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USE OF MULTIVARIATE METHODS IN QUANTIFYING THE VARIABILITY IN NEONATAL INTENSIVE CARE UNIT CHARACTERISTICS IN NINE HOSPITALS IN THE WASHINGTON, DC AREA: THE NIH-DC INITIATIVE TO REDUCE INFANT MORTALITY IN MINORITY POPULATIONS IN THE DISTRICT OF COLUMBIA

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Running Title: Variability in NICU Characteristics in Washington, DC

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## Abstract

In assessing the relationship between organizational characteristics of health care facilities and patient outcomes, standard questionnaires about the organizational components are often administered to health care facility staff and the results from the questionnaires are then related to the outcomes. The questionnaires used in these studies have often been developed and tested in populations somewhat different from the study populations. Hence, there may be considerable noise in the instruments as they relate to the study subjects.

In this paper, we consider such a situation when we look at the organizational characteristics of nine neonatal intensive care units (NICUs) in the Washington, DC, area. The ultimate objective of the study was to look at the relationship between organizational characteristics and neonatal morbidity and mortality. However, in preparation for this an investigation was made of the organizational characteristics data generated from a standard instrument developed for adult intensive care units by Shortell. The goal of this preliminary investigation was to screen out items (questions) that did not discriminate among hospitals and to develop optimal linear composite scores of the discriminating items to be used in the morbidity and mortality analyses.

Tailored versions of the Shortell instrument were administered to 241 Nurses, 78 Physicians, and 85 Respiratory Therapists (RTs) at the nine Washington, DC, hospitals. The instrument contained 109 items making up 29 scales and 7 constructs. Using a multivariate selection process, 66 items, 12 scales, and 2 constructs were eliminated for Nurses; 96 items, 21 scales, and 3 constructs for Physicians; and 98 items, 21 scales and 2 constructs for RTs. The final composite of scales was a measure that had canonical correlations of 0.77, 0.81, and 0.77 with hospitals for Nurses, Physicians, and RTs, respectively.

## Background

The NIH-DC Initiative to Reduce Infant Mortality in Minority Populations in the District of Columbia is a cooperative agreement in the District of Columbia tasked with identifying the determinants of high levels of infant mortality in minority populations. One of the protocols implemented in this cooperative agreement is entitled "The Association of Neonatal Outcomes with the Characteristics of Neonatal Units." This protocol presents a plan for studying the relationship between characteristics of neonatal intensive care units (NICUs) and neonatal outcomes. One of the primary goals of this study is to identify NICU management characteristics, as reported by Nurses, Physicians and respiratory therapists (RTs), which are predictive of risk-adjusted mortality and morbidity, thereby identifying the most effective current practices in the NICUs of District of Columbia hospitals. This study is of national importance; once identified, these characteristics and care patterns could then be disseminated to the medical community to promote the best care structure for NICUs in similar communities in other parts of the country. This study was funded by the NIH Office of Research on Minority Health and the NIH National Institute of Child Health and Human Development.

The literature is replete with studies of care characteristics that are associated with outcomes. These include: the volume of patients treated by hospitals and/or practitioners [1-3]; care giver characteristics [4,5]; the health facility size [6]; the organization and coordination of care [7,8]; the urban/rural location of the hospital [6]; the teaching status of the hospital [6,9,10]; the availability of specialized facilities for patient care [8]; and the ownership status of the hospital [10]. Hospital characteristics associated with better outcomes for one type of patient or disease are not necessarily associated with better outcomes for other types of patients or diseases. For example, the surgical volume of the hospital and/or surgeon may be important for some operations but not others [1]. A recent study of pediatric intensive care units (PICUs) also supports this conclusion [11]; characteristics positively associated with improved outcomes from the general hospital population were negatively associated with outcomes from PICUs.

Traditionally, research has focused on the classic quality triad of structure-process-outcome. Although health care practitioners generally believe that organizational structures and processes can influence patient outcomes such as mortality, the evidence for such relationships is, at best, inconsistent (12). Research, however, has only recently begun to investigate elements from organizational theory and organizational behavior including collaboration, leadership, climate, bureaucracy, practice models, and job satisfaction (13-17). Within the context of this study, the theoretical framework for the belief that structure and process may influence outcome includes the following (12): (1) organizational structures and processes can help insure an experienced and thus more qualified staff since they are related to job satisfaction and increased retention; (2) collaboration as evidenced by the interdisciplinary sharing of time, expertise, and resources is a crucial link between patient care and organizational structures and processes.

