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Use of the ICU Nurse-Physician Questionnaire (ICU N-P-Q): testing reliability and validity in neonatal intensive care units in Japan

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ABSTRACT

Objective: Although communication among health providers has become a critical part of improving quality of care, few studies on this topic have been conducted in Japan. This study aimed to examine the reliability and validity of the ICU Nurse–Physician Questionnaire (ICU N-P-Q) for use among nurses and physicians in neonatal intensive care units (NICUs) in Japan.

Methods: A Japanese translation of the ICU N-P-Q was administered to physicians and nurses working at 40 NICUs across Japan, which were participating in the Team Approach Cluster randomized controlled trial (INTACT). Convergent and discriminant validity was assessed by examining Spearman correlations between subscales. Analysis of variance (ANOVA) was performed to examine the variance of within-unit and between-unit responses, and the consistency of individual scores within a unit was examined using intraclass correlation coefficients (ICCs). Cronbach's alpha coefficients were used to assess reliability.

Results: In total, 2006 questionnaires were completed by 316 physicians (response rate = 92 %) and 1690 nurses (response rate = 94 %). Convergent and discriminant validity was confirmed in the nurse questionnaire. In the physician questionnaire, 'Nursing Leadership' was not positively correlated with several subscales from the viewpoint of convergent validity. ANOVA of scales showed that scores were more variable among between-unit responses than among within-unit responses. ICCs indicated that the consistency of nurses' individual scores was higher than those for physicians across the units. Cronbach's alpha coefficients were acceptable for both physicians (range: 0.50 - 0.89) and nurses (range: 0.61 - 0.89).

Conclusion: Although the psychometric property behaved somewhat differently by occupation, the Japanese ICU N-P-Q can be used to measure the degree and quality of communication and collaboration among staff at NICUs and similar healthcare settings in Japan.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

■ The Japanese ICU N-P-Q can be used to measure the extent and quality of communication/collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

■ Examining the questionnaires for physicians and nurses separately may have revealed the psychometric properties more accurately than the original study, which had a combined nurse–physician sample.

■ The present study, considering intraclass correlation coefficients, showed that individual nurses' scores were less variable than physicians' scores in most subscales.

■ Some items were deleted from the questionnaire due to copyright restrictions. Therefore, the data in this study cannot fully compare with the psychometric property of the original study.

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INTRODUCTION

Good relationships among staff in healthcare organizations are an essential factor to provide safe and high quality care. Previous studies have observed that better communication and collaboration among healthcare providers is associated with higher technical quality of care,[1] lower length of stay,[2] superior clinical care in disease,[3] and risk-adjusted morbidity.[4] Communication and collaboration among health professionals has been shown to make an impact on patient outcomes. A Cochrane systematic review[5] found that practice-based interprofessional collaboration interventions (IPC) enhanced healthcare processes and outcomes; however, generalizing the core components of IPC and its effectiveness remains an ongoing challenge.

To advance our understanding of IPC's impact and effectiveness on patient outcomes, it is critical to accurately assess the degree and quality of communication and collaboration among health professionals. A recent systematic review of survey instruments for measuring teamwork in healthcare settings identified 36 scales which met the study criteria.[6] Twelve out of 36 scales documented relationships between teamwork and objective outcomes of interest in peer-reviewed studies[6]. Another systematic review[7] of survey instruments for assessing collaboration in healthcare settings found five instruments that met the study criteria for psychometric validity. The ICU Nurse–Physician Questionnaire (ICU N-P-Q)[8] was one of the two scales identified by both reviews as a useful valid scale for future research.

The ICU N-P-Q was originally developed using a large national sample to measure collaboration at the unit level and organizational components that facilitate a collaborative clinical interaction. The scale has been used to assess perceptions of nurse–physician collaboration in critical and non-critical care in the United States (US)[9-12] and the United Kingdom.[13] Although the importance of communication and collaboration among health providers has grown significantly in healthcare settings with several key studies in this area in the US and Europe,[14-16] few studies in Japan have investigated this topic. In this study, we aimed to examine the reliability and validity of the translated ICU N-P-Q among nurses and physicians from neonatal intensive care units (NICUs) across Japan.

METHODS

Translation process

Permission to use the ICU N-P-Q and create a Japanese version was obtained from the original authors. A professional translator of Japanese translated the original English version into Japanese,

after which a different professional translator conducted back translation of the scale. However, two components of the scale (workplace and facility safety scales/culture) were not translated or included because of copyright restrictions. In order to maintain quality control, the back translation was shared with Dr. Stephen M. Shortell, Principal Investigator of the original study.[8] Two authors (HS and RM) assessed the expressions used in the Japanese ICU N-P-Q to increase the face validity of the instrument. A pretest was performed on physicians and nurses from three pre-intervention facilities, which were participating in a trial known as the Improvement of NICU Practice and Team Approach Cluster randomized controlled trial (INTACT). The pretest aimed to assess whether the Japanese ICU N-P-Q was appropriate and easily understandable for nursing and physician personnel. The Japanese ICU N-P-Q was finalized after some modifications were made to the wording in response to pretest feedback.

Ethical statement

Participation in this study was voluntary and written consent was obtained from each participant. Anonymity and confidentiality of the data was assured to all participants. Ethical approval was obtained on 15 July 2011 from the independent review board of INTACT (UMIN000007064), which has its administrative office in Tokyo Women's Medical University. This study was also approved by the Ethics Committee of the Kyoto University Graduate School and Faculty of Medicine on 28 March 2014.

Sample and data

In this study, we used baseline data from a questionnaire distributed to physicians and nurses working at 40 NICUs that were participating in INTACT and located in different areas of Japan. Questionnaires were distributed to 345 physicians and 1800 nurses. The unlinked anonymous survey was administered from December 2011 to March 2012. We excluded data from the analysis if there were missing values for any variables in the ICU N-P-Q, and if all or almost all of the items in each subscale were scored with the same number (e.g. scored "1" in all values).

Instrument

ICU Nurse–Physician Questionnaire (ICU N-P-Q)

The original ICUN-P-Q is a 120-item scale derived from the Organizational Culture Inventory with

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response items ranked on a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree.[17] A revised and shortened version of the instrument is also available as an 81-item scale. In this study, we used the shorter version. Although a separate test for reliability and validity has not been completed for the shorter version, the authors who developed the ICU N-P-Q believed that the shorter version was easier to administer and was therefore able to achieve better survey compliance while ensuring good validity and reliability.[17] Two components of the scale (workplace and facility safety scales/culture) were excluded because of copyright restrictions.[18] The subscales of the ICU N-P-Q consist of Leadership, Communication, Coordination, Problem-solving, Conflict Management, Unit Cohesiveness and Unit Effectiveness, and the scale includes separate questionnaires for physicians and nurses. Shortell et al.[8] reported that Cronbach's alpha reliabilities ranged from 0.61 to 0.88 for subscales. Other researchers have reported reliabilities from 0.66 to 0.92. [9 11 12 19]

Nurse–Physician Collaboration Scale (NPCS)

The NPCS [20] was developed to measure collaboration between nurses and physicians in Japan. The questionnaire is a 27-item scale and consists of three subscales: Joint Participation in Care, Sharing of Patient Information, and Cooperativeness. Participants rate how often they experience these positive work-related states using a 7-point Likert scale ranging from 1="never" to 7="always/every day". Cronbach's alpha reliabilities for nurses' responses to the subscales ranged from 0.80 to 0.92 and that of physicians' responses ranged from 0.84 to 0.93. Psychometric testing showed that the NPCS was reliable and valid with high internal consistency and the results for test-retest reliability were adequate. Similar to the ICU N-P-Q, the NPCS focuses on nurses' and physicians' collaborative and problem-solving skills.[20] In this study, the NPCS was administered to test concurrent validity of the Japanese ICU N-P-Q.

Statistical analysis

All statistical analyses were undertaken in SPSS version 21.0 (IBM Corporation, USA). The P value of ≤0.05 was considered as statistically significant.

Item analysis and reliability

Means and standard deviations were calculated for the ICU N-P-Q. We also calculated Cronbach's

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alphas to test internal consistency of the items within subscales. The value of Cronbach's alpha depends on the number of items on the scale.[21] Therefore, we calculated the mean inter-item correlations, for which Briggs and Cheek[22] suggested 0.20 to 0.40 as the optimal level of homogeneity.

Validity

Convergent and discriminant validity was assessed separately for physicians' and nurses' questionnaires by examining Spearman correlations between subscales. Considering the convergent validity of the original validation study,[8] it was assumed that nurse and physician leadership would be positively correlated with each other and with all measures of effective communication and coordination, with open collaborative problem-solving, team cohesion, and performance measures related to technical quality of care, meeting family member needs, and lower nurse turnover. In terms of discriminant validity, it was assumed that nursing and physician leadership would be negatively correlated with problem-solving methods related to avoidance and forcing issues. If the subscales were correlated according to the assumption of the original study, it would be considered that convergent and discriminant validity was confirmed.

Concurrent validity of the scale was assessed by the NPCS, in which items are thought to reflect the fundamental aspects of nurse–physician relationships. Therefore, we assumed that the NPCS would have a positive correlation with the Japanese ICU N-P-Q.

Analyses of variance (ANOVA) were conducted by examining the variance of within-unit to between-unit responses for all scales across 40 NICUs. We assumed the variability of within-unit responses would be less than the variability of between-unit responses, as verified by the original study[8]. P values were reported as a measure of the variability of between-unit responses. We also calculated the point estimate of the intraclass correlation coefficients (ICCs) to examine the consistency of individual scores within a unit. ICCs would indicate how the individual scores within a unit differ by unit and occupation. Presumably, the less variability found in samples such as job positions or years of practice, the higher the ICCs would be within a unit, and vice versa.

