

A comparative study of occupancy and patient care quality in four different types of intensive care units in a children's hospital¹

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Abstract. This paper reports a comparative study of occupancy and patient care quality in four types of intensive care units in a children's hospital; an Infant Care Center (ICC), a Medical/Surgical (Med/Surg) unit, a Neonatal Intensive Care Unit (NICU), and a Pediatric Intensive Care Unit (PICU), each featuring a mix of multi-bed and private room (PR) patient care environments. The project is prompted by interest by the project sponsor in a pre-occupancy analysis, before the units are upgraded to exclusive PR designs. Methods comprised, for each unit: (1) observations of ergonomic design features; (2) task activity analyses of job performance of selected staff; and (3) use of a survey to collect perceptions by unit nursing and house staff (HS) of indicators of occupancy and patient care quality. *Conclusions:* (1) the five most common task activities are interaction with patients, charting, and interaction with equipment, co-workers and family members; (2) job satisfaction, patient care, work environment, job, patient care team interaction, and general occupancy quality rankings by ICC and/or NICU respondents are significantly higher than those by other staff respondents; and (3) ergonomic design shortcomings noted are excess noise, problems with equipment, and work environment, job-related health, and patient care quality issues.

Keywords: intensive care, private room design, occupancy quality

1. Introduction

This report describes methods, results and conclusions for a comparative study of occupancy and patient care quality in four different types of intensive care units of a children's hospital in the U.S. upper midwest. These units are: (1) an Infant Care Center (ICC); (2) a Medical/Surgical (Med/Surg) unit; (3) a Neonatal Intensive Care Unit (NICU); and (4) a Pediatric Intensive Care Unit (PICU). Each of these units contains a mix of private and multi-bed patient rooms, the latter containing from 2 to 8 beds.

The ICC and NICU both specialize in providing care for babies with congenital anomalies, for very premature and very low birth weight babies, and for infants born with other complex diagnoses. The purpose of the NICU is to provide care for critically ill newborns, with a particular emphasis on care of

premature infants. The ICC specializes in the care of fragile, longer-term neonates and infants up to one year of age who require a higher level of observation and care, relative to infants admitted for more routine pediatric care.

The purpose of the PICU is to provide emergency and continuing care of critically-ill infants, children, and adolescents to age 18, encompassing the full spectrum of pediatric critical illnesses. The Med/Surg unit provides medical and post-surgical care for pediatric patients in less critical condition, again up to age 18.

Subsections below provide the rationale and background for the study, and a description of each of the four units. Subsequent sections present methods, results, and conclusions from the evaluation.

Background and Rationale. The rationale for this study rests upon both scientific and practical

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science [1-3]. This concept predicts that differences in the design of work environments are likely to evoke new patterns of variability in staff work performance, and that therefore it essentially is impossible to predict in advance what specific effects such a change in work design will have. A substantial body of empirical research supports these predictions [4]. Given that the ICC, NICU, Med/Surg unit and PICU each have distinctive designs, only an empirical comparative study can establish how design differences between the units may affect perceptions and performance of patient care staff on each unit.

The practical rationale rests upon hospital plans to upgrade the units to exclusive PR designs, based upon the assumption that this change will benefit developmental and therapeutic care of patients on these units. The medical system framework for this idea is that of individualized developmental care, a concept dating back at least to the early 1980's [5,6]. One strategy for implementing such care is that of replacing multi-bed or OB with PR patient care environments in hospitals, based the prediction that a series of patient care benefits will be realized with this type of design change [7-9]. Research to document the putative benefits of this type of intervention represents the application of what is called evidence-based design (EBD) to the health care field [9-10].

Over the past three decades, a primary focus of EBD research on how the design of patient care rooms and environments influences the performance of patients, families and staff has been the NICU. The possible advantages of a PR NICU first was formally proposed in 1992 by White and Whitman [11], and the idea has received growing endorsement since then [12-16].