The lack of a demonstrated effect of structure and process on major outcomes may be due to imprecision in the measurement instruments when applied to the population under study. For example, if an instrument has been developed and tested in one population and is subsequently used in a different population, then certain elements of the instrument may no longer be relevant and may simply add noise to the data and the analytic results. To overcome this difficulty, one has to develop ways of filtering out

the noise or increase the sample size to compensate for the increased variability. In this study, we have chosen the former approach and this paper describes the methodology for doing so.

The purpose of this paper is to study the management practices and perceptions in nine Washington, DC, NICUs as measured by the Shortell instrument [18]. This instrument was first developed and validated with the use of data from 1700 respondents (Physicians and Nurses) from 42 intensive care units around the country [18]. This paper will assess the degree to which the Shortell items and scales differentiate among the nine DC NICUs and will determine weighted composites of items and scales that maximally discriminate among the NICUs. The weighted composites will be used in a future publication in relating NICU characteristics to infant outcomes in the nine hospitals surveyed.

## Materials and Methods

### Data

The protocol for “The Association of Neonatal Outcomes with Care Characteristics of Neonatal Units” hypothesized that infant outcomes are related to risk-adjusted characteristics of NICUs. A retrospective cohort of 235 infants and a prospective cohort of 312 infants have been enrolled in the study from nine area hospitals: Providence Hospital, Washington Hospital Center, Children’s National Medical Center, Howard University Hospital, Georgetown University Hospital, Columbia Hospital for Women, George Washington University Hospital, DC General Hospital, and Hospital for Sick Children.

One component of this study involved data collection from a special survey of Physicians, Nurses, and RTs working in the NICUs of these hospitals. The Shortell instrument was administered to 241 Nurses, 78 Physicians, and 85 RTs. The questionnaires were delivered individually to NICU staff members and were mailed back to the Data Coordinating Center at Research Triangle Institute in Research Triangle Park, North Carolina. Anonymity of staff and hospital was assured. These data are the basis for illustration of the methodology discussed in this paper.

### The Instrument

The original Shortell instrument sought to assess staff perceptions of organizational and managerial characteristics by utilizing 29 scales divided into 7 constructs. These constructs are defined in [18] as:

**Unit Culture** “constitutes the norms, values, beliefs, and expectations shared by people who work in a given unit”;

**Leadership** reflects “the capacity of individuals to influence others toward the accomplishment of organizationally relevant goals/objectives”;

**Communication** is “measured along a number of dimensions including openness, accuracy, timeliness, understanding and satisfaction”;

**Coordination** is “the degree to which work activities are coordinated within the Nursing and Physician groups and between the two groups within the unit”;

**Problem Solving/Conflict Management** distinguishes between “four different approaches to problem solving and conflict resolution,” including: (1) open, collaborative problem-solving approaches, (2) arbitration approaches, (3) avoidance, and (4) forcing;

**Unit Cohesiveness** “involves the degree to which people identify with the work unit”; and

**Unit Effectiveness** has “three ‘outcome’ measures of effectiveness examined as criterion tests of validity. The first involves Nurse and Physician perceptions of absolute technical quality of care provided in the unit. The second involves their judgment of the ability of the unit to meet family member needs, and the third involves the use of data on Nursing turnover in the unit.”

The version of the Shortell instrument used in this study was a shorter version of the original instrument that was developed by its authors and composed of 109 items. The shorter version used in this study eliminated the constructs measuring Unit Culture and Unit Cohesiveness, used only a subset of the original scales to assess the constructs for Coordination, Communication, and Conflict Management, and added new questions measuring Authority and Job Satisfaction constructs.

The instrument was originally developed for Nurses and Physicians, and consisted of parallel questions for each professional group. For example, questions about leadership for Nurses referred to Nursing leadership, and leadership questions for Physicians were identical except they referred to Physician leadership. The instrument was modified for this study to be applicable to RTs as well. This modification consisted of adding parallel questions for RTs to the questions already existing for Physicians and Nurses. Hence, each of the three professional groups (Nurses, Physicians, and RTs) had their own parallel version of the instrument. Each professional responded to questions about their own group as well as questions about the other two groups. The constructs and scales for the modified instrument are given in Table 1.