RESULTS

Description of sample

A total of 2006 questionnaires were completed by 316 physicians (response rate = 92 %) and 1690

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nurses (response rate = 94 %). After excluding missing values and values scored with the same numbers, 1762 questionnaires were used in the analysis, including those of 285 physicians and 1475 nurses. Of the 285 participating physicians, 57 (20%) were head physicians, 200 (70.2%) were physicians, 24 (8.4%) were residents, and there were 3 missing values. Of the 1475 participating nurses, 130 (8.8%) were head nurses, 1328 (90.0%) were nurses, 2 (1.0%) were assistant nurses, and there were 15 missing values (1.0%). The highest number of practice years in one's own unit was 5 to 9 years for nurses and less than 1 year for physicians (Table 1).

Table 1: Sample characteristics

	Physicians (N=285) n (%)	Nurses (N=1475) n (%)
SEX		
Male	195 (68.4)	25 (1.7)
Female	87 (30.5)	1430 (96.9)
Missing	3 (1.1)	20 (1.4)
STATUS		
Head physician	57 (20.0)	—
Physician	200 (70.2)	—
Resident	24 (8.4)	—
Missing	4 (1.4)	—
Head nurse	—	130 (8.8)
Nurse	—	1328 (90.0)
Assistant nurse	—	2 (1.0)
Missing	—	15 (1.0)
YEARS OF PRACTICE		
Less than 1 year	79 (27.7)	281 (19.0)
1 to 2 years	49 (17.2)	330 (22.4)
3 to 4 years	55 (19.3)	304 (20.6)
5 to 9 years	53 (18.6)	336 (22.8)
More than 10 years	46 (16.1)	208 (14.1)
Missing	3 (1.1)	16 (1.1)

Item analysis and reliability

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The lowest score was given for "Between-group Avoiding Conflict Strategy" (nurse: mean= 2.26, SD=0.67; physician: mean= 2.17, SD=0.71). The highest scores were given for "Medical Director Patient Care Authority" (nurse: mean=3.79, SD=0.76) and "Within-group Communication Openness" (physician: mean= 4.01, SD=0.63). Cronbach's alpha for physicians ranged from 0.50 to 0.89. The lowest alpha value was found in "Perceived Effectiveness Meeting Family Needs" for physicians with 0.50. Almost all of the subscales demonstrated good to high reliability for nurses, ranging from 0.61 to 0.89. The mean inter-item correlations for each subscale ranged from 0.32 to 0.70 for physicians, and from 0.19 to 0.71 for nurses (Table 2).

Validity

Convergent and discriminant validity

Correlations of the 21 subscales with "Job Satisfaction" are shown in Appendix 1 and 2. The correlation among physicians was the highest with "Within-group Problem-solving" and "Within-group Avoiding Conflict" (r=-0.854, P<0.001) and the lowest with "Medical Director Budgeting Authority" and "Between-group Problem-solving" (r=0.117, P=0.494). Among nurses, the highest correlation was with "Within-group Problem-solving" and "Between-group Avoiding Conflict" (r=-0.985, P<0.001) and the lowest with "Relative Technical Quality of Care" and "Between-group Openness" (r=0.052, P=0.453). Concerning convergent validity, items of "Nursing and Physician Leadership" in the nurse questionnaire were positively correlated with each other and with all measures of effective communication and coordination, open collaborative problem-solving, team cohesion, performance measures related to technical quality of care, and meeting family member needs. In the physician questionnaire, "Nursing Leadership" was not positively correlated with "Within-group Communication Openness" and "Relative Technical Quality of Care". Both "Nursing Leadership" and "Physician Leadership" were not correlated with "Medical Director Budgeting Authority". Concerning discriminant validity, "Nursing and Physician Leadership" were negatively correlated with "Within-group Avoiding Conflict Strategies" and "Between-group Avoiding Conflict Strategies".

Concurrent validity

Positive correlations between the results were obtained with the NPCS and with both the nurses' (r=0.432, P<0.001) and physicians' responses (r=0.372, P<0.001) (Table 3).

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Table 2: Descriptive statistics and Cronbach's alphas for subscales

Subscales	No. of Items	Total (N=1760)				Nurse (N=1475)				Physician (N=285)			
		Mean	SD	Cronbach's α	Mean-inter item correlations	Mean	SD	Cronbach's α	Mean-inter item correlations	Mean	SD	Cronbach's α	Mean-inter item correlations
Teamwork and Leadership													
Nursing Leadership	8	3.52	0.44	0.67	0.21	3.51	0.43	0.64	0.19	3.60	0.53	0.79	0.32
Physician Leadership	8	3.38	0.49	0.73	0.25	3.33	0.45	0.68	0.21	3.68	0.58	0.81	0.34
Unit Relations with Other Units	4	3.31	0.66	0.76	0.43	3.26	0.64	0.74	0.41	3.62	0.70	0.79	0.48
Relationships and Communications within the Unit													
Within-group Communication Openness	4	3.43	0.71	0.80	0.51	3.31	0.67	0.77	0.46	4.01	0.63	0.81	0.51
Between-group Communication Openness	4	3.15	0.80	0.87	0.40	3.10	0.65	0.71	0.38	3.35	0.73	0.76	0.45
Within-group Communication Accuracy	4	3.14	0.67	0.73	0.62	3.02	0.77	0.86	0.60	3.85	0.54	0.77	0.45
Between-group Communication Accuracy	3	3.31	0.72	0.74	0.49	3.40	0.68	0.71	0.45	2.86	0.73	0.77	0.52
Communication Timeliness	3	3.71	0.51	0.62	0.35	3.67	0.50	0.61	0.35	3.92	0.49	0.62	0.36
Conflict Management													
Within-group Problem-solving Conflict Strategy	4	3.23	0.68	0.80	0.49	3.73	0.66	0.80	0.48	3.37	0.70	0.76	0.52
Between-group Problem-solving Conflict Strategy	4	3.27	0.68	0.84	0.51	3.25	0.68	0.80	0.50	3.37	0.66	0.84	0.55
Within-group Avoiding Conflict Strategy	3	2.31	0.67	0.74	0.51	2.34	0.66	0.80	0.50	2.18	0.72	0.83	0.55
Between-group Avoiding Conflict Strategy	3	2.25	0.67	0.81	0.57	2.26	0.67	0.84	0.58	2.17	0.71	0.84	0.57
Perceived Unit/Team Effectiveness													
Perceived Effectiveness at Recruiting and Retaining Nurses	4	2.80	0.61	0.71	0.38	2.77	0.59	0.68	0.35	2.94	0.70	0.78	0.48
Perceived Effectiveness at Recruiting and Retaining Physicians	4	3.02	0.54	0.72	0.40	3.01	0.51	0.70	0.39	3.09	0.69	0.77	0.45
Absolute Technical Quality of Care	5	3.47	0.51	0.74	0.36	3.45	0.50	0.73	0.35	3.54	0.56	0.77	0.40
Relative Technical Quality of Care	3	3.59	0.74	0.89	0.74	3.57	0.73	0.89	0.73	3.69	0.80	0.89	0.75
Perceived Effectiveness at Meeting Family Member Needs	2	3.42	0.63	0.60	0.43	3.38	0.63	0.61	0.44	3.61	0.59	0.50	0.34
Authority													
Nursing Director Budgeting Authority	3	3.09	0.84	0.77	0.53	3.11	0.83	0.78	0.54	2.98	0.87	0.77	0.53
Medical Director Budgeting Authority	3	3.57	0.76	0.76	0.51	3.53	0.74	0.75	0.50	3.81	0.84	0.77	0.55
Nursing Director Patient Care Authority	2	2.91	0.92	0.79	0.66	2.95	0.92	0.80	0.68	2.73	0.93	0.74	0.50
Medical Director Patient Care Authority	2	3.78	0.79	0.78	0.64	3.79	0.76	0.77	0.63	3.78	0.90	0.82	0.70
Job Satisfaction	1	2.99	0.93	—	—	2.88	0.90	—	—	3.55	0.88	—	—

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Table 3: Correlation coefficients (Pearson r) for total score of the ICU Nurse–Physician Questionnaire with the Nurse–Physician Collaboration Scale (NPCS)

	Nurse–Physician Collaboration Scale (NPCS)			
	Joint Participation in Care	Sharing of Patient Information	Cooperativeness	Total
ICU Nurse–Physician Questionnaire (Nurse) total	.416**	.362**	.394**	.453**
ICU Nurse–Physician Questionnaire (Physician) total	.375**	.263**	.281**	.345**

**P<0.01

Analysis of variance of scales

Table 4 showed that the variability of between-unit responses was larger than the within-unit error, except for the subscale "Communication Timeliness" for physicians (P=0.39). The variability of scores for within-unit responses for "Communication Timeliness" was larger than that of between-unit responses. Appendix 3 shows the within-unit responses for ICCs by subscales. Dots in the graphs indicate the point estimate of the ICCs at each unit. In most subscales, consistency of individual scores for physicians was lower than those for nurses across NICUs.

DISCUSSION

Main findings

This is the first study to reveal the psychometric property of the ICU N-P-Q in a Japanese sample with a large number of working units. Moderate to high reliabilities were observed for internal consistency, except for the subscale of "Perceived Effectiveness Meeting Family Needs," which was 0.50 for physicians. Convergent and discriminant validity was confirmed by assessing correlations for the 21 subscales and "Job Satisfaction" in the nurses' questionnaire. From the viewpoint of convergent validity in the physicians' questionnaire, the predicted relationships were not fully supported. Concurrent validity was confirmed by correlations between the NPCS and both the nurses' and physicians' responses. ANOVA of scales showed that the variability of between-unit responses exceeded the within-unit error, except for the physicians' responses to the "Communication Timeliness" subscale. As for this subscale, the scores were more variable for between-unit responses than for within-unit responses. ICCs indicated that individual nurses' scores were less variable than physicians' scores across NICUs.