The irony of this growing interest in PR NICUs is that the medical benefits of individualized developmental care for pre-term infants, across a range of interventions generally, and for PR patient care environments particularly, have not been conclusively demonstrated through empirical research. For example, although White [16] predicted that such benefits would be realized, he also noted that the value of individual rooms for NICU patients for enhanced growth and development of the infants themselves remains unproven. More recently, Stevens et al. [17] note that although the PR NICU is hypothetically superior to the conventional multi-bed NICU, from the standpoints both of improved physiologic stability and of better long-term development of the pre-term infant, convincing

scientific evidence supporting these hypotheses is not yet available.

In contrast to the lack of unequivocal evidence regarding the putative developmental care benefits of PR NICU patient care environments, there is convincing evidence that relative to OB or multi-bed patient rooms, a number of clear benefits for parents and patient care staff have been demonstrated with PR NICU patient care environments. Positive outcomes for families and staff--in terms of improvements in privacy, noise and lighting quality, plus a less hectic work environment--were noted by Brown and Taquino [12] after the conversion of NICU patient care rooms to single room environments. More recently, the studies of Carlson et al. [13], Harris et al. [14], and Shepley, Harris & White [15] cite staff perceptions of improved job satisfaction, reduced job stress, enhanced noise and lighting quality, and better privacy, patient care participation, and space accommodation for parents and family, when a multi-bed is replaced by a PR NICU.

The most comprehensive occupancy and patient care quality studies of the changes in staff perceptions and performance that occur when a multi-bed is replaced by a PR NICU are those carried out by Smith and colleagues [18-20], by Stevens et al. [17], and by Domanico et al. [21], at NICUs in three different U.S. hospitals. The goal of the research by Smith and colleagues was to assess how a change from an OB to a PR NICU patient care environment would influence staff perceptions of the quality of, and their job performance in, their work environment, based on 6-month and follow-up 22-month analyses. As a result of the transition from the OB to the PR environment: (1) rankings of overall physical environment, patient care, job, technology, and off-the-job quality significantly improved; but (2) rankings of patient care team interaction quality significantly declined. Results for the 22-month PR survey indicate essentially no meaningful changes in rankings of occupancy and patient care quality from the 6-month survey, suggesting no consolidation of quality gains in the intervening 16-month period. Collectively, the findings suggest that NICU operational management was not effectively modified to deal with the new design, and that an OB to PR NICU transition requires a systems approach to macroergonomic challenges imposed by the new design [19,20].

1.1. Occupancy and patient care quality studies of ICC, Med/Surg and PICU patient care environments

As noted above, most EBD research to date on how the occupancy and patient care quality of patient care environments influences the perceptions and performance of users of those environments has focused on NICUs. Comparable studies of ICC, Med/Surg and PICU patient care environments, with an emphasis on PR versus multi-bed room configurations, are less numerous.

Among such studies, analyses of PICUs are most prevalent. An early example is the study by Jones [22] of the psychodynamics of both an NICU and a PICU environment, based on three weeks of round-the-clock observations of patients, parents and staff on each unit. A study of eight different PICUs by Pollack et al. [23] concludes that one of the factors influencing differences in the patient care efficiency of these units is bed number---they therefore suggest that efficiency analysis should precede expansion projects for such units. Sweeney [24] advocates family-centered care based on parent-staff partnership in both NICUs and PICUs to improve patient care experience and outcomes. Brown and Taquino [12] refer to the conversion of a PICU in a children's hospital in Seattle, WA from a multi-bed to a single-room patient care environment, but their study is limited to a parallel conversion of an NICU at the same hospital. Physical facility specifications included in the comprehensive PICU guidelines provided by Rosenberg and Moss [25] cite provision of patient privacy as one design objective, but these authors provide no guidance as to how this objective might be achieved.