(Table 1 about here)

### Data Analysis

The analyses were formulated to address two related issues: scale refinement and selection of that set of scales which accounts for the most variation among the nine hospitals. For this refinement and selection, we chose a variation of a multivariate selection procedure introduced by Rao [19]. He proposed this method as a way of testing whether a subset of components of a vector in a multivariate test accounts for the statistical significance of the multivariate test. In our modification, this procedure performs a multivariate analysis of variance that tests the equality of vectors (here, items or scales) across comparison groups (hospitals) and successively moves components from the dependent variable vector into covariate positions until the multivariate significance has vanished or the components have been exhausted. We chose a liberal  $p$ -value of 0.10 for this screening in order to guard against eliminating items and scales that may have been retained with a larger sample size. The same procedure was used for scale refinement and scale selection for each professional group separately

(RTs, Nurses, and Physicians). Hence, there was no attempt to force the selection process to select the same items and scales for the three professional groups. A byproduct of the selection process was a determination of the linear combination of the different items (scales) that maximized the variation among the hospitals. It should be emphasized that this selection procedure in no way depends on outcome variables that were later studied with respect to their relationship with the organizational characteristic scales.

The selection and optimal weighting strategy may be summarized in the following schema for each professional group:

<b>Select Items</b>	<b>Optimally Weight</b>	<b>Select Scales</b>	<b>Optimally Weight</b>
<b>Within Scales</b>	<b>Selected Items to Form Scales</b>	<b>to Form Composite Score</b>	<b>Selected Scales to Form Composite Score</b>

Scale Refinement

We refined scales by first conducting separate Multivariate Analysis of Variance (MANOVA) tests for each set of items (questions) of each section of the questionnaire to test the hypothesis of no difference in the vector of item means across the nine hospitals. The refinement process was done in stages as follows:

Stage 1 model for items:  $(item_1, item_2, \dots, item_k) = \text{hospital sites}$

where  $k$  is the number of items in the set from the Shortell scale assessing a single subconstruct. If the multivariate test statistic was significant ( $p < 0.10$ ), we examined for each item the univariate Analysis of Variance (ANOVA) for testing the hypothesis of no difference in item means across the nine hospitals. That item, say  $item_i$ , with the largest univariate  $F$  was moved to the right side of the equation and led to the second stage:

Stage 2 model for items:  $(item_1, \dots, item_{i-1}, item_{i+1}, \dots, item_k) = \text{hospital sites}, item_i$

Items within the same construct are highly correlated; therefore, using  $item_i$  as a covariate reduces the variability of the error term in the multivariate and univariate ANOVAs. If Stage 2 results in a statistically significant multivariate statistic, the item on the left side of the model equation with the largest univariate  $F$  was moved to the right side of the equation as another covariate for further analyses. This process is repeated until the multivariate test is no longer statistically significant (i.e.,  $p > 0.10$ ) or the items have been exhausted.

If  $m$  items are selected then at Stage  $m+1$ , a MANOVA was used to model the relation between the final subset of  $m$  selected items (as the dependent variables) and the nine hospitals:

Stage  $(m+1)$  model for items:  $(item_1, item_2, \dots, item_m) = \text{hospital sites}$

The first principal component of the  $E^{-1}H$  matrix, the matrix from which the multivariate test of hospital differences is constructed, gives that linear combination of the  $m$  items that maximizes the variation across hospital sites. This defines the scale of interest such that each item in the final subset contributes independent increments to the total variation and is optimally weighted.

We also determined in a similar manner which scales (i.e., linear combinations of items) account for the most unique variation among hospitals. For each professional group and construct separately, we reduced the number of scales by performing a series of MANOVAs as described above in order to select that set of scales which is most highly discriminating with respect to the nine hospitals. The procedure is the same as that described above for selecting the final subset of items. For example:

Stage 1 model for scales:  $(scale_1, scale_2, \dots, scale_p) = \text{hospital sites}$

where  $p$  is the number of scales analyzed. In the presence of a significant multivariate test ( $p > .10$ ), that scale with the largest univariate  $F$ , say  $scale_i$ , was moved to the right side of the equation, and the new model was re-estimated:

Stage 2 model for scales:  $(scale_1, scale_2, \dots, scale_{i-1}, scale_{i+1}, \dots, scale_p) = \text{hospital sites}, scale_i$

This produced the linear combination of the remaining set of scales that is most highly discriminating with respect to the nine hospitals, effectively adjusting for the covariance associated with the scale identified in Stage 1. The process terminates when the multivariate test is no longer statistically significant or the scales have been exhausted, providing us with the final set of scales that explains the most unique variation among hospitals.