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Table 4: Analysis of variance of scales

	Total (N=1760)			Nurses (N=1475)			Physicians (N=285)		
	Mean	SD	P	Mean	SD	P	Mean	SD	P
Teamwork and Leadership									
Nursing Leadership	3.52	0.44	0.00	3.50	0.43	0.00	3.60	0.53	0.00
Physician Leadership	3.38	0.49	0.00	3.33	0.45	0.00	3.68	0.58	0.00
Unit Relations with Other Units	3.31	0.66	0.00	3.25	0.64	0.00	3.62	0.70	0.00
Relationships and Communications within the Unit									
Within-group Communication Openness	3.43	0.71	0.00	3.31	0.67	0.00	4.01	0.63	0.00
Between-group Communication Openness	3.14	0.67	0.00	3.09	0.65	0.00	3.35	0.73	0.00
Within-group Communication Accuracy	3.15	0.80	0.00	3.02	0.77	0.00	3.85	0.54	0.03
Between-group Communication Accuracy	3.31	0.72	0.00	3.40	0.68	0.00	2.86	0.73	0.00
Communication Timeliness	3.71	0.51	0.00	3.67	0.50	0.00	3.92	0.49	0.39
Conflict Management									
Within-group Problem-solving Conflict Strategy	3.23	0.68	0.00	3.20	0.67	0.00	3.37	0.70	0.00
Between-group Problem-solving Conflict Strategy	3.27	0.68	0.00	3.25	0.68	0.00	3.37	0.66	0.00
Within-group Avoiding Conflict Strategy	2.31	0.67	0.00	2.34	0.66	0.00	2.18	0.72	0.00
Between-group Avoiding Conflict Strategy	2.25	0.67	0.00	2.26	0.67	0.00	2.17	0.71	0.00
Perceived Unit/Team Effectiveness									
Perceived Effectiveness at Recruiting and Retaining Nurses	2.80	0.61	0.00	2.77	0.59	0.00	2.94	0.70	0.00
Perceived Effectiveness at Recruiting and Retaining Physicians	3.02	0.54	0.00	3.01	0.51	0.00	3.09	0.69	0.00
Absolute Technical Quality of Care	3.47	0.51	0.00	3.45	0.50	0.00	3.54	0.56	0.00
Relative Technical Quality of Care	3.59	0.74	0.00	3.57	0.73	0.00	3.69	0.80	0.00
Perceived Effectiveness at Meeting Family Member Needs	3.42	0.63	0.00	3.38	0.63	0.00	3.61	0.59	0.02
Authority									
Nursing Director Budgeting Authority	3.09	0.84	0.00	3.11	0.83	0.00	2.98	0.87	0.02
Medical Director Budgeting Authority	3.57	0.76	0.00	3.53	0.74	0.00	3.81	0.84	0.00
Nursing Director Patient Care Authority	2.91	0.92	0.00	2.95	0.92	0.00	2.73	0.93	0.00
Medical Director Patient Care Authority	3.78	0.79	0.00	3.79	0.76	0.00	3.78	0.90	0.00
Job Satisfaction	2.99	0.93	0.00	2.88	0.90	0.00	3.55	0.88	0.00

*P values indicate that the variability of between-unit responses is statistically significant.

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Explanation and interpretation

Although Cronbach's alpha coefficients for both the nurses' and physicians' questionnaires were mostly acceptable, they were not fully comparable with the original validation study[8] and previous studies using the ICU N-P-Q[9-12], which had a combined nurse–physician sample. The lowest reliability was found in the subscale "Perceived Effectiveness Meeting Family Needs" for physicians. This relatively low reliability was probably because this subscale was composed of only two items; importantly, the value of Cronbach's alpha depends on the number of items on the scale [21]. However, we decided to retain these items as the mean inter-item correlations (0.34) were in the range of the optimal level of homogeneity (0.20 to 0.40) suggested by Briggs and Cheek [22]. To enhance the subscale's consistency, these two items could be refined by several additional statements. It is important to consider these aspects when administering the scale. The assumption of convergent validity was not satisfactorily verified in the subscales "Within-group Communication Openness", "Relative Technical Quality of Care", and "Medical Director Budgeting Authority" in the physicians' questionnaire. This suggests that items in these three subscales may not be well grouped. On the other hand, the convergent validity was confirmed for a combined sample of physicians and nurses, as performed in the original study (see Appendix 4).

The variability of between-unit responses did not exceed the within-unit error in the subscale of "Communication Timeliness" for physicians (P=0.39), which was inconsistent with the original study[8]. In sum, greater variability was observed among within-unit responses compared with between-unit responses when assessing the extent to which information about patient care was directly circulated to the relevant health professionals. Regarding within-unit responses for ICCs by subscales, individual nurses' scores were less variable than physicians' scores in most subscales (Figure 1). This implies that ICCs may be related to years of practice. The highest number of practice years in one's own unit was 5 to 9 years for nurses (23.0%), while for physicians was less than 1 year (27.7%). The variability of scores within units may be influenced by the length of working relationships.

This study examined the questionnaires for physicians and nurses separately. Therefore, the present results may have revealed the psychometric properties more accurately than the original study, which had a combined nurse–physician sample, and highlighted some points for further research concerning the difference between perceptions of physicians and nurses. Considering the burden of administration time and the response rate to the short version of the 81-item scale, it might

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be a better approach to use only selected parts of the scales depending on the purpose of individual studies and researchers' specific interests, as previous studies have done [9-11] [19].

Limitations

The present study has a few limitations. First, two components (workplace and facility safety scales/ culture) of the original instrument were not available because of copyright restrictions. Second, some items and subscales (e.g. "Team Cohesion", "Understanding", "Satisfaction with Nurse Communication", "Satisfaction with Physician Communication", "Within-group Forcing", "Between-group Forcing", "Within-group Arbitration", and "Between-group Arbitration") were not included in the shorter version of the physician and nurse questionnaires. Therefore, the data in this study cannot fully compare with the psychometric property of the original study. Finally, the study population was made up of nurses and physicians in the unique environment of NICUs. As the participants in this study were also taking part in a large intervention trial (INTACT), participants in our sample may have had a particular interest in or motivation for improving teamwork and collaboration. Inter-professional communication in NICUs could also be different from general ICUs and other healthcare groups, even in Japan.

CONCLUSION

Although the psychometric property of the Japanese ICU N-P-Q acted slightly differently in this study according to occupation, this scale can be used to measure the extent and quality of communication and collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

Acknowledgments

Contributors

HS administered the survey, acquired the data, performed the statistical analysis, and prepared the

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draft. NY provided supervision of the study design, the data analysis and interpretation. RM supervised the design of the study. TNi and SK managed the whole research process. TNa supervised the data analysis and critically revised the manuscript for important intellectual content. All authors were involved in critical commentary and approved the final version of the manuscript.

Competing interests None declared.

Patient consent Not obtained.

Data sharing statement   No additional data available.

REFERENCES

1. Shortell SM, Zimmerman JE, Rousseau DM, *et al*. The performance of intensive care units: does good management make a difference? *Medical Care* 1994:508-25.

2. Narasimhan M, Eisen LA, Mahoney CD, *et al*. Improving nurse-physician communication and satisfaction in the intensive care unit with a daily goals worksheet. *American Journal of Critical Care* 2006;**15**(2):217-22.

3. Bower P, Campbell S, Bojke C, *et al*. Team structure, team climate and the quality of care in primary care: an observational study. *Quality and Safety in Health Care* 2003;**12**(4):273-79.

4. Davenport DL, Henderson WG, Mosca CL, *et al*. Risk-adjusted morbidity in teaching hospitals correlates with reported levels of communication and collaboration on surgical teams but not with scale measures of teamwork climate, safety climate, or working conditions. *Journal of the American College of Surgeons* 2007;**205**(6):778-84.

5. Zwarenstein M, Goldman J, Reeves S. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. *The Cochrane Database of Systematic Reviews* 2009;**3**(CD000072).

6. Valentine MA, Nembhard IM, Edmondson AC. Measuring teamwork in health care settings: A review of survey instruments. *Medical Care* 2015;**53**(4):e16-e30.

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7. Dougherty MB, Larson E. A review of instruments measuring nurse‑physician collaboration. *Journal of Nursing Administration* 2005;**35**(5):244-53.

8. Shortell SM, Rousseau DM, Gillies RR, *et al*. Organizational assessment in intensive care units (ICUs): construct development, reliability, and validity of the ICU nurse-physician questionnaire. *Medical Care* 1991;**29**(8):709-26.

9. Manojlovich M, DeCicco B. Healthy work environments, nurse-physician communication, and patients' outcomes. *American Journal of Critical Care* 2007;**16**(6):536-43.

10. Miller PA. Nurse-physician collaboration in an intensive care unit. *American Journal of Critical Care* 2001;**10**(5):341-50.

11. Manojlovich M, Antonakos CL, Ronis DL. Intensive care units, communication between nurses and physicians, and patients' outcomes. *American Journal of Critical Care* 2009;**18**(1):21-30.

12. Manojlovich M. Linking the practice environment to nurses' job satisfaction through nurse‑physician communication. *Journal of Nursing Scholarship* 2005;**37**(4):367-73.

13. Reader TW, Flin R, Mearns K, *et al*. Interdisciplinary communication in the intensive care unit. *British Journal of Anaesthesia* 2007;**98**(3):347-52.

14. Dietz AS, Pronovost PJ, Mendez-Tellez PA, *et al*. A systematic review of teamwork in the intensive care unit: What do we know about teamwork, team tasks, and improvement strategies? *Journal of Critical Care* 2014;**29**(6):908-14.

15. Russ S, Rout S, Sevdalis N, *et al*. Do safety checklists improve teamwork and communication in the operating room? A systematic review. *Annals of Surgery* 2013;**258**(6):856-71.

16. Gysels M, Richardson A, Higginson IJ. Communication training for health professionals who care for patients with cancer: a systematic review of effectiveness. *Supportive Care in Cancer* 2004;**12**(10):692-700.

17. Shortell SMaR, D.M. The Organization and Management of Intensive Care Units. ICU Nurse Questionnaire (Short Version). 1989.