To the knowledge of the author, across the types of units addressed in the present study, the most comprehensive EBD analysis of a unit other than an NICU is that of Gurses and Carayon [26]. These authors evaluated what they termed performance obstacles to the patient care effectiveness of 15 nurses working on a medical-surgical ICU at an academic hospital, based on a semi-structured interview protocol. Seven categories of such obstacles were identified, related to the physical work environment, family relations, supplies, equipment, information transfer and communication, help from others, and intra-hospital transport. The physical work environment obstacles identified include insufficient space for charting, noise, crowding, and disorganized patient rooms. The NICU EBD research cited above suggests that all of these

obstacles would be mitigated with the installation of a PR patient care environment.

In summary, relative to EBD research attention paid to the occupancy and patient care quality of NICUs, there is a relative paucity of comparable research on ICC, PICU and Med/Surg patient care environments. The present study thus may be considered particularly distinctive in the health care EBD literature in filling this gap. Methods developed by Smith et al. for the NICU research cited above [18-20] were carried over to the present project. Sections below describe these methods, and the results and conclusions derived therefrom.

2. Methods

Methods for this study comprised, for each unit: (1) observations of ergonomic design features of patient care environments; (2) task activity analyses of the patient care performance of selected staff; and (3) use of a perceptual response survey instrument to collect perceptions by ICC, Med/Surg, NICU, PICU, and house staff (HS) respondents of various indicators of occupancy and patient care quality.

2.1. Analyses of task activities of unit staff

The process for carrying out a task analysis observation session on a given unit involved the following steps: (1) the Charge Nurse and/or Patient Care Manager for the unit were consulted for purposes of assigning patient care staff and rooms to be observed; (2) each staff person selected for observation first was asked to read and sign an informed consent form; (3) a brief interview was conducted to collect information about the patient or patients assigned to that staff person, and also about the staff person's work schedule and patient care responsibilities; and (4) to make task analysis observations, the researcher took a position outside the assigned patient care room, such that all patient care activities in the room were readily visible---researchers were instructed to try and not interfere with ongoing patient care activities.

Once an observation session was underway, A sampled data protocol was employed. The researcher noted, at one-minute intervals, every patient care task activity that the staff person under observation was engaged in, and marked the occurrence of these activities on an observation form developed for this

purpose. Observed tasks that did not occur at 1-minute marks were not recorded.

The elapsed time target for a given task analysis observation session was one hour. The researcher then moved on to another assigned patient care room and staff person, and repeated the observation process.

A total of 127 nursing staff, all female, were observed during the task analysis phase of the project.

Task analysis independent measures are, for the different staff members observed: (1) the type of unit; (2) the shift (first or second) during which data were collected; (3) the day of week; (4) the number of beds assigned; (4) the acuity of care for assigned patients; and (5) the staff members observed (an approximately equal number of staff were observed on each unit).

Task analysis dependent measures are: (1) the relative frequencies (as percentages of the total number of activities observed) with which different patient care task activities occur; and (2) the number of task activities per minute observed for different activities.

2.2. Occupancy and patient care quality perceptual response survey

Two different versions of the survey were made available online for staff to access, a 130-question version for ICC, NICU, PICU and house staff, and a 127-question version for Med/Surg staff (three questions without relevance to Med/Surg patient care were deleted).

Items on both versions were grouped into 10 sections. Section 1 solicits respondent personal information. Section 10 contains three questions that invite the respondent to enter written comments about: (1) any personal health problems that they attribute to their job; (2) specific issues with their work environment that may be of concern; and (3) any suggestions they may have for improving problems or issues identified in the preceding question (Point 2).

Each of the intervening 8 sections of the survey features a series of ranking questions relevant to a specific topic area, followed by a Comment question asking respondents to enter written comments about that topic that may not have been addressed by the ranking questions. Each of the ranking questions present a Likert scale ranging from 1 to 7, for which respondents are asked either to judge the quality of a specified occupancy or patient care attribute relevant to their unit, or to state whether they agree or

disagree with a statement about their unit. Section 2 is preceded by three questions that ask respondents to rank the overall quality of their employment with CHC, their perceived level of satisfaction with their CHC job, and their perceived level of patient care effectiveness on-the-job.