## Results

(Table 2 about here)

Table 2 contains the descriptive statistics for the unselected, unweighted scales and constructs using Shortell's scoring procedure of simply summing the component items. The scores for negatively worded items were reflected so that larger scores corresponded to positive attitudes for all items. The values are in the units of the Likert scale (i.e., ranging from 1 to 5) and indicate that for most scales each of the groups, on average, responded slightly above the apparent midpoint of 3. Also of interest is the fact that for most scales based on the raw data, the Physicians scored the highest of the three professional groups, the Nurses scored second highest, and the RTs scored the lowest.

## **Multivariate Analysis of Items**

Tables 3, 4, and 5 about here)

Tables 3, 4, and 5 contain all scales surviving the first stage of the multivariate analyses, that is, those scales that include at least one item (i.e., question) that differs across hospitals. For Nurses (Table 3), 27 of the original 29 scales were retained after the first stage screening of items, but 11 of these became single-item scales. For Physicians (Table 4), 17 scales were retained (13 are single-item



scales). In the case of RTs (Table 5), 14 scales were retained, 10 of which were consisted of only one item. Optimal weights from the item analysis MANOVAs were applied to the items of multi-item scales to form the scales for scale selection.

### **Multivariate Analysis of Scales**

Seventeen Nurses' scales were selected in the second stage of the MANOVA (shown in Table 3 in **bold italics**), and eight scales each for both Physicians and RTs (shown in Tables 4 and 5 in **bold italics**).

In the last columns of Tables 3, 4, and 5, the percent of variation in each weighted scale due to Hospital effect ( $R^2$ s) is displayed. For example, 23.7% of the variation in the three-item "Timeliness" scale (i.e., the optimally weighted linear combination of the three items) for Nurses is accounted for by hospital-to-hospital variation. Hospitals account for 35.3% of the variation in the five-item "Absolute Technical Quality" scale for Nurses. For multi-item scales, the next to the last column in Tables 3, 4, and 5 gives the percent of the total variance of the items in the scale accounted for by the optimum linear combination. All multi-item scales account for at least 50% of the total variation in the scale items.

Also of interest is the proportion of variation in the entire set of scales explained by Hospitals. In the context of a one-way MANOVA, a canonical analysis of the scales and Hospitals produces a first canonical correlation that maximizes the relation between the optimal linear combinations of two sets of variables. In this case, the canonical correlation describes the relation between Hospitals and the entire set of scales for each professional group. For Nurses, the first canonical correlation between Hospitals and the final set of 17 scales is 0.772; the  $R^2$  is 0.595, indicating that nearly 60% of the variation in the scales is accounted for by Hospital variation. The first canonical correlation for Physicians is similar at 0.809 ( $R^2=0.655$ ), and for RTs, 0.768 ( $R^2 =0.591$ ).

The final analysis of the scales and constructs consisted of the derivation of a composite construct measuring Nurse, Physician, and RT perception of the organization and management of the NICU in which they worked. This composite is that linear combination of the scales that survived the item and scale screening that best discriminate among the nine hospitals. Per person averages of these composites are displayed for each professional group by hospital combination in Table 6 and Figure 1. The composites have been scaled to the original range (i.e., 1 to 5). For comparison purposes we have also included Figure 2 that shows the per person averages of the item averages prior to the multivariate selection and differential weighting. Clearly the selection and refinement procedures have resulted in measures that exhibit more variability across hospitals than do the unweighted averages.

## Discussion

In this paper, we have presented a method of modifying the Shortell scales and composites of the scales to maximize the discrimination among Neonatal Intensive Care Units (NICUs) in nine Washington, DC, hospitals. In order to eliminate nondiscriminating questionnaire items, scales (groups of questions), and constructs (groups of scales), and to form optimal linear combinations of items, scales, and constructs, we used a multivariate selection and weighting procedure. This method first eliminated items from scales that did not show independent variation across hospitals, and then optimally weighted the retained items to form scale scores. The procedure then eliminated scale scores that did not show independent variation across hospitals and optimally weighted the retained scale scores to form construct scores. Finally, it weighted construct scores to form a composite score for each hospital by professional group combination (27 values in all).