18. Cooke RA LJ. Level V: Organizational Culture Inventory: Plymouth, Mich: Human Synergistics, 1987.

19. Hansen HE, Biros MH, Delaney NM, *et al*. Research utilization and interdisciplinary collaboration in emergency care. *Academic Emergency Medicine* 1999;**6**(4):271-9.

20. Ushiro R. Nurse–Physician Collaboration Scale: development and psychometric testing. *Journal of Advanced Nursing* 2009;**65**(7):1497-508.

21. Cortina JM. What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology* 1993;**78**(1):98.

22. Briggs SR, Cheek JM. The role of factor analysis in the development and evaluation of personality scales. *Journal of Personality* 1986;**54**(1):106-48.

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Appendixes

Appendix 1: Spearman correlations of physician questionnaire (N=285)

<ATTACHED SEPARATELY>

Appendix 2: Spearman correlations of nurse scales (N=1475)

<ATTACHED SEPARATELY>

Appendix 3: Intraclass correlation coefficients (ICCs) within-unit responses by subscales

<ATTACHED SEPARATELY>

The dots in the graphs indicate the point estimate of ICCs at each unit.

Appendix 4: Spearman correlations of scales (Total N=1760)

<ATTACHED SEPARATELY>

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Appendix 1: Spearman correlations of physician questionnaire (N=285)

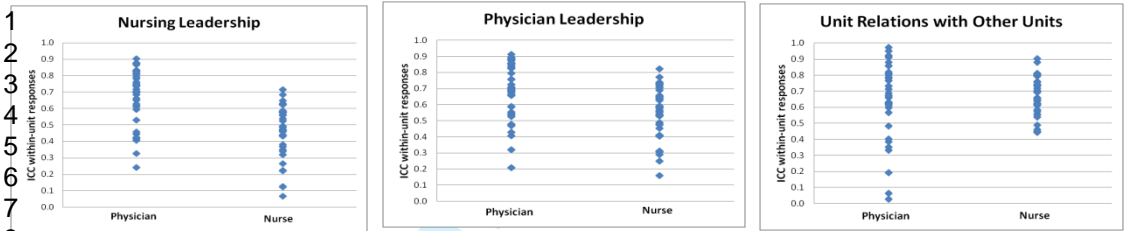| Subscales	Nursing Leadership	Physician Leadership	Unit Relations with Other Units	Within-group Openness	Between-group Openness	Within group accuracy	Between-group Accuracy	Communication Timeliness	Within group Problemsolving	Between-group Problem-solving	Within-group Avoiding Conflict	Between group Avoiding Conflict	Perceived Effectiveness in Recruiting and Retaining Nurses	Perceived effectiveness at recruiting and retaining physician	Absolute Technical Quality of Care	Relative technical quality of care	Perceived Effectiveness at Meeting Family Member Needs	Nursing Director Budgeting Authority	Medical Director Budgeting Authority	Nursing Director Patient Care Authority	Medical Director Patient Care Authority	Job Satisfaction
Teamwork and Leadership																						
Nursing Leadership	1.00																					
Physician Leadership	.403**	1.00																				
Unit relations with Other Units	.312**	.405**	1.00																			
Relationships and Communications within the Unit																						
Within-group Communication Openness	0.07	.423**	.283**	1.00																		
Between-group Communication Openness	.262**	.383**	.356**	.411**	1.00																	
Within-group Communication Accuracy	.176**	.160**	.133*	.356**	0.10	1.00																
Between-group Communication Accuracy	.383**	.276**	.227**	0.09	.462**	0.09	1.00															
Communication Timeliness	.232**	.203**	.159**	.320**	.245**	.299**	.298**	1.00														
Conflict Management																						
Within-group Problem-solving Conflict Strategy	.221**	.346**	.247**	.441**	.272**	.293**	.210**	.296**	1.00													
Between-group Problem-solving Conflict Strategy	.259**	.385**	.326**	.433**	.333**	.260**	.260**	.251**	.655**	1.00												
Within-group Avoiding Conflict Strategy	-.227**	-.403**	-.284**	-.472**	-.291**	-.207**	-.196**	-.187**	-.854**	-.602**	1.00											
Between-group Avoiding Conflict Strategy	-.248**	-.378**	-.262**	-.316**	-.255**	-.341**	-.222**	-.215**	-.831**	-.552**	.690**	1.00										
Perceived Unit/Team Effectiveness																						
Perceived Effectiveness at Recruiting and Retaining Nurses	.343**	.238**	.189**	0.08	.211**	.181**	.318**	.165**	.222**	.288**	-.199**	-.248**	1.00									
Perceived Effectiveness at Recruiting and Retaining Physicians	.160**	.425**	.243**	.322**	.332**	.152**	.192**	.154**	.229**	.302**	-.244**	-.185**	.455**	1.00								
Absolute Technical Quality of Care	.268**	.508**	.288**	.425**	.402**	.216**	.291**	.312**	.380**	.497**	-.377**	-.333**	.388**	.460**	1.00							
Relative Technical Quality of Care	0.10	.187**	0.03	0.10	0.07	.130*	0.10	.191**	.131*	.154**	-0.11	-.127*	.330**	.357**	.356**	1.00						
Perceived Effectiveness at Meeting Family Member Needs	.174**	.255**	.176**	.225**	.204**	.178**	.147*	.243**	.240**	.269**	-.229**	-.203**	.308**	.295**	.523**	.392**	1.00					
Authority																						
Nursing Director Budgeting Authority	.137*	.143*	.119*	0.00	0.11	0.01	0.08	0.03	0.02	.117*	-0.01	-0.06	.137*	0.07	.158**	0.05	0.08	1.00				
Medical Director Budgeting Authority	-0.05	0.00	-0.02	0.07	0.01	0.07	-0.11	0.10	0.01	0.02	0.03	0.02	0.10	0.09	0.10	.146*	0.04	.357**	1.00			
Nursing Director Patient Care Authority	.177**	.131*	0.07	0.07	.120*	0.09	.166**	0.08	0.11	.161**	-.151*	-.163**	.281**	.203**	.253**	0.09	.193**	.437**	0.03	1.00		
Medical Director Patient Care Authority	.150*	.289**	0.02	.135*	.179**	0.00	.170**	.150*	0.08	.241**	-0.07	-0.09	0.02	0.11	.245**	0.08	.128*	.158**	.177**	.297**	1.00	
Job Satisfaction	.157**	.362**	.231**	.412**	.250**	.192**	0.12	.263**	.217**	.278**	-.252**	-.159**	.225**	.439**	.420**	.235**	.285**	0.09	.174**	.159**	0.10	1.00

*P<0.05, **P<0.01

Appendix 2: Spearman correlations of nurse scales (N=1475)

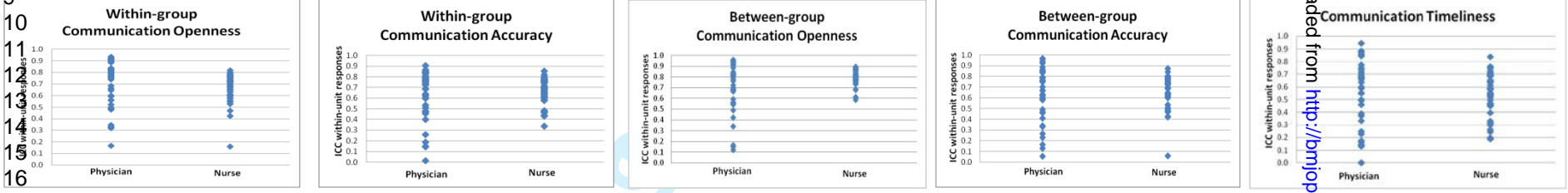| Subscales	Nursing Leadership	Physician Leadership	Unit Relations with Other Units	Within-group Openness	Between group Openness	Within-group Accuracy	Between-group Accuracy	Communication Timeliness	Within group Problem-solving	Between group Problem-solving	Within group Avoiding Conflict	Between group Avoiding Conflict	Perceived Effectiveness at Recruiting and Retaining nurses	Perceived Effectiveness at Recruiting and Retaining physician	Absolute Technical Quality of Care	Relative Technical Quality of Care	Perceived Effectiveness at Meeting Family Member Needs	Nursing Director Budgeting Authority	Medical Director Budgeting Authority	Nursing Director Patient Care Authority	Medical Director Patient Care Authority	Job Satisfaction
Teamwork and Leadership																						
Nursing Leadership	1.00																					
Physician Leadership	.412**	1.00																				
Unit Relations with Other Units	.302**	.288**	1.00																			
Relationships and Communications within the Unit																						
Within-group Communication Openness	.265**	.128**	.266**	1.00																		
Between-group Communication Openness	.248**	.235**	.296**	.265**	1.00																	
Within-group Communication Accuracy	.126**	.240**	.210**	.398**	.145**	1.00																
Between-group Communication Accuracy	.209**	.282**	.219**	0.04	.444**	.175**	1.00															
Communication Timeliness	.169**	.105**	.177**	.357**	.214**	.313**	.102**	1.00														
Conflict Management																						
Within-group Problem-solving Conflict Strategy	.276**	.314**	.250**	.159**	.290**	.229**	.259**	.130**	1.00													
Between-group Problem-solving Conflict Strategy	.299**	.343**	.271**	.177**	.309**	.207**	.218**	.135**	.498**	1.00												
Within-group Avoiding Conflict Strategy	-.301**	-.243**	-.271**	-.278**	-.300**	-.127**	-.205**	-.111**	-.675**	-.436**	1.00											
Between-group Avoiding Conflict Strategy	-.276**	-.324**	-.252**	-.158**	-.287**	-.238**	-.263**	-.125**	-.985**	-.490**	.663**	1.00										
Perceived Unit/Team Effectiveness																						
Perceived Effectiveness at Recruiting and Retaining Nurses	.357**	.260**	.381**	.289**	.300**	.149**	.146**	.149**	.215**	.340**	-.284**	-.219**	1.00									
Perceived Effectiveness at Recruiting and Retaining Physicians	.184**	.339**	.272**	.100**	.207**	.214**	.296**	.113**	.242**	.292**	-.172**	-.245**	.495**	1.00								
Absolute Technical Quality of Care	.336**	.388**	.343**	.234**	.297**	.208**	.260**	.223**	.317**	.430**	-.284**	-.316**	.452**	.429**	1.00							
Relative Technical Quality of Care	.159**	.164**	.151**	0.02	.052*	.058*	0.01	.100**	.124**	.159**	-.081**	-.132**	.288**	.287**	.357**	1.00						
Perceived Effectiveness at Meeting Family Member Needs	.237**	.251**	.270**	.204**	.243**	.141**	.129**	.204**	.216**	.327**	-.237**	-.220**	.427**	.337**	.550**	.373**	1.00					
Authority																						
Nursing Director Budgeting Authority	.203**	.207**	.179**	0.05	.073**	.153**	0.02	-0.02	.138**	.179**	-.092**	-.153**	.226**	.184**	.236**	.150**	.167**	1.00				
Medical Director Budgeting Authority	.124**	.102**	.089**	.125**	0.03	.119**	-0.01	.136**	0.02	.068**	0.04	-0.02	.113**	.128**	.128**	.129**	.119**	.416**	1.00			
Nursing Director Patient Care Authority	.199**	.247**	.213**	.059*	.146**	.112**	.067**	0.00	.137**	.238**	-.127**	-.142**	.248**	.190**	.216**	.134**	.186**	.546**	.191**	1.00		
Medical Director Patient Care Authority	.148**	.175**	.111**	.085**	.055*	.066*	.062*	.120**	.068**	.118**	-0.03	-.071**	.067**	.117**	.176**	.137**	.158**	.193**	.440**	.269**	1.00	
Job Satisfaction	.257**	.166**	.324**	.440**	.200**	.247**	.106**	.196**	.179**	.218**	-.246**	-.173**	.389**	.221**	.281**	.059*	.206**	.122**	.088**	.122**	.060*	1.00