After the first set of questions in the survey, described above, there are nine subsequent sections in the survey, each containing a set of ranking questions that address nine different topic areas relevant to occupancy and patient care quality in the ICC, NICU and PICU. Topic areas addressed by Sections 2-9 of the survey are as follows.

- Section 2 deals with physical work environment issues.
- Section 3 deals with patient care issues.
- Section 4 deals with on-the-job work performance and working condition issues.
- Section 5 deals with on-the-job health and safety issues.
- Section 6 deals with on-the-job safety and security issues.
- Section 7 deals with issues related to respondent interaction with their patient care team.
- Section 8 deals with issues related to respondent interaction with patient care technology.
- Section 9 deals with off-the-job quality issues.

Among the successive sets of questions in each of these sections, the first question in each set asks respondents to judge the overall quality of the topic area addressed by that section. Hereafter, the different topic areas addressed by these overall quality questions collectively are termed major indicators of overall occupancy and patient care quality for the different units. Issues addressed by ranking questions within each section of the survey, that refer specifically to that section's topic area, are termed specific attributes of occupancy and patient care quality.

Sixty-seven (all but 3 female) staff, out of a total of 625 eligible employees, responded to the surveys, for a disappointing aggregated survey response rate of 10.7 percent.

Independent measures for the survey data are: (1) the type of unit; (2) the employee category (unit staff plus house staff); and (3) study participants. Dependent measures are responses to the ranking questions.

For both the task analysis and survey phases of the project, the null hypotheses are that no main or

interactive effects of the independent measures on the dependent measures will be observed.

2.3. Observations of ergonomic design features of patient care environments

Ergonomic design features of patient care environments on the different units were assessed by: (1) heuristic (informed judgment) observations by different members of the research team, included those made by the author during collection of photographs on the different units; (2) comments made by unit staff to researchers during the task analysis observations; and (3) written comments made by staff respondents on the different units during completion of the occupancy and patient care quality perceptual response survey.

2.4. Statistical analysis

Analysis of variance (ANOVA), for the main and interactive effects of type of unit on task analysis and perceptual survey dependent measures, was carried out using Pillai's trace to test for statistical significance (SPSS, 1997). This was followed by *post hoc* analysis of statistically significant effects using the Bonferroni procedure (IBID). High and marginal levels of statistical significance are set at $p < .05$ and $p < .10$ respectively. Error bars in figures are 95% confidence intervals.

3. Results

Figures 1 and 2 illustrate two main sets of results from the study across the four different units, namely: (1) the relative percentages of the total number of task activities observed, for 16 different tasks recorded (Fig. 1); and (2) average perceptions of major indicators of occupancy and patient care quality by staff in five different respondent categories (Fig. 2). Conclusions supported by these results are summarized in the next section.

4. Discussion and conclusions

4.1. Task analysis and occupancy quality perceptual response survey findings

Results from univariate ANOVA analyses of average differences between units in task analysis observations (Fig. 1) support the following key conclusions: (1) the task activities with the highest

observed percentages are interaction with patients, charting, interaction with equipment, co-workers and family members, and preparing or administering patient medications or foods; (2) for these 6 task activities, there is no unit with consistently higher or lower activity percentages, relative to the other units; and (3) the percentage time spent standing at work is significantly higher for NICU staff.

Univariate ANOVA analyses of differences in averages between units for rankings of perceived quality for 12 major indicators of occupancy and patient care quality (Fig. 2), by ICC, NICU, PICU, Med/Surg, and house staff, support the following key conclusions: (1) job satisfaction, patient care, work environment, job, and patient care team interaction quality rankings by ICC and/or NICU respondents are significantly higher than those by respondents in the other three units; and (2) ICC and NICU respondents perceive the occupancy and patient care quality of their units to be at a significantly higher level, relative to perceptions of PICU, Med/Surg and house staff respondents.