From an original set of 109 items, 29 scales, and 7 constructs for each professional group, this screening and compositing procedure resulted in eliminating 66 items, 12 scales and 2 constructs for Nurses; 96 items, 21 scales, and 3 constructs for Physicians; and 98 items, 21 scales and 2 constructs for RTs. The final best single composite of these scales for the three professional groups (Table 6 and Figure 1) resulted in a measure that was highly correlated with hospital site (canonical correlations 0.77, 0.81, and 0.77 for Nurses, Physicians, and RTs, respectively). These analyses suggest that a tailored version of the Shortell scales may be useful in quantifying the perceptions by Nurses, Physicians, and RTs of management and operations in hospital NICUs. This tailoring is justified by the fact that the Shortell scales were developed from a study of adults and previous studies have shown that measurement instruments developed in one population are not necessarily directly transferrable to a different population.

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TABLE 1

CONSTRUCTS AND SCALES OF THE SHORTELL INSTRUMENT  
USED TO QUANTIFY THE ORGANIZATIONAL CHARACTERISTICS OF NICUS

***I. Team Work and Leadership***

Nursing Leadership The degree to which Nursing leadership sets and communicates clear goals and expectations, and is responsive to changing needs and situations.

Physician Leadership The degree to which Physician leadership sets and communicates clear goals and expectations, and is responsive to changing needs and situations.

RT Leadership The degree to which RT leadership sets and communicates clear goals and expectations, and is responsive to changing needs and situations.

***II. Relationships and Communications Within the NICU***

Within-group Communication Openness The degree to which Physicians, Nurses, or RTs are able to “say what they mean” when speaking with others of their own kind without fear of repercussions or misunderstanding.

Between-group Communication Openness The degree to which Physicians, Nurses or RTs are able to “say what they mean” when speaking with members of the other groups, without fear of repercussions or misunderstandings.

Within-group Communication Accuracy The degree to which Nurses (Physicians, RTs) believe in the consistent accuracy of the information conveyed to them by others of their own kind.

Between-group Communication Accuracy The degree to which Nurses (Physicians, RTs) believe in the consistent accuracy of the information conveyed to them by members of other groups.

Communication Timeliness The degree to which patient care information is relayed promptly to the people who need to be informed.

***III. Coordination***

The degree to which relationships with other units in the hospital facilitate ICU performance.

***IV. Perceived Unit/Team Effectiveness***

Perceived Effectiveness at Recruiting and Retaining Nurses (Physicians, RTs) The degree to which the unit is perceived as recruiting and retaining excellent Nurses (Physicians, RTs).

Absolute Technical Quality of Care The perceived effectiveness of the unit with regard to patient care needs and outcomes.

Perceived Effectiveness at Meeting Family Needs The perceived degree to which the unit meets the needs of the patient’s family.

## **V. Authority**

Perceived Authority of Nurses (Physicians, RTs) to direct patient management.

Perceived Authority of Nurses (Physicians, RTs) to manage budgetary matters.

## **VI. Conflict Resolution**

Within-group Problem-solving Conflict Strategy The degree to which parties to a disagreement among Nurses (Physicians, RTs) communicate actively to make sure that all available expertise is brought to bear on the problem, and that the best possible solution is developed.

Between-group Problem-solving Conflict Strategy The degree to which parties to a disagreement between groups (e.g., between Nurses and Physicians) communicate actively to make sure that all available expertise is brought to bear on the problem, and that the best solution is developed.

Within-group Avoiding Conflict Strategy The degree to which disagreements among Nurses (Physicians, RTs) are ignored or are not directly discussed by the parties involved.

Between-group Avoiding Conflict Strategy The degree to which disagreements between groups (e.g., between Physicians and Nurses) are ignored or are not directly discussed by the parties involved.

## **VII. Job Satisfaction**

The degree of happiness or unhappiness with one's job on the NICU.

