater work satisfaction due to greater control over their work environment in the pod/SFR one year after their transition. As well, we expected there would be greater satisfaction with noise and light levels in the pod/SFR unit compared to the OW. However, based on findings of previous studies, we expected that team effectiveness and support would be lower in the pod/SFR compared to the OW perhaps due to a decrease in communication.

Lastly, we wished to explore adverse events in the OW compared to the pod/SFR unit as the new design may decrease work interruptions, resulting in fewer adverse outcomes linked to interruptions, particularly medication errors. Previous studies have shown that nurse colleagues are a common source of work interruptions during medication administration, and that interruptions during medication administration may significantly increase the risk of medication

errors.[17-19] With a reduction in interruptions from other nurses, we expected to see a decrease in medication errors among nurses working in this unit.

Methods

Design

A pre-test/post-test design study was undertaken. Following research ethics approval (Federal Assurance Number 0796), data were collected in the OW unit in the summer of 2014. The pod/SFR was scheduled to open in mid-2015, however this was delayed until January 2016. Post-occupancy data were collected in the first 3 months of 2017, twelve months after the transition. In both units, parents can visit 24 hours per day, and family-centred care is provided. The former OW was a 34-bed level-3 unit of 400-m^2 with around 550 admissions per year, including about 115 infants born very low birthweight. Six neonatologists and 94 nurses were on staff. The OW had florescent lighting and windows on only one of the four walls. There was one room designated for mothers to express breast milk, and a parent room with one sofa bed for over-night stays.

The current 1125-m^2 pod/SFR unit is located in a recently constructed hospital wing, and has new ventilators, monitors, and robotic arms. The design is a combination of five 6-bed pods and 10 SFRs, thus there is space for 40 beds. However, due to funding it remains a 34-bed unit with the same volume of admissions per year. Two SFRs are in an area designated for isolation, whereas the other eight are in another area dedicated to step-down care. Newborns are admitted to a pod for acute and intermediate care and moved to a SFR for step-down care as they near discharge. The nurse-patient ratio remained unchanged, and is 1:2 in acute care, 1:3 in intermediate care, and 1:4 in step-down. The active staff at the time of data collection included seven neonatologists and 91 nurses who work in both pods and SFRs. The lighting is indirect

florescent, and in all the pods there are large windows with blinds for light control. There are two rooms dedicated for parents to sleep overnight on a full-size bed, and in the SFRs a parent lounger chair can also be used for overnight stays. To communicate between pods, nurses use the telephone, walk if they can leave the pod (e.g., there is another nurse present), or send a text message. There are also portable phones provided to key staff persons to utilize for communication in the case of emergencies.

Measures

Nurse stress

The Nurse Stress Scale (NSS)[20, 21] is the gold standard in the measurement of nurse stress and measures the frequency and sources of stress experienced by nurses in hospitals. We used the 48-item version[16] which includes nine subscales: workload, problems with supervisors, conflict with physicians, problems with peers, inadequate preparation, death and dying, patients and families, discrimination, and uncertainty concerning treatment. A 4-point Likert scale is used to indicate the frequency of stressors from "never" to "very frequently". Higher scores indicate greater stress. Reliability is very good, and validity established. Other measures assessed nurses' perceptions of the quality of their work environment.

Work obstacles

The Performance Obstacles ICU Nurses questionnaire[22, 23] assesses factors that impede intensive care nurses' ability to provide care. There are four subscales: tasks (e.g., dealing with family needs), organization (e.g., locating charts), environment (e.g., insufficient space), and technology and tools (e.g., obtaining equipment). Twenty-two items ask respondents to rate the extent to which they encountered these obstacles in the past month on a 5-point scale ranging from "strongly disagree" to "strongly agree". Higher scores reflect greater obstacles.

Family centered care

The Family Centered Care Questionnaire – Staff (FCC) assesses health professionals' perception of their ability to provide a child and their family with family-centered care during hospitalization.[24] This self-report measure consists of 20 items that tap three aspects: respect, collaboration and support. Validity and reliability are adequate. All items were answered on a 4-point scale ranging from "never" to "always". Higher scores reflect a more favorable perception of the unit's ability to provide family-centered care.

Work satisfaction

The Global Measure of Work Satisfaction[25, 26] is a 4-item reliable and valid measure of overall job satisfaction. Respondents indicate how satisfied they are with work and their co-workers on a 5-point scale ranging from "strongly disagree" to "strongly agree". A sample item is: "I feel very satisfied with my job". Higher scores are indicative of greater job satisfaction.