4.2. Observations of ergonomic design features of unit patient care environments

Three different sources of information were employed---namely, observations made during task activity analysis sessions, written comments offered by some staff respondents during completion of the occupancy and patient care quality perceptual response survey, and observations made during photographic sessions---to develop a limited characterization of ergonomic design features of patient care environments on the four different units.

These sources of information support the following conclusions: (1) disruptive sources of noise and various problems with equipment represent the two most frequent ergonomic design issues noted by research team members; (2) over half of staff comments on the survey expressed concerns about three topic areas, namely work environment, job-related health, and patient care quality issues; (3) staff choosing to provide written comments on the survey have somewhat longer CHC and unit employment experience, relative to all survey respondents, suggesting that more experienced staff may be more aware of patient care quality issues on their respective units, and more likely to comment on these issues; (4) based on analysis of photographic images recorded for selected patient care rooms on each of the four units, the range and complexity of in-

room patient care technology for Med/Surg and PICU patient care rooms appear to be markedly less than that documented for ICC and NICU patient care rooms; and (5) based on an inventory of equipment observed in the hallways for each of the four units, IICC hallways are the most cluttered, NICU and PICU hallways are somewhat less cluttered, and Med/Surg hallways are the least cluttered.

4.3. General conclusions

Results from this study point to two general conclusions. First, the prediction that different work environment designs evoke different patterns of staff perceptions and performance, that only can be discerned through empirical analysis (Introduction), is borne out by the results. All four units addressed by this study provide intensive clinical care for children, two for the very young (the NICU and ICC), two for a younger and older mix (the PICU and Med/Surg). Yet there is no consistency across these units in terms of either the relative distribution of task activities, or rankings by unit staff of different major indicators of occupancy and patient care quality. These results could not have been predicted in advance by *a priori* assumptions.

Second, the more favorable views of NICU and ICC relative to PICU and Med/Surg staff, regarding the occupancy quality of their jobs and work environments, suggests that intensive care of children with a broad age range may impose physical and emotional demands on staff not shared by staff who deal only with children of a narrow age range. It also is possible that caring for tiny babies may be particularly gratifying for their female caregivers (all

staff enlisted for this study were female). These design advantages of the NICU and ICC may explain the more favorable occupancy quality views of their staff.

5. Future work

The second phase of this project, scheduled for 2011, will involve a post-occupancy evaluation of the same four units, after a major hospital remodeling project has been completed. It is anticipated that, after remodeling, the units will have transitioned exclusively to private patient room environments. Identical methods of task activity analyses, occupancy and patient care quality perceptual response surveys, and ergonomic design evaluations will be applied for this second phase.

Completion of the post-occupancy phase of the project will provide a pre- plus post-occupancy body of findings for all four units that will not only extend past NICU research, but also will introduce new and original insights into occupancy quality implications of multi-bed to PR transitions for ICC, Med/Surg, and PICU patient care environments that no prior research has addressed. To reiterate the point made in the introduction, the entire project thus may be considered highly distinctive in the health care EBD field in extending our understanding of how such transitions impact both the micro- and macro-ergonomics of the design of these units, as well as the performance and perceptions of the occupancy quality of nursing staff employed on these units.