TABLE 2

AVERAGE SCORES FOR CONSTRUCTS AND SUBCONSTRUCTS OF SHORTELL SCALES

	<b>N</b>	<b>Mean</b>
<b>Leadership</b>		
Nursing leadership		
By Nurses	237	3.01
By Physicians	76	3.53
By RTs	82	2.87
Physician Leadership		
By Nurses	236	3.13
By Physicians	76	3.79
By RTs	82	2.95
RT Leadership		
By Nurses	235	3.22
By Physicians	75	3.46
By RTs	82	3.28
<b>Communication</b>		
<i>Openness</i>		
Nurses' Assessment		
Nurses with Nurses	240	3.90
Nurses with Physicians	239	3.56
Nurses with RTs	239	3.77
Physicians' Assessment		
Physicians with Nurses	74	4.07
Physicians with Physicians	75	4.11
Physicians with RTs	76	3.72
RTs' Assessment		
RTS with Nurses	84	3.42
RTS with Physicians	84	3.28
RTS with RTs	85	3.85
<i>Accuracy</i>		
Nurses' Assessment		
Nurses with Nurses	240	3.20
Nurses with Physicians	239	3.52
Nurses with RTs	239	3.46
Physicians' Assessment		
Physicians with Nurses	75	3.48
Physicians with Physicians	75	3.93
Physicians with RTs	76	3.36
RTs' Assessment		
RTS with Nurses	85	3.16
RTS with Physicians	84	3.34
RTS with RTs	85	3.26
<i>Timeliness</i>		
By Nurses	240	3.76
By Physicians	76	3.93
By RTs	83	3.57
<b>Coordination with Other Units</b>		
Nurses' Assessment	236	3.23
Physicians' Assessment	75	3.54
RTs' Assessment	82	3.07

**Unit Effectiveness***Recruitment Retention*

Nurses'			
	By Nurses	237	2.85
	By Physicians	75	3.19
	By RTs	82	2.86
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Physicians'			
	By Nurses	237	3.34
	By Physicians	76	3.81
	By RTs	82	3.07
<hr/>			
RTs'			
	By Nurses	236	3.03
	By Physicians	74	3.07
	By RTs	82	3.10

*Absolute Technical Quality*

Nurses' Assessment	237	3.85
Physicians' Assessment	76	4.20
RTs' Assessment	82	3.72

*Meeting Family Needs*

Nurses' Assessment	235	3.63
Physicians' Assessment	76	4.03
RTs' Assessment	83	3.55

**Authority**

Medical Director Patient Care Authority		
	Nurses' Assessment	231 3.93
	Physicians' Assessment	75 4.31
	RTs' Assessment	78 3.69
<hr/>		
Medical Director Budgeting Authority		
	Nurses' Assessment	229 3.54
	Physicians' Assessment	74 3.50
	RTs' Assessment	78 3.32
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Head Nurse Patient Authority		
	Nurses' Assessment	232 3.14
	Physicians' Assessment	73 3.41
	RTs' Assessment	79 3.13
Head Nurse Budgeting Authority		
	Nurses' Assessment	231 3.62
	Physicians' Assessment	73 3.02
	RTs' Assessment	79 3.11
RT Manager Patient Authority		
	Nurses' Assessment	231 2.78
	Physicians' Assessment	72 2.73
	RTs' Assessment	80 2.65
RT Manager Budgeting Authority		
	Nurses' Assessment	228 3.08
	Physicians' Assessment	72 2.58
	RTs' Assessment	80 3.04



**Conflict Management**

## Problem Solving Within Professional Groups

By Nurses	236	3.07
By Physicians	76	3.54
By RTs	80	3.28

## Problem Solving by Nurses and Physicians

Nurses' Assessment	237	3.05
Physicians' Assessment	76	3.57

## Problem Solving by Nurses and RTs

Nurses' Assessment	233	3.26
RTs' Assessment	80	3.01

## Problem Solving by Physicians and RTs

Physicians' Assessment	73	3.55
RTs' Assessment	78	3.05

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**Job Satisfaction**

Nurses	228	3.67
Physicians	74	3.95
RTs	75	3.52

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TABLE 3

NURSES' SCALES AND PERCENT OF VARIATION IN EACH EXPLAINED BY HOSPITALS AFTER SELECTION AND OPTIMALLY WEIGHTING ITEMS

Scale	Number of Items Selected for Scale	Percent of Variation Explained	Percent of Shared Variation Explained (R <sup>2</sup> )
<b>Accuracy within Nurses</b>	2	89.4	19.9
<b>Openness between Nurses and Physicians</b>	2	95.4	40.5
Accuracy between Nurses and Physicians	2	85.2	20.4
<b>Openness between Nurses and RTs</b>	3	74.8	22.5
Accuracy between Nurses and RTs	2	79.4	18.6
<b>Timeliness</b>	3	51.5	23.7
<b>Nursing leadership</b>	5	58.3	33
<b>Physician leadership</b>	5	64.2	39.4
<b>Respiratory therapist leadership</b>	2	83.0	24.4
Unit relations with other units	3	78.3	31.6%
<b>Absolute technical quality</b>	5	64.1	35.3
Meeting family needs	1		18.3
<b>Recruiting and retaining Nurses</b>	1		38.7
<b>Recruiting and retaining Physicians</b>	2	72.2	16.2
Recruiting and retaining RTs	1		12.8
<b>Problem solving within Nurses</b>	2	87.7	29.4
Avoiding within Nurses	1		14.5
<b>Problem solving between Nurses and Physicians</b>	2	93.4	37.1
Avoiding between Nurses and Physicians	1		12.7
Problem solving between Nurses and RTs	1		22.9