Support

Nurses' support was measured with the support subscale of the Job Content Questionnaire (JCQ).[27] Eleven items tap emotional, instrumental, and conflict support on a 4-point scale ranging from "strongly disagree" to "strongly agree". One subscale summarizes support from colleagues and the other from superiors. Higher scores indicate greater perceived support. Validity and reliability have been demonstrated.[28,29, 30]

Care team effectiveness

A subscale of the Team Effectiveness Tool assessed nurses' perception of their health care team's ability to address patient satisfaction with care.[31, 32] Five items are rated on a 5-point scale ranging from "agree" to "disagree". For example, one item asks: "The unit uses data from patients or parents to improve services". Lower scores indicate that the team is more effective.

Satisfaction with noise and light in the unit

Nurses' satisfaction with noise, light and sightlines was measured with our adaptation of Walsh's questionnaire which was developed to survey NICU staff about the appropriateness of noise and light for parents and infants and their satisfaction with noise and light for staff.[33] Satisfaction with noise was assessed with three items (e.g., "The sound level is satisfactory for parents") and satisfaction with light included four items (e.g., "The light level is appropriate for babies"). At the post-occupancy data collection, nurses were asked to rate their perceptions the new unit's pod and SFR areas separately. At both times, they also responded to six items we included to tap nurses' satisfaction with sightlines (e.g., "I can easily see and observe the babies"). Responses to all these items were made on a 5-point scale ranging from "strongly disagree" to "to strongly agree", and higher scores reflect greater satisfaction with these aspects of the work environment.

Other data collection tools

At the end of these standardized questionnaires, two open-ended questions invited comments from participants about what they liked and what they would like to see changed concerning their new unit. For purposes of sample description, we also collected data on nurses' age, sex, education, years of practice in the NICU and overall; as well as hours worked per week using a demographic questionnaire. Pilot work showed that all these questionnaires could be completed in less than 20 minutes.

Lastly, to explore adverse events in the OW compared to the pod/SFR unit we examined the data on such events routinely collected in standardized incidents reports by the hospital administration, classified and stored in a central database. Since the most frequent adverse events

in this NICU are medication, diet (e.g., infant receives incorrect breast milk or formula) and treatment related; we obtained and reported on these specific events.

Sample inclusion and procedure

Staff were invited to participate if they were registered nurses, had worked in the unit for at least 3 months at the time of data collection, and worked at least one shift per week. Only nurses were studied as there are few physicians on staff. Following research ethics approval at the study site, research staff attended meetings, rounds, and change of shift to describe the study. Nurses who agreed to participate provided informed written consent and if they wished to complete questionnaires on-line were issued access to an on-line secure website address that meets the privacy standards of local research ethics committees. Paper questionnaires were available to those who preferred. Nurses were able to complete questionnaires at work or home, and those who did so received a $20 gift certificate as a token of appreciation for their time.

Data analysis

The online survey had the advantage of minimizing missing answers which resulted in minimal missing data: 0 to 4.7% of all items at Time 1 were missing and 0 to 4.0 % at Time 2. If any participant failed to complete several items on a questionnaire, they were excluded from the analyses pertaining to that specific variable but were nonetheless included in analyses pertaining to variables for which they provided all responses. We examined skewness statistics for all variables and the only variables with a value above 1.00 were the NSS discrimination subscale at both times and sightlines at T2.

Socio-demographic variables were examined with descriptive statistics. The OW and pod/SFR unit nurse data were compared with paired-sample t-tests. To conduct paired-sample t-tests with a medium effect size, an alpha of 0.05 and a power of 0.95, a minimum sample size of

45 individuals is necessary (G*Power Version 3.1.9.2). Cohen's d[34] was computed by calculating the difference between two means divided by their standard deviation. Because the present analysis are within-subjects, the correlation between the two means was added to the equation to correct for the dependence among means[35](equation 8).

Responses to open-ended questions were analyzed using content analysis and frequencies of main categories reported. To explore adverse events occurring in the OW compared to the pod/SFR unit, data from hospital records were obtained and an average monthly number of events calculated. The percentage change in adverse events from the OW to pod/SFR was calculated with the following equation ((1- post-move/pre-move) *100). All analyses were conducted with SPSS statistical software version 20 (IBM Corp: Armonk, NY).