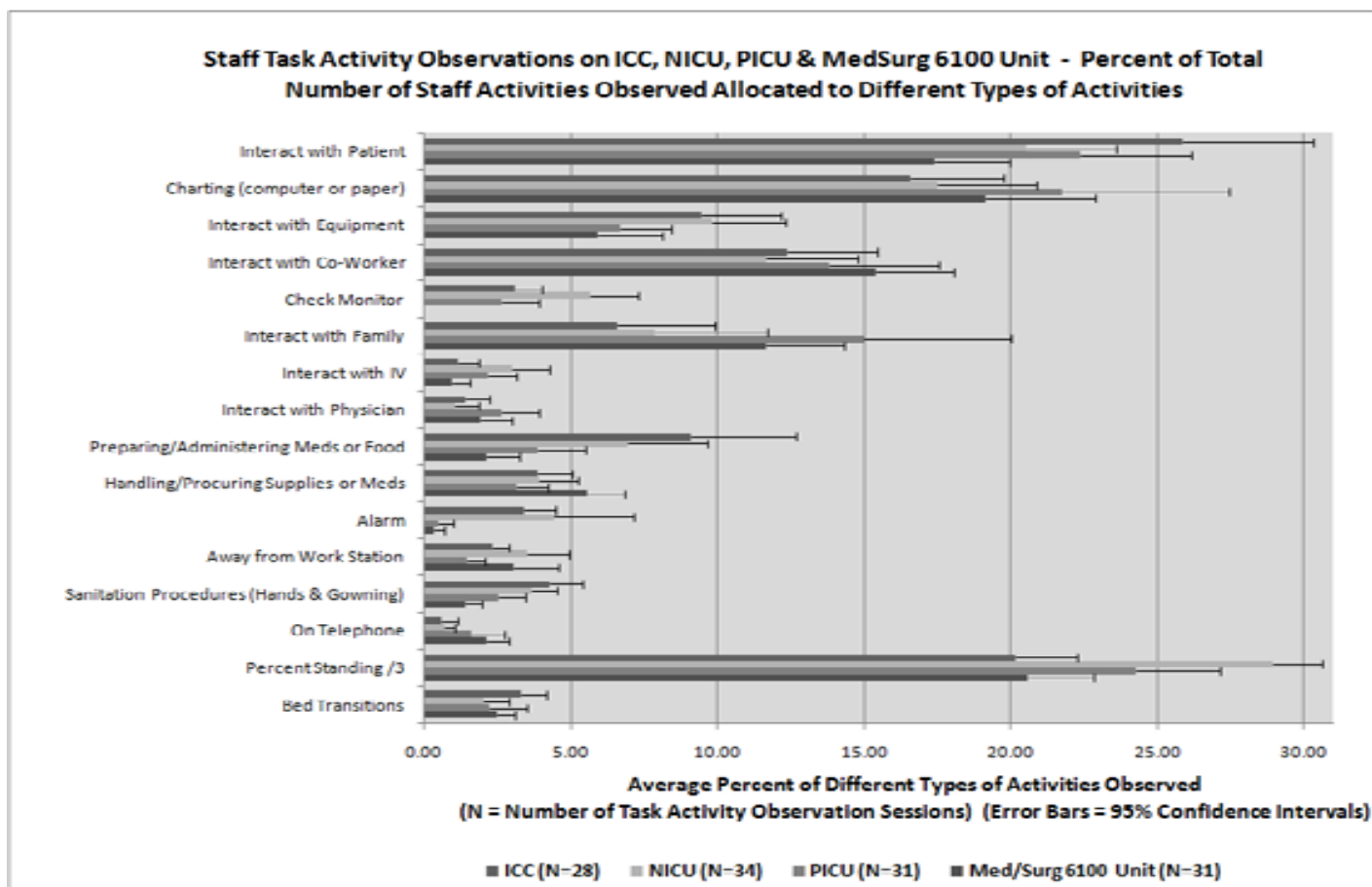


Figure 1. Average percentages (abscissa), with 95% confidence intervals, for the total number of task activities allocated to different types of activities (listed on ordinate), for staff observed on the ICC, NICU, PICU, and Med/Surg unit (top to bottom bars respectively, for each set of histograms). For sake of visual clarity in graphical presentation of the average values, those for percent standing are divided by 3.