*P<0.05, **P<0.01

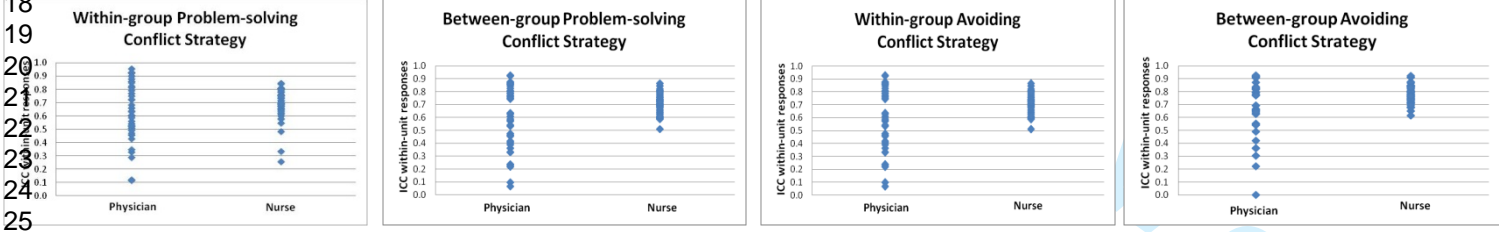## Teamwork and Leadership

Relationships and Communications within the Unit

Conflict Management

Perceived Unit/Team Effectiveness
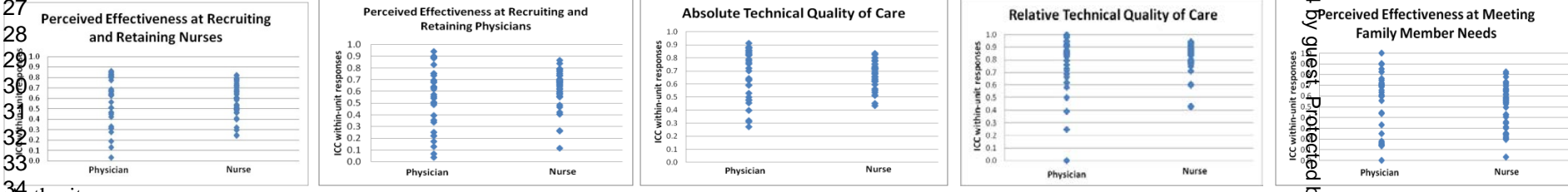
Authority
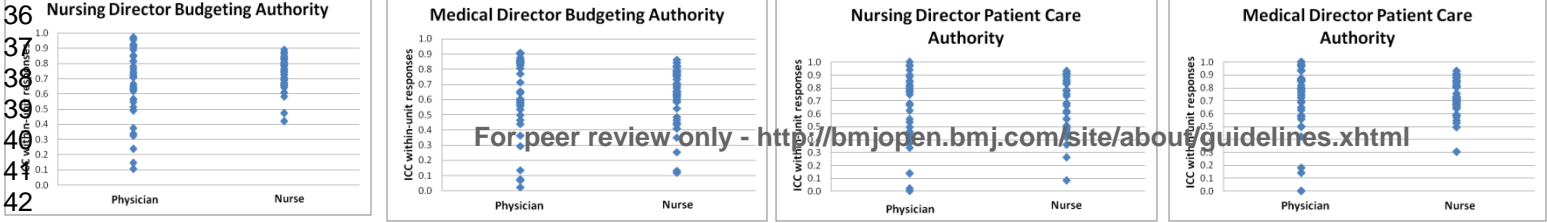
Appendix 4: Spearman correlations of scales (Total N=1760)

Subscales	Nursing Leadership	Physician Leadership	Unit Relations with Other Units	Within-group Openness	Between-group Openness	Within-group Accuracy	Between-group Accuracy	Communication Timeliness	Within-group Problem-solving	Between-group Problem-solving	Within-group Avoiding Conflict	Between-group Avoiding Conflict	Perceived Effectiveness at Recruiting and Retaining Nurses	Perceived Effectiveness at Recruiting and Retaining Physicians	Absolute Technical Quality of Care	Relative Technical Quality of Care	Perceived Effectiveness at Meeting Family Member Needs	Nursing Director Budgeting Authority	Medical Director Budgeting Authority	Nursing Director Patient Care Authority	Medical Director Patient Care Authority	Job Satisfaction
Teamwork and Leadership																						
Nursing Leadership	1.00																					
Physician Leadership	.415**	1.00																				
Unit relations with Other Units	.312**	.348**	1.00																			
Relationships and Communications within the Unit																						
Within-group Communication Openness	.240**	.258**	.319**	1.00																		
Between-group Communication Openness	.258**	.291**	.326**	.317**	1.00																	
Within-group Communication Accuracy	.150**	.299**	.257**	.476**	.179**	1.00																
Between-group Communication Accuracy	.213**	.188**	.151**	-.054*	.387**	0.04	1.00															
Communication Timeliness	.191**	.164**	.204**	.388**	.239**	.351**	.077**	1.00														
Conflict Management																						
Within-group Problem-solving Conflict Strategy	.267**	.321**	.254**	.208**	.290**	.236**	.226**	.164**	1.00													
Between-group Problem-solving Conflict Strategy	.294**	.353**	.287**	.224**	.318**	.220**	.198**	.161**	.525**	1.00												
Within-group Avoiding Conflict Strategy	-.291**	-.289**	-.285**	-.320**	-.307**	-.160**	-.170**	-.138**	-.709**	-.467**	1.00											
Between-group Avoiding Conflict Strategy	-.273**	-.335**	-.258**	-.188**	-.284**	-.248**	-.232**	-.146**	-.958**	-.501**	.669**	1.00										
Perceived Unit/Team Effectiveness																						
Perceived Effectiveness at Recruiting and Retaining Nurses	.359**	.272**	.354**	.269**	.292**	.178**	.144**	.167**	.220**	.333**	-.273**	-.228**	1.00									
Perceived Effectiveness at Recruiting and Retaining Physicians	.181**	.362**	.270**	.152**	.240**	.204**	.246**	.128**	.240**	.294**	-.191**	-.233**	.487**	1.00								
Absolute Technical Quality of Care	.325**	.416**	.338**	.271**	.323**	.216**	.236**	.246**	.331**	.443**	-.306**	-.321**	.443**	.436**	1.00							
Relative Technical Quality of Care	.151**	.177**	.137**	.056*	.062**	.084**	0.01	.124**	.127**	.161**	-.090**	-.133**	.301**	.304**	.359**	1.00						
Perceived Effectiveness at Meeting Family Member Needs	.231**	.274**	.274**	.239**	.250**	.183**	.089**	.229**	.224**	.323**	-.244**	-.221**	.412**	.329**	.547**	.379**	1.00					
Authority																						
Nursing Director Budgeting Authority	.184**	.171**	.153**	0.02	.070**	.101**	.047*	-0.02	.114**	.164**	-.072**	-.133**	.201**	.155**	.217**	.129**	.143**	1.00				
Medical Director Budgeting Authority	.096**	.111**	.093**	.155**	0.04	.154**	-.067**	.150**	0.02	.067**	0.02	-0.02	.124**	.124**	.129**	.139**	.122**	.392**	1.00			
Nursing Director Patient Care Authority	.186**	.192**	.165**	0.03	.127**	.067**	.104**	0.00	.128**	.219**	-.123**	-.141**	.242**	.186**	.216**	.121**	.173**	.529**	.148**	1.00		
Medical Director Patient Care Authority	.148**	.193**	.090**	.086**	.079**	.051*	.081**	.123**	.069**	.139**	-0.04	-.073**	.057*	.115**	.189**	.125**	.150**	.186**	.382**	.273**	1.00	
Job Satisfaction	.157**	.248**	.259**	.346**	.488**	.238**	.315**	0.03	.245**	.193**	.237**	-.262**	-.178**	.371**	.269**	.312**	.101**	.244**	.097**	.135**	.101**	.065**

*P<0.05, **P<0.01

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	manuscript page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 5, 6
Bias	9	Describe any efforts to address potential sources of bias	Page 5
Study size	10	Explain how the study size was arrived at	Page 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 6, 7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	Page 5
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7, 8
		(b) Indicate number of participants with missing data for each variable of interest	Page 8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		*Cross-sectional study—*Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Use of the ICU Nurse–Physician Questionnaire (ICU N-P-Q): testing reliability and validity in neonatal intensive care units in Japan

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Manuscripts

Use of the ICU Nurse-Physician Questionnaire (ICU N-P-Q): testing reliability and validity in neonatal intensive care units in Japan

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ABSTRACT

Objective: Although communication among health providers has become a critical part of improving quality of care, few studies on this topic have been conducted in Japan. This study aimed to examine the reliability and validity of the ICU Nurse–Physician Questionnaire (ICU N-P-Q) for use among nurses and physicians in neonatal intensive care units (NICUs) in Japan.