Results

Sample characteristics

Eighty-six nurses completed the questionnaires in the OW phase (91% rate of participation), and 78 twelve months after the transition into the pod/SFR unit (86%). Fifty-four nurses completed data collection at both times and this paired-data was used for the analyses. We also conducted the analysis comparing all participating nurses in the OW to all participating during the pod/SFR phase, and findings were similar.

The 54 participants who took part both pre- and post-transition were 52 females and 2 males. At the time of pre-transition data collection in the OW their mean age was 32.94 years (SD = 9.8). A total of 70.4% had a bachelor's degree, 14.8% Masters' and 14.9% a technical college diploma. The mean number of years spent working in this NICU was 8.33 (SD = 8.07), while the mean number of years working as a nurse was slightly longer at 9.91 (SD = 9.49). Half

the sample were employed full-time. Regarding work schedule, 75.6% worked rotating day and evening shifts, and 24.4% worked days and nights.

Table 1 presents the pre- and post-transition means, and t-test results. There were no significant differences in nurses' total stress, nor any of the nine specific sub-dimensions of stress between the OW and pod/SFR.

Although the total obstacles mean scores were no different in the new pod/SFR unit compared with the OW, significant differences were found on three of the four obstacle subscales. While organizational obstacles were significantly lower in the pod/SFR unit compared to the OW; environmental and technology obstacles were greater in the new pod/SFR unit. There was no difference in task obstacles.

No significant differences were found in team effectiveness, work satisfaction, family-centred care, and support received from colleagues. However, there was a significant difference in support received from supervisors: it was higher in the pod/SFR.

Recall that nurses were asked to report their satisfaction with noise, light and sightlines in both the pods and the SFRs of their new unit. Satisfaction with noise was significantly better for both pods and SFR areas of the new unit compared to the OW (Table 2). Nurses were also significantly more satisfied with the light in the pods, as well as the SFRs. In contrast, there was no difference in satisfaction with light or noise in the SFRs compared to the pods of the new unit. Regarding sightlines, there was no difference in satisfaction between the OW and the new pods; however, nurses were less satisfied with the SFRs compared to the former OW. Comparing the pods to the SFR areas of the new unit, nurses were significantly more satisfied with sightlines in the pods (Table 2).

At the study site, data are routinely compiled on adverse events for the hospital's fiscal year (April through March). The pre-transition OW data presented in Table 3 corresponds to the fiscal year prior to the move (April 2014 to March 2015), while the post-transition data in the pod/SFR includes events occurring in the 22 months afterwards (April 2016 to January 2018). As shown in Table 3, an overall reduction in recorded events was observed, from a monthly average of 15.33 events in the OW to 8.64 in the pod/SFR unit. Medication, diet and treatment error adverse events all declined in the pod/SFR unit compared to the OW (61%, 75%, and 52% respectively).

Most nurses shared comments concerning what they liked about the pod/SFR unit. More than half of those who commented appreciated the lower noise level, with some adding that they felt less fatigued at the end of their shift or had fewer headaches (Table 4a). A variety of positive impacts for infants and their families; including better provision of developmental care and greater privacy were reported by 13%. Almost all the participants described what they did not like (Table 4b). Undoubtedly the most common concern was feeling isolated or lonely in the new unit (48%), and a related concern about lower staff cohesion. Issues related to supplies; such as lack of, or difficulties accessing items needed; and challenges with the organization of work such as making patient assignments were also evident.

Discussion

Our study provides insights into NICU nurses' work-related stress and perceptions of the quality of their work environment in units of differing designs. Contrary to what was hypothesized based on previous evidence, in this study there were only a few significant differences observed in nurses' work-related stress and perceptions of their work environment before and after this unit's transition from an OW to a pod/SFR design. We found no significant

differences in nurses' job stress, team effectiveness, work satisfaction, and extent to which the staff felt able to provide family-centred care. The timing of our measurements post-transition might be important to consider as we purposefully assessed nurses one year after the transition to allow time for staff to adjust to their new circumstances. Van den Berg et al.[36] found that although nurses' job strain had increased pre-to post-transition, by two years it had returned to pre-occupancy levels. The pattern of significant differences we did find was mixed: NICU nurses found some aspects of the pod/SFR unit optimal, while other aspects of the OW were viewed more favourably. This conclusion is congruent with Smith and colleagues'[37] study of five pediatric critical care units transitioning to SFR design.