Scale	Number of Items Selected for Scale	Percent of Variation Explained	Percent of Shared Variation Explained (R <sup>2</sup> )
<i>Avoiding between Nurses and RTs</i>	1		13.8
<i>Medical Director patient authority</i>	1		15.6
<i>Nurse manager patient authority</i>	1		18.1
<i>Nurse manager budgeting authority</i>	3	67.9	17
RT manager patient authority	1		11.6
<i>RT manager budgeting authority</i>	3	50.5	15.9
Job satisfaction	1		17.6

TABLE 4

PHYSICIANS SCALES AND PERCENT OF VARIATION IN EACH EXPLAINED BY HOSPITALS AFTER SELECTION AND OPTIMALLY WEIGHTING ITEMS

Scale	Number of Items Selected for Scale	Percent of Variation Explained	Percent of Shared Variation Explained (R <sup>2</sup> )
<b><i>Openness within Physicians</i></b>	1		44.0
Accuracy within Physicians	1		19.3
Openness between Nurses and Physicians	1		30.3
Openness between Physicians and RTs	1		27.1
Timeliness	1		27.8
<b><i>Unit relations with other units</i></b>	1		31.2
<b><i>Absolute technical quality</i></b>	2	75.3	33.2
<b><i>Meeting family needs</i></b>	1		20.6
Recruiting and retaining Nurses	1		33.6
Recruiting and retaining Physicians	1		17.6
<b><i>Recruiting and retaining RTs</i></b>	1		32.8
Problem solving within Physicians	1		44.1
<b><i>Medical Director patient authority</i></b>	2	57.1	32.8
<b><i>Medical Director budgeting authority</i></b>	2	71.3	32.2
Nurse manager patient authority	1		26.4
<b><i>Nurse manager budgeting authority</i></b>	3	69.1	39
RT manager patient authority	1		24.0