Methods: A Japanese translation of the ICU N-P-Q was administered to physicians and nurses working at 40 NICUs across Japan, which were participating in the Team Approach Cluster randomized controlled trial (INTACT). We used the principal components analysis to evaluate the factor structure of the instruments. Convergent validity was assessed by examining correlations between the subscales of Communication and Conflict Management of the ICU N-P-Q, and the subscales and total score of the Nurse-Physician Collaboration Scale (NPCS). Correlations between the subscales of Communication and Conflict Management by correlation with scales that refer to performance, including Job satisfaction and Unit effectiveness, were calculated to test the criterion validity.

Results: In total, 2006 questionnaires were completed by 316 physicians and 1690 nurses. The exploratory factor analysis revealed sixteen factors in the physicians' questionnaire and fifteen in the nurses' questionnaire. Convergent validity was confirmed, except for 'Between-group Accuracy' and 'Cooperativeness' in the physicians' scale, and for 'Between-group Accuracy' and 'Sharing of Patient Information' in the nurses' scale. Correlations between the subscales of communication and outcomes were confirmed in the nurses' questionnaire but were not fully supported in the physicians' questionnaire.

Conclusion: Although the psychometric property behaved somewhat differently by occupation, the present findings provide preliminary support for the utility of the common item structure with the original scale, to measure the degree and quality of communication and collaboration among staff at NICUs and similar healthcare settings in Japan.

STRENGTHS AND LIMITATIONS OF THIS STUDY

■ This is the first study to reveal the psychometric properties of the ICU N-P-Q in a Japanese sample with a large number of working units.

■ The present findings provided preliminary support for the Japanese ICU N-P-Q, which can be used to measure the extent and quality of communication/collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

■ Examining the questionnaires for physicians and nurses separately may have revealed the psychometric properties more accurately than the original study, which had a combined nurse–physician sample.

■ Some items were deleted from the questionnaire due to copyright restrictions. Therefore, the data in this study cannot fully compare with the psychometric property of the original study.

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INTRODUCTION

Good relationships among staff in healthcare organizations are an essential factor to provide safe and high quality care. Previous studies have observed that better communication and collaboration among healthcare providers is associated with higher technical quality of care,[1] lower length of stay,[2] superior clinical care in disease,[3] and risk-adjusted morbidity.[4] Communication and collaboration among health professionals has been shown to make an impact on patient outcomes. A Cochrane systematic review[5] found that practice-based interprofessional collaboration interventions enhanced healthcare processes and outcomes; however, generalizing the core components of interprofessional collaboration interventions and its effectiveness remains an ongoing challenge.

The aspects of communication include the degree to which physicians or nurses can carry out discussions without fear of repercussions or misunderstanding, the degree to which they believe in the consistent accuracy of the information conveyed by others, and the degree to which patient care information is relayed promptly to the people who need to be informed.[6] Collaboration can be defined as the process where nurses and physicians work together in the delivery of quality care, jointly contributing in a balanced relationship characterized by mutual trust.[7] There is a great deal of overlap between communication and collaboration; as Shortell et al.[8] described, collaboration involves open and timely communication, integration of individual's varied work activities, and ensuring that all available expertise is brought together to support problem solving and conflict resolution. To advance our understanding of the impact and effectiveness of communication and collaboration on patient outcomes, it is critical to accurately assess the degree and quality of communication and collaboration among health professionals. A recent systematic review of survey instruments for measuring teamwork in healthcare settings identified 36 scales which met the study criteria.[9] Twelve out of 36 scales documented relationships between teamwork and objective outcomes of interest in peer-reviewed studies[9]. Another systematic review[10] of survey instruments for assessing collaboration in healthcare settings found five instruments that met the study criteria for psychometric validity. The ICU Nurse-Physician Questionnaire (ICU N-P-Q)[8] was one of the two scales identified by both reviews as a useful valid scale for future research.

The ICU N-P-Q was originally developed using a large national sample to measure collaboration at the intensive care unit level and organizational components that facilitate a collaborative clinical interaction. The scale has been used to assess perceptions of nurse–physician collaboration in critical and non-critical care in the United States (US)[11-14] and the United Kingdom.[15] A part of the scale was

also used to assess leadership, disagreements, and authority within the context of a neonatal intensive care unit (NICU).[16] The biggest difference between ICU and NICU is the size of patients. Medication dosages of neonatal patients depend on their weight, and a large NICU is likely to have a much wider variety of diagnoses as compared with a small NICU. Therefore, inter-professional communication in NICUs could be different from general ICUs and other healthcare groups, even in Japan. In this study, we aimed to examine the reliability and validity of the translated ICU N-P-Q among nurses and physicians from neonatal intensive care units (NICUs) across Japan.

METHODS

Translation process

Permission to use the ICU N-P-Q and create a Japanese version was obtained from the original authors. A professional translator of Japanese translated the original English version into Japanese, after which a different professional translator conducted back translation of the scale. However, two components of the scale (workplace and facility safety scales/culture) were not translated or included because of copyright restrictions. In order to maintain quality control, the back translation was shared with Dr. Stephen M. Shortell, Principal Investigator of the original study.[8] After two authors (HS and RM) assessed the expressions used in the Japanese ICU N-P-Q, a pretest was performed on 30 physicians and 124 nurses from three pre-intervention facilities, which were participating in a trial known as the Improvement of NICU Practice and Team Approach Cluster randomized controlled trial (INTACT). The pretest aimed to assess whether the Japanese ICU N-P-Q was appropriate and easily understandable for nursing and physician personnel. The Japanese ICU N-P-Q was finalized after some modifications were made to the wording in response to pretest feedback.

Ethical statement

Participation in this study was voluntary and written consent was obtained from each participant. Anonymity and confidentiality of the data was assured to all participants. Ethical approval was obtained on 15 July 2011 from the independent review board of INTACT (UMIN000007064), which has its administrative office in Tokyo Women's Medical University. This study was also approved by the Ethics Committee of the Kyoto University Graduate School and Faculty of Medicine on 28 March 2014.

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Sample and data

In this study, we used baseline data from a questionnaire distributed to physicians and nurses working at 40 NICUs that were participating in INTACT and located in different areas of Japan. Questionnaires were distributed to 345 physicians and 1800 nurses. The unlinked anonymous survey was administered from December 2011 to March 2012. We excluded data from the analysis if there were missing values for any variables in the ICU N-P-Q, and if all or almost all of the items in each subscale were scored with the same number (e.g. scored '1' in all values).

Instrument

ICU Nurse–Physician Questionnaire (ICU N-P-Q)

The original ICUN-P-Q is a 120-item scale derived from the Organizational Culture Inventory with response items ranked on a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree.[17] A revised and shortened version of the instrument is also available as an 81-item scale. In this study, we used the shorter version. Although a separate test for reliability and validity has not been completed for the shorter version, the authors who developed the ICU N-P-Q believed that the shorter version was easier to administer and was therefore able to achieve better survey compliance while ensuring good validity and reliability.[17] Two components of the scale (workplace and facility safety scales/culture) were excluded because of copyright restrictions.[18] The subscales of the ICU N-P-Q consist of Leadership, Communication, Coordination, Conflict Management, Unit Effectiveness, and Authority, and a single item on Job Satisfaction. The scale includes separate questionnaires for physicians and nurses. Shortell et al.[8] reported that Cronbach's alpha reliabilities ranged from 0.61 to 0.88 for subscales. Other researchers have reported reliabilities from 0.66 to 0.92. [11 13 14 19]

Nurse-Physician Collaboration Scale (NPCS)

The NPCS [20] was developed to measure collaboration between nurses and physicians in Japan. The questionnaire is a 27-item scale and consists of three subscales: Joint Participation in Care, Sharing of Patient Information, and Cooperativeness. Participants rate how often they experience these positive work-related states using a 7-point Likert scale ranging from 1='never' to 7='always/every day'. Cronbach's alpha reliabilities for nurses' responses to the subscales ranged from 0.80 to 0.92 and that of physicians' responses ranged from 0.84 to 0.93. Psychometric testing showed that the

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NPCS was reliable and valid with high internal consistency and the results for test-retest reliability were adequate. Similar to the ICU N-P-Q, the NPCS focuses on nurses' and physicians' collaborative and problem-solving skills.[20] In this study, the NPCS was administered to test convergent validity of the Japanese ICU N-P-Q.

Conceptual framework

The conceptual framework of this study was based on the analytic framework of managerial and organizational factors affecting ICU performance, which was developed by Shortell et al.[8] This concept focuses on the identification of main managerial practices and organizational processes that might influence effective performance. The important consideration is that these practices and processes are under the control of managers. According to this theory, organizational culture, leadership, communication, coordination, and problem-solving should be included in these practices and processes. Specifically, a complex environment, such as that observed in intensive care units, requires effective teamwork. More open, accurate, and timely communication, and more open collaborative problem solving approaches would produce more effective patient care and improve health providers' occupational satisfaction.[4 21] The ICU N-P-Q consists of the Leadership and Authority scales assessing organizational factors, Communication and Conflict Management scales measuring the degree and quality of communication and collaboration within and between groups, and Unit Effectiveness and Job Satisfaction scales indicating outcomes of communication and collaboration. This study mainly focused on validating the Communication and Conflict Management scales of the ICU N-P-Q.