In the current study, we found that total work obstacles were no different from nurses' perspective in the pod/SFR unit compared to the OW (Mean = 61.5 versus 58.4). It is noteworthy that scores on this measure can range from 22 to 110, thus obstacles were not high in either environment. Nonetheless, we found that nurses who worked in both units reported greater environmental and technological obstacles in the pod/SFR unit compared to the OW, but fewer organizational obstacles. To better understand why there might be greater environmental obstacles in the pod/SFR unit, we examined the mean scores for each item in this subscale and found that the question concerning the distance between isolettes contributed to this finding. In the former OW unit, isolettes were typically only a few feet apart; whereas in the new pods and SFR areas distances are much greater. Previous studies of SFR units have found that increased walking due to greater distances is an issue for nurses,[6] and this might apply to nurses adjusting to a more spacious pod/SFR unit after working in an OW with much less square footage.

Nurses reported greater technological obstacles in the pod/SFRs. Technological obstacles include how easy it is to locate equipment or supplies, and how well supplies are stocked.

Indeed, when asked about their likes and dislikes concerning their new unit, problems with supplies not being adequately stocked was cited by 20% of those who commented. In the pod/SFR unit, supplies were decentralized in each individual pod and SFR. The unit's nurse manager was aware of this problem and staffing for stocking was increased. In sum, our findings concerning environmental and technological obstacles are consistent with Smith's study of SFR units[37]: challenges for ICU nurses were too much walking and inadequate stocking of supplies.

In contrast, in our study nurses reported fewer organizational obstacles in the pod/SFR unit. Organizational obstacles include nurses' ability to obtain information from others (e.g., the quality and length of report), particularly at change of shift. In this new pod/SFR unit, nurses can sit one-on-one at a desk area near the infants' bedside for report at change of shift, and their ability to acquire and exchange information may be improved in this new environment. It is noteworthy that our measurements of noise (in decibels (dB)) in former OW taken while data collection was underway showed that it was particularly high (e.g., 60 – 62 dBs) at change of shift where staff congregated for report compared to 48 – 53 dBs in various areas of the current pod/SFR unit. Interestingly when we conducted the independent samples analyses this was the only finding concerning nurses' perceptions of their work environment that differed. When all the nurses who participated in the OW were compared to all those who participated in the pod/SFR unit, we found no significant difference in organizational obstacles. This full sample included new nurses who were hired after the transition to the pod/SFR unit. They may have reported fewer obstacles because they did not have a point of comparison since they had never worked in the OW.

Moreover, support received from colleagues was no different in the pod/SFR compared to the OW. The measure we utilized addresses the overall quality of the relationships with other staff;

not isolation from other staff specifically, nor adequacy of staffing. In prior studies, nurses in a SFR unit compared to an OW have reported that their colleagues are less available,[9] and they are less satisfied with interactions with other team members.[12-14] Twenty nurses commented about feeling isolated, and we did find that nurses' work satisfaction decreased but not significantly. It is important to highlight that 79% of our sample is from Generation Y (born 1980 - 2000). This is much higher than the overall average (29%) for nurses in the Canadian workforce.[38] Generation Y values collaboration, seeks continuous training, mentoring and career development[39, 40]; and connection with others and the emotional aspects of work are of importance to them.[41] These values are reflected in the comments made in response to the open-ended questions.

We also found that nurses reported a greater level of support received from their supervisors in the pod/SFR unit. In the former OW, the manager and other nurse leaders' offices were located on another floor of the hospital; whereas in the current SFR their offices are centrally located within the unit and adjacent to several pods. Their greater visibility may contribute to nurses' feeling greater support from the leadership group. Moreover, there were many practical strategies employed to address issues that arose in the first several months after the move to the new unit. For example, nurses were encouraged to post any challenges they encountered anonymously on a special bulletin board, and the leadership posted solutions they were implementing to address these. This may have augmented nurses' perceptions of support from their leaders at a critical time in their transition.

Our findings concerning noise and sightlines are consistent with the reported benefits and limitations of SFRs. Nurses in our study were more satisfied with noise and light levels in the pods and SFR area of the new unit compared to the former OW. Sightlines in the SFR area were

reported to be poorer, and this is not surprising as in the study unit there is a turn in the hallway and nurses are unable to see into all rooms from any one point. Sightlines are of importance to critical care nurses.