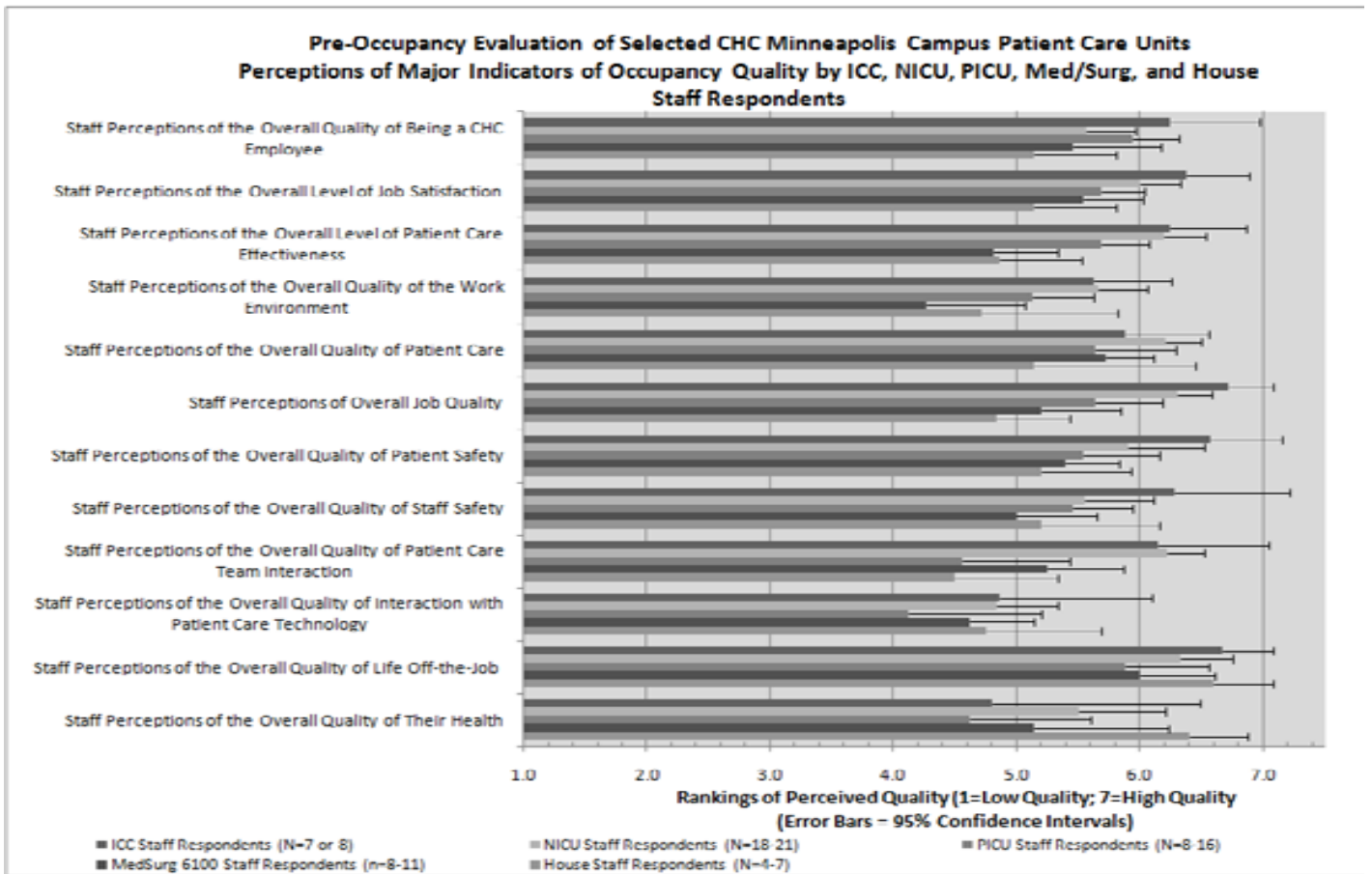


Figure 2. Average perceptions of major indicators of occupancy and patient care quality by staff in five different respondent categories.