Statistical analysis

All statistical analyses were undertaken in SPSS version 21.0 (IBM Corporation, USA). The P value of ≤0.05 was considered as statistically significant.

Item analysis and reliability

First, the normality of the distribution of the scores was checked for each item using means, standard deviations, and skewness and kurtosis, and then the corrected item-total correlations and corrected item-subscale Cronbach's alpha were calculated separately for the physicians' and nurses' scales of the ICU N-P-Q. Items with skewness and kurtosis outside the range -2.00 to +2.00,[22] items with

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corrected item-total correlations <0.3,[23] and items with corrected item-subscale Cronbach's alpha >0.9 were identified for possible exclusion from the scale.

Factor analysis

An exploratory factor analysis was conducted using a principle-component factor analysis with varimax rotation. The latent root criterion was used to decide the number of factors extracted, and factors having eigenvalues greater than 1 were considered significant. The Kaiser-Meyer-Olkin (KMO) was applied to measure the strength of the relationship among variables. KMO values greater than 0.7 are acceptable and values between 0.8 and 0.9 indicate a strong relationship.[24] Factor loadings >0.4 were retained. If the items load on more than one factor, indicating the items are not clearly influenced by one dimension, we dropped the items from the scales.

Validity

Convergent validity of the Communication and Conflict Management scales of the N-P-Q was assessed by means of the scales and total score of the NPCS, in which items are thought to reflect the fundamental aspects of the nurse-physician relationships. The Communication and Conflict Management scales of the N-P-Q included 'Within-group Accuracy', 'Between-group Accuracy', 'Between-group Avoiding Conflict Strategy', and 'Between-group Problem-solving Conflict Strategy' because the NPCS only examines the relationships between physicians and nurses. We assumed that the NPCS would have a positive correlation with the Japanese ICU N-P-Q. We also tested the criterion validity of the Communication and Conflict Management scales by examining their correlation with scales that refer to performance, including Job satisfaction and Unit effectiveness.

RESULTS

Description of sample

A total of 2006 questionnaires were completed by 316 physicians (response rate = 92 %) and 1690 nurses (response rate = 94 %). After excluding missing values and values scored with the same numbers, 1762 questionnaires were used in the analysis, including those of 285 physicians and 1475 nurses. Of the 285 participating physicians, 57 (20%) were head physicians, 200 (70.2%) were physicians, 24 (8.4%) were residents, and there were 3 missing values. Of the 1475 participating

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nurses, 130 (8.8%) were head nurses, 1328 (90.0%) were nurses, 2 (1.0%) were assistant nurses, and there were 15 missing values (1.0%). The highest number of practice years in one's own unit was 5 to 9 years for nurses and less than 1 year for physicians (Table 1).

Table 1: Sample characteristics

	Physicians (N=285) n (%)	Nurses (N=1475) n (%)
SEX		
Male	195 (68.4)	25 (1.7)
Female	87 (30.5)	1430 (96.9)
Missing	3 (1.1)	20 (1.4)
STATUS		
Head physician	57 (20.0)	—
Physician	200 (70.2)	—
Resident	24 (8.4)	—
Missing	4 (1.4)	—
Head nurse	—	130 (8.8)
Nurse	—	1328 (90.0)
Assistant nurse	—	2 (1.0)
Missing	—	15 (1.0)
YEARS OF PRACTICE		
Less than 1 year	79 (27.7)	281 (19.0)
1 to 2 years	49 (17.2)	330 (22.4)
3 to 4 years	55 (19.3)	304 (20.6)
5 to 9 years	53 (18.6)	336 (22.8)
More than 10 years	46 (16.1)	208 (14.1)
Missing	3 (1.1)	16 (1.1)

Item analysis and reliability

Six items were identified for possible exclusion from the physicians' scale. These included one item (number 36) with kurtosis >2.0, three items with corrected item-total correlations <0.3 (number 1, 9, and 38), and two items with corrected item-subscale Cronbach's alphas >0.9 (number 51 and 68). Similarly, nine items were identified for possible exclusion from the nurses' scale. These included

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two items (number 36 and 60) with kurtosis >2.0, five items with corrected item-total correlations <0.3 (number 1, 4, 9, 12, and 38), and two items with corrected item-subscale Cronbach's alphas >0.9 (number 51 and 68) (Appendix 1).

Factor analysis

The principle component factor analysis for the physicians' scale returned to sixteen factors (KMO=0.84, p<0.001) (Appendix 2). These sixteen factors explained 67.9% of the observed variance. Seven items were dropped because three of them loaded less than 0.4 and four loaded equally on both factors. The following items that originally belonged to separate scales were combined into one factor: 2 items on Within-group Avoiding Conflict Strategy and 3 items on Between-group Avoiding Conflict Strategy, 4 items on Within-group Problem-solving Conflict Strategy and 3 items on Between-group Problem-solving Conflict Strategy, 3 items on Absolute Technical Quality of Care and 1 item on Perceived Effectiveness at Meeting Family Member Needs, and 3 items on Nursing Director Budgeting Authority and 2 items on Nursing Director Patient Care Authority.

The factor analysis revealed fifteen factors in the nurses' scale (KMO=0.89, p<0.001) (Appendix 3). The fifteen-factor solution accounted for 61.9% of the total variance. Four items with factor loadings less than 0.4 and five items that loaded equally on both factors were deleted. The following items that originally belonged to separate scales were combined into one factor: 3 items on Within-group Avoiding Conflict Strategy and 3 items on Between-group Avoiding Conflict Strategy; 4 items on Within-group Problem-solving Conflict Strategy and 3 items on Between-group Problem-solving Conflict Strategy; 1 item on Perceived Effectiveness at Recruiting and Retaining Nurses, 1 item on Perceived Effectiveness at Recruiting and Retaining Physicians, 2 items on Absolute Technical Quality of Care, and 1 item on Perceived Effectiveness at Meeting Family Member Needs; and 3 items on Nursing Director Budgeting Authority and 2 items on Nursing Director Patient Care Authority. Other items of both physicians' and nurses' scales were loaded same as the factor structure reported in the original study.

Validity

Convergent and criterion validity

Correlations of the Communication and Conflict Management subscales of the ICU N-P-Q with the

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subscales and total score of the nurse–physician collaboration scale (NPCS) have been shown in Table 2. Since the factor solutions did not reveal clear within-groups and between-groups distinctions for 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy', these scales were not included in the correlation matrix. A positive correlation was observed between the physicians' scale and the NPCS, except for 'Between-group Accuracy' and 'Cooperativeness' (r=0.081, P=0.173). Similarly, a positive correlation was observed between the nurses' scale and the NPCS, except for 'Between-group Accuracy' and 'Sharing of Patient Information' (r=0.036, P=0.162).

The correlations between the subscales on communication/collaboration (Communication, Coordination, and Conflict Management) and the subscales on performance (Job satisfaction and Unit effectiveness) in the ICU N-P-Q have been shown in Table 3. Positive correlations were observed for the physicians' subscales, except for 'Unit relations with other units' and 'Relative Technical Quality of Care' (r=0.024, P=0.684), 'Within-group Openness' and 'Perceived Effectiveness at Recruiting and Retaining Nurses' (r=0.081, P=0.174), 'Within-group Accuracy' and 'Perceived Effectiveness at Recruiting and Retaining Nurses' (r=0.047, P=0.431), 'Between-group Accuracy' and 'Perceived Effectiveness at Recruiting and Retaining Nurses' (r=0.102, P=0.084), and 'Between-group Accuracy' and 'Job satisfaction' (r=0.117, P=0.052). There were positive correlations for all the subscales of the nurses' scale.

DISCUSSION

Main findings

This is the first study to reveal the psychometric property of the ICU N-P-Q in a Japanese sample with a large number of working units. Sixteen out of the 21 scales for physicians, and fifteen out of 21 scales for nurses, were retained as a result of the factor analysis. For both scales, there was no distinction between the within-group and between-group factor solutions on 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy'. Convergent validity was confirmed by assessing correlations between the NPCS and the Communication and Conflict Management subscales of the ICU N-P-Q, except for 'Between-group Accuracy' and 'Cooperativeness' from the physicians' scale and 'Between-group Accuracy' and 'Sharing of Patient Information' from the nurses' scale. With reference to concurrent validity, the predicted relationships between the subscales of communication and outcomes were confirmed in the nurses' questionnaire but were not fully supported in the

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Table 2: Correlation coefficients (Pearson r) for the subscales on communication/collaboration of the ICU Nurse-Physician Questionnaire with the subscales and total score of the Nurse-Physician collaboration scale (NPCS)

		Nurse-physician collaboration scale (NPCS)														
		joint participation in care				sharing of patient information				cooperativeness				total			
		Dr		Ns		Dr		Ns		Dr		Ns		Dr		Ns	
	subscales	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p
ICU Nurse-Physician Questionnaire	Between Openness	.270**	<0.01	.310**	<0.01	.248**	<0.01	.350**	<0.01	.525**	<0.01	.605**	<0.01	.402**	<0.01	.490**	<0.01
	Between Accuracy	.224**	<0.01	.154**	<0.01	.117*	<0.05	.036	0.16	.080	0.17	.073**	<0.01	.155**	<0.01	.098**	<0.01

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Table 3: Correlations between the subscales on communication/collaboration and the outcomes

| | | Subscales of communication/collaboration | | | | | | | | | | | | |
| | | Unit relations with other units | | Within group Openness | | Within group Accuracy | | Between group Openness | | Between group Accuracy | | Avoiding Conflict | | Problem solving Conflict | |
		Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p
Perceived Effectiveness Nurses	Dr	.189**	<0.01	0.078	0.19	.211**	<0.01	.181**	<0.01	.318**	<0.01	.239**	<0.01	.292**	<0.01
Perceived Effectiveness Physicians	Dr	.184**	<0.01	.259**	<0.01	.250**	<0.01	.128*	0.031	.142*	0.016	.173**	<0.01	.233**	<0.01
Absolute Care and Perceived Effectiveness at Meeting Family Member Needs	Ns	.352**	<0.01	.237**	<0.01	.307**	<0.01	.208**	<0.01	.260**	<0.01	.335**	<0.01	.460**	<0.01
	Dr	.228**	<0.01	.339**	<0.01	.325**	<0.01	.168**	<0.01	.261**	<0.01	.275**	<0.01	.448**	<0.01
Relative Technical Quality of Care	Dr	.024	0.68	.081	0.17	.047	0.431	.136*	0.02	.102	0.08	.155**	<0.01	.176**	<0.01
Satisfaction	Ns	.324**	<0.01	.440**	<0.01	.200**	<0.01	.247**	<0.01	.106**	<0.01	.230**	<0.01	.257**	<0.01
	Dr	.231**	<0.01	.412**	<0.01	.250**	<0.01	.192**	<0.01	.117	0.052	.227**	<0.01	.342**	<0.01

'Perceived Effectiveness Nurses', 'Perceived Effectiveness Physicians', and 'Relative Technical Quality of Care' have only been shown for physicians because, for nurses, the items of these subscales are mixed with other components.