Our observation that the rate of medication errors decreased in the pod-SFR unit is supported by research in other settings, which has shown lower rates of medication errors in units with SFR rooms.[41, 42]. In a review of the literature, Chaudhury et al.[41] found five studies in which medication errors occurred less frequently in SFR than in rooms with multiple patients. In one study, medication errors were reduced by 67% after an acute care unit made the transition to all SFRs[42]; and we observed a 61% decrease at our study site. Moreover, based on the literature, as well as interviews and focus groups with nurses; Chaudhury et al.[43] recommended SFRs as strategy for reducing noise in the work environment, thereby reducing staff stress and fatigue, two other important contributors to medication errors.

Diet errors also decreased after the move to the new unit. The change in unit design coincided with a change in the storage of mothers' breastmilk. In the OW, all breastmilk was stored centrally in two large refrigerators. In the current pod/SFR unit, there are smaller refrigerators in each pod, as well as a small refrigerator in each of the SFRs. This change in organization might have contributed to the reduction observed in diet errors. Qualitative interviews with the nursing staff would have been beneficial to provide further insights into what drove the reduction in errors we found.

Strengths and Limitations

A possible limitation of our study is that we may not have fully captured some of the challenges or benefits for nursing staff in the pod/SFR unit because the variables of interest were measured with generic, reliable and valid questionnaires not specifically designed to capture

challenges or improvements that might arise specifically in the transition to a new unit. Responses to the open-ended questions revealed improvements and concerns not captured by the questionnaires. It is important to note that we deliberately collected data 12 months after the transition to the new unit to allow time for adaptation, however as a result we may have not captured some of the differences that might have been evident in the early months after the transition. Strengths of this investigation are the high rate participation at both times, the size of the sample, the inclusion of nurses who worked in both units and could compare their work-related stress and perceptions of their work environment in both, and the use of well-established, reliable and valid measures of the constructs of interest.

In conclusion, this study found that NICU nurses considered some specific aspects of the pod/SFR unit optimal, while other aspects of the OW were perceived more favourably. It is likely that each type of design has both advantages and disadvantages for nursing staff, as well as infants and their parents. Our study points to some of the challenges that nurses who practice in pod/SFR type units might encounter that managers might want to anticipate. Future research should continue to explore nurses' work-related stress and perceptions of their work environment in units combining pods and SFRs as recent studies have suggested some drawbacks of NICUs consisting of only SFRs for both infants and parents,[15, 44, 45] thus it is likely that some decision-makers may be opting for a combination design going forward. A fuller and better understanding of the advantages and disadvantages of diverse unit designs for infants, parents and staff is needed.

Conflict of interest

The authors declare that they have no conflicts of interest to report.

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What this study adds:

NICU nurses reported no significant differences in their job stress, their team's effectiveness, their work satisfaction, and extent to which they felt able to provide family-centered care in a combination pod and SFR unit compared to an OW.

NICU nurses found some aspects of the pod/SFR unit optimal, while other aspects of the OW were viewed more favorably.

The rate of medication errors decreased in the pod-SFR unit compared to the OW unit.

Summary of recommendations for practice and research

What we know	Communication and interaction among staff and the ability to monitor multiple infants simultaneously are considered by staff to be better in open ward NICUs compared to single family rooms. After a move to a new unit, nurses may need time to adjust to the new design.
What needs to be studied	More studies on the isolation nurses may experience in pods or single family rooms, and strategies to reduce isolation. Additional studies on adverse events in NICUs of differing designs is needed.
What we can do today	In units where equipment and supplies are decentralized, ensure that nurses can easily locate needed equipment and supplies, and ensure that supplies are adequately stocked. Managers should collaborate with nursing staff to develop strategies to reduce the isolation from their colleagues that they might experience. When designing new units, attend to sightlines. When sightlines are not optimal, ensure that there are other mechanisms for nurses to adequately supervise infants.