TABLE 5

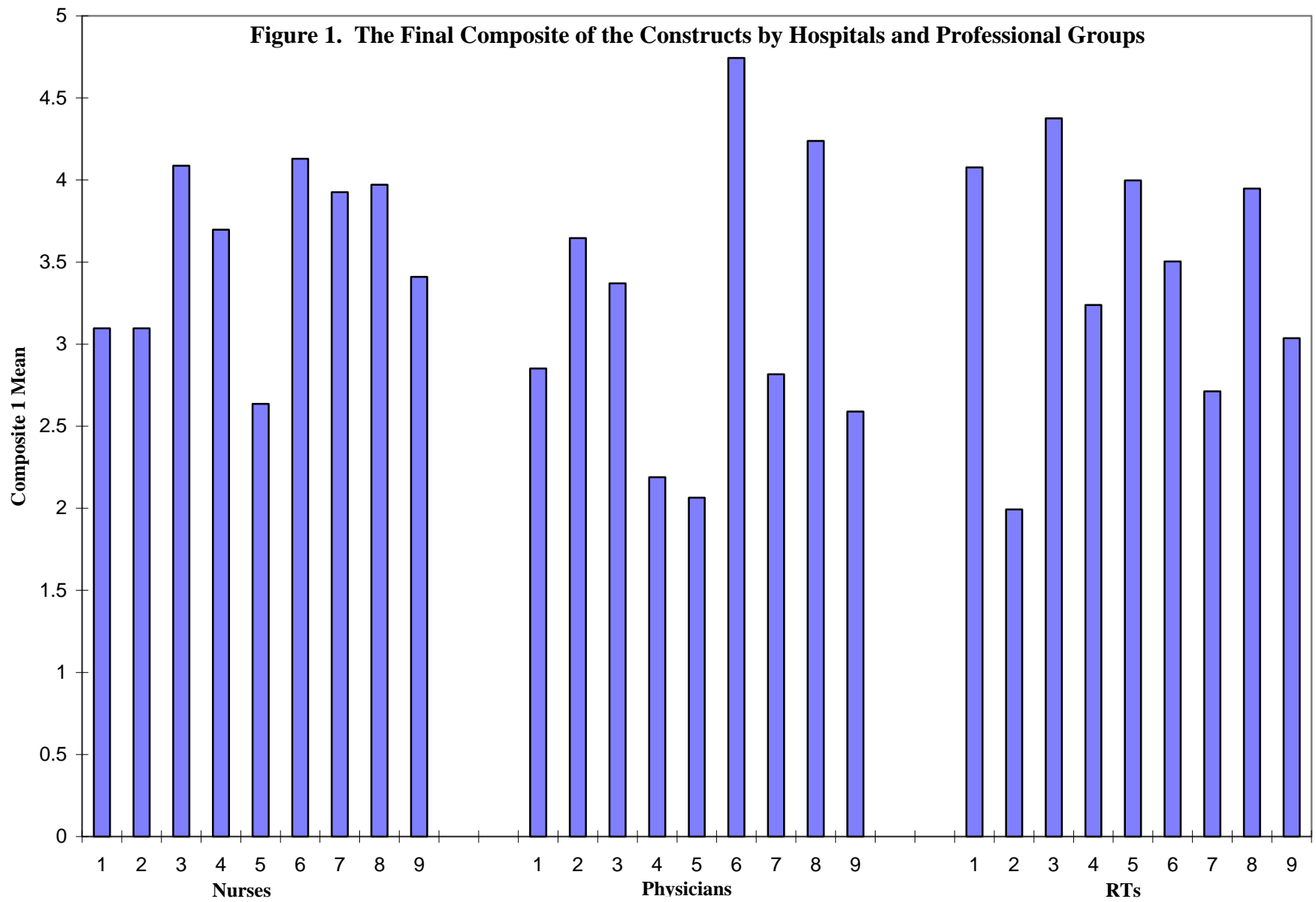
RESPIRATORY THERAPISTS SCALES AND PERCENT OF VARIATION IN EACH EXPLAINED BY HOSPITALS AFTER SELECTION AND OPTIMALLY WEIGHTING ITEMS

Scale	Number of Items Selected for Scale	Percent of Variation Explained	Percent of Shared Variation Explained (R <sup>2</sup> )
Accuracy within RTs	1		19.9
<b><i>Openness between RTs and Physicians</i></b>	1		29.7
<b><i>Accuracy between RTs and Nurses</i></b>	2	75.9	30.8
<b><i>Timeliness</i></b>	2	61.2	32.6
Physician leadership	2	58.1	21.8
<b><i>Nursing leadership</i></b>	1		37.6
<b><i>Unit relations with other units</i></b>	1		19.9
Absolute technical quality	1		26.3
Recruiting and retaining Nurses	1		25.6
Recruiting and retaining Physicians	1		28.1
<b><i>Problem solving within RTs</i></b>	2	82.3	29.9
<b><i>Avoiding within RTs</i></b>	1		24
Medical Director patient authority	1		28.3
<b><i>Nurse manager budgeting authority</i></b>	1		26

TABLE 6

THE LINEAR COMBINATION COMPOSITE OF THE SCALES FOR EACH PROFESSIONAL GROUP  
THAT BEST DISCRIMINATES AMONG THE HOSPITALS

<b>Hospital</b>	<b>Nurses</b>	<b>Physicians</b>	<b>Respiratory Therapists</b>
1	3.10 (.54) N=28	2.85 (.50) N=13	4.08 (.41) N=7
2	3.10 (.52) N=21	3.65 (.66) N=7	1.99 (1.1) N=4
3	4.09 (.28) N=25	3.37 (.50) N=11	4.38 (.62) N=6
4	3.70 (.62) N=10	2.19 (.83) N=10	3.24 (.56) N=4
5	2.64 (.61) N=50	2.07 (.39) N=14	4.0 (.65) N=11
6	4.13 (.45) N=15	4.74 (.36) N=2	3.5 (.49) N=17
7	3.93 (.42) N=15	2.82 (.53) N=9	2.71 (.56) N=6
8	3.97 (.54) N=18	4.24 (.58) N=2	3.95 (.30) N=7
9	3.41 (.45) N=17	2.59 (.52) N=5	3.04 (.45) N=7



**Figure 2. The Unselected, Unweighted Average of All Items by Hospital and Professional Group**