Table

Table 1: Nurses in the open ward compared to the pod/SFR unit (n = 54)

	Possible range	Open ward		Pod/SFR					
		M	*SD*	*M*	*SD*	*df*	*t*	*p*	Cohen's *d*
Nurse stress scale									
Total stress	0 - 4	1.68	0.51	1.69	0.56	52	-0.14	.88	-0.02
Workload		1.92	0.56	2.03	0.53	52	-1.41	.16	-0.21
Problems with supervisors		1.46	0.79	1.45	0.87	52	0.09	.93	0.01
Conflict with physicians		1.54	0.71	1.64	0.76	52	-1.15	.26	-0.14
Problems with peers		1.39	0.52	1.34	0.58	52	0.62	.54	0.08
Inadequate preparation		2.19	0.76	2.08	0.82	52	0.83	.41	0.11
Death and dying		2.03	0.66	2.04	0.61	52	-0.05	.96	-0.02
Patients and families		1.85	0.77	1.79	0.81	52	0.52	.61	0.07
Discrimination		0.35	0.53	0.41	0.53	52	-0.76	.45	-0.10
Uncertainty concerning treatment		1.95	0.64	1.90	0.72	52	0.64	.53	0.08
Performance obstacles									
Total obstacles	22 - 110	58.39	10.59	61.47	11.83	52	-1.95	.06	-0.27
Tasks	4 – 20	10.83	3.10	11.81	2.68	52	-1.89	.07	-0.26
Organization	7 – 35	17.11	3.97	15.66	4.03	52	2.80	.01	0.38
Environment	4 – 20	11.19	2.39	12.40	3.08	52	-2.42	.02	-0.34
Technology and tools	7 – 35	19.26	5.46	21.60	5.53	52	-2.88	.01	-0.40
Support									
Support from colleagues	1 – 4	2.98	0.32	2.97	0.33	53	0.26	.80	0.03
Support from supervisors	1 – 4	2.95	0.20	3.13	0.49	53	-2.41	.02	-0.36
Team effectiveness	5 - 25	13.15	3.75	13.98	4.83	52	-1.29	.20	-0.18
Global work satisfaction	4 - 20	14.38	2.59	13.57	3.26	52	1.61	.11	0.22
Family centered care									
Respect	1 – 4	3.17	0.39	3.12	0.44	51	0.77	.45	0.11
Collaboration	1 – 4	3.12	0.43	3.14	0.42	51	-0.37	.72	-0.05
Support	1 – 4	2.83	0.38	2.77	0.48	51	0.90	.37	0.12

Table 2: Comparisons nurses' satisfaction with noise, light and sightlines (n = 53)

	Open ward			Pod/SFR					
	M	*SD*		*M*	*SD*	*df*	*t*	*p*	Cohen's *d*
Satisfaction with noise, light, and sightlines									
Noise	5.17	1.95	Pod	12.35	2.64	51	-15.73	.001	-2.21
Noise			SFR	12.44	2.68	51	-16.61	.001	-2.34
Light	10.04	2.59	Pod	16.98	3.24	51	-11.55	.001	-1.61
Light			SFR	17.04	2.95	51	-12.87	.001	-1.79
Sightlines	22.83	4.38	Pod	24.10	5.14	51	-1.47	.150	-0.21
Sightlines			SFR	15.75	6.81	51	6.58	.001	0.94
	Pod			SFR					
	M	*SD*		*M*	*SD*	*df*	*t*	*p*	Cohen's *d*
Satisfaction with noise, light, and sightlines									
Noise	12.34	2.62		12.45	2.66	52	0.27	.788	-0.04
Light	16.98	3.21		17.06	2.92	52	0.21	.836	-0.03
Sightlines	24.09	5.09		15.70	6.75	52	-9.49	.001	1.40

Notes: Noise scores can range from 3 to 15, light scores from 4 to 20, and sightlines from 6 to 30. Higher scores indicate greater satisfaction.

Table 3: Average number of adverse events reported monthly		
Type of adverse event	Open ward unit	Pod-SFR unit[1]
Medication	6.17	2.41
Diet	2.67	0.68
Treatment	2.25	1.09
Total events	15.33	8.64
[1] Includes a period of 22 months after the transition into the new unit.		

Table 4a: What nurses liked most about the pod/SFR unit (n = 45)		
Issue	n	%
Less noise	28	62.2
More space	14	31.1
Light	8	17.8
Less chaotic	6	13.3
Positive impact for infant and family	6	13.3
Positive impact for nurses	3	6.7

Table 4b: What nurses liked least about the pod/SFR unit (n = 50)		
Issue	n	%
Loneliness	24	48.0
Supplies (availability)	10	20.0
Work organization challenges	5	10.0
Safety issues	4	8.0
Work relationships (less cohesion)	3	6.0
Sightlines	2	4.0