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physicians' questionnaire.

Explanation and interpretation

The number of factors in the physicians' scale was not identical with that in the nurses' scale, where the 'Relative Technical Quality of Care' was combined with 'Perceived Effectiveness at Recruiting and Retaining Physicians' and 'Perceived Effectiveness at Meeting Family Member Needs'. This suggests that the items in these three subscales may not group well. There was no distinction between the within-group and between-group factor solutions on 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy'. This may be because the conflicts between nurses and physicians are due to the overlapping nature of their domains and the lack of clarity regarding their roles,[25] and they differ in terms of their beliefs about responsibility, barriers to progress, and possible solutions to the problem.[26] In some NICUs, indeed nurses fulfil a part of the physicians' role in Japan.

'Cooperativeness' in the NPCS did not correlate with the 'Between-group Accuracy' of the ICU N-P-Q for physicians, while 'Sharing of Patient Information' in the NPCS did not associate with the 'Between-group Accuracy' of the ICU N-P-Q for nurses. Although there are correlations between 'Cooperativeness' and 'Between-group Accuracy' for nurses, and 'Sharing of Patient Information' and 'Between-group Accuracy' for physicians, these correlations are weak. 'Cooperativeness' and 'Sharing of Patient Information' in the NPCS may not have reflected concepts similar to the 'Between-group Accuracy' subscale in the ICU N-P-Q.

One of the outcome measures, 'Relative Technical Quality of Care', was not correlated with the three subscales of communication. This subscale measures the perceived effectiveness of the unit with regard to patient care needs and outcomes, relative to other local NICUs. Generally, as compared with physicians, nurses communicate more closely with patients and their families. This also depends on how much you know about other NICUs. These outcomes are therefore subjective, which can be different from objectively measured outcomes.

Two issues need to be examined in future studies. First, the construct validity of the original English version needs to be examined more closely because though the ICU N-P-Q is one of the well-known measures on the organizational culture and communication in health care settings,[27] the questionnaire has been used only partially.[4 11 12 19] This also restricts comparison across studies and countries. Secondly, the findings of the present study revealed that several subscales are different

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constructs of the original scales. We did not rename or eliminate these subscales in this study because further validity would clarify why several subscales that originally belonged to separate scales were combined in this study, and how these can be distinct constructs.

This study examined the questionnaires for physicians and nurses separately. Therefore, the present results may have revealed the psychometric properties more accurately than the original study, which had a combined nurse-physician sample, and highlighted some points for further research concerning the difference between perceptions of physicians and nurses. Considering the burden of administration time and the response rate to the short version of the 81-item scale, it might be a better approach to use only selected parts of the scales depending on the purpose of individual studies and researchers' specific interests, as previous studies have done [11-13 19].

Limitations

The present study has a few limitations. First, two components (workplace and facility safety scales/ culture) of the original instrument were not available because of copyright restrictions. Second, some items and subscales (e.g. 'Team Cohesion', 'Understanding', 'Satisfaction with Nurse Communication', 'Satisfaction with Physician Communication', 'Within-group Forcing', 'Between-group Forcing', 'Within-group Arbitration', and 'Between-group Arbitration') were not included in the shorter version of the physician and nurse questionnaires. Therefore, the data in this study cannot fully compare with the psychometric property of the original study. Third, the NPCS measures the cooperation between physicians and nurses, and therefore, examination of the scale correlations only with the two subscales assessing openness and accuracy of between groups was appropriate for testing the convergent validity. Finally, the present study could not determine whether the differences in the factorial structure are caused by the sample characteristics or cultural differences, since the original study did not perform an item analysis or factor analysis.

CONCLUSION

Although the psychometric property of the Japanese ICU N-P-Q acted slightly differently in this study according to occupation, the present findings provide preliminary support for the utility of the common item structure of the original scale to measure the extent and quality of communication and collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

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REFERENCES

1. Shortell SM, Zimmerman JE, Rousseau DM, *et al*. The performance of intensive care units: does good management make a difference? *Medical Care* 1994:508-25.

2. Narasimhan M, Eisen LA, Mahoney CD, *et al*. Improving nurse-physician communication and satisfaction in the intensive care unit with a daily goals worksheet. *American Journal of Critical Care* 2006;**15**(2):217-22.

3. Bower P, Campbell S, Bojke C, *et al*. Team structure, team climate and the quality of care in primary care: an observational study. *Quality and Safety in Health Care* 2003;**12**(4):273-79.

4. Davenport DL, Henderson WG, Mosca CL, *et al*. Risk-adjusted morbidity in teaching hospitals correlates with reported levels of communication and collaboration on surgical teams but not with scale measures of teamwork climate, safety climate, or working conditions. *Journal of the American College of Surgeons* 2007;**205**(6):778-84.

5. Zwarenstein M, Goldman J, Reeves S. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. *The Cochrane Database of Systematic Reviews* 2009;**3**(CD000072).

6. Roberts, K. H., & O'Reilly, C. A. Measuring organizational communication. *Journal of applied psychology* 1974; 59.3: 321.

7. Alt-White, A. C., Charns, M., & Strayer, R. Personal, organizational and managerial factors related to nurse-physician collaboration. *Nursing Administration Quarterly* 1983; 8.1: 8-18.

8. Shortell SM, Rousseau DM, Gillies RR, *et al*. Organizational assessment in intensive care units (ICUs): construct development, reliability, and validity of the ICU nurse-physician questionnaire. *Medical Care* 1991;**29**(8):709-26.

9. Valentine MA, Nembhard IM, Edmondson AC. Measuring teamwork in health care settings: A review of survey instruments. *Medical Care* 2015;**53**(4):e16-e30.

10. Dougherty MB, Larson E. A review of instruments measuring nurse‐physician collaboration. *Journal of Nursing Administration* 2005;**35**(5):244-53.

11. Manojlovich M, DeCicco B. Healthy work environments, nurse-physician communication, and patients' outcomes. *American Journal of Critical Care* 2007;**16**(6):536-43.

12. Miller PA. Nurse-physician collaboration in an intensive care unit. *American Journal of Critical Care* 2001;**10**(5):341-50.

13. Manojlovich M, Antonakos CL, Ronis DL. Intensive care units, communication between nurses and physicians, and patients' outcomes. *American Journal of Critical Care* 2009;**18**(1):21-30.

14. Manojlovich M. Linking the practice environment to nurses' job satisfaction through nurse‐physician communication. *Journal of Nursing Scholarship* 2005;**37**(4):367-73.

15. Reader TW, Flin R, Mearns K, *et al*. Interdisciplinary communication in the intensive care unit.

Appendix1: Descriptive statistics of the ICU Nurse-Physician Questionnaire

	Scales	Items	Physician (N=285)				Corrected Item-Total Correlations	Corrected Item-Subscale Cronbach's	Nurse (N=1477)				Corrected Item-Subscale Correlations	Corrected Item-Subscale Cronbach's
			Mean	SD	Skewness	Kurtosis			Mean	SD	Skewness	Kurtosis		
Leadership	Nursing leadership	1	3.07	0.86	-0.03	-0.21	0.21	0.81	3.13	0.83	-0.33	-0.13	0.13	0.66
		2	3.59	0.81	-0.95	0.71	0.57	0.75	3.38	0.85	-0.80	0.12	0.45	0.58
		3	3.37	0.82	-0.39	-0.24	0.57	0.75	3.32	0.82	-0.42	-0.28	0.43	0.58
		4	3.92	0.83	-0.73	0.62	0.41	0.77	3.52	0.88	-0.27	-0.30	0.04	0.69
		5	3.87	0.81	-0.70	0.74	0.46	0.77	3.67	0.75	-0.04	-0.36	0.40	0.59
		6	3.71	0.84	-0.72	0.50	0.73	0.72	3.57	0.75	-0.25	0.30	0.47	0.58
		7	4.01	0.87	-0.93	1.06	0.56	0.75	4.18	0.70	-0.55	0.20	0.43	0.59
		8	3.24	0.85	-0.25	-0.18	0.45	0.77	3.26	0.78	-0.52	0.31	0.41	0.59
	Physician leadership	9	3.38	0.93	-0.27	-0.56	0.13	0.84	3.28	0.84	-0.36	-0.26	0.07	0.71
		10	3.72	0.80	-0.93	0.88	0.65	0.76	3.14	0.86	-0.44	-0.25	0.48	0.62
		11	3.49	0.91	-0.46	-0.40	0.56	0.78	3.14	0.80	-0.18	-0.34	0.38	0.64
		12	3.88	0.85	-0.91	0.99	0.39	0.80	3.46	0.83	-0.22	-0.28	0.14	0.70
		13	3.85	0.87	-0.69	0.45	0.56	0.78	3.51	0.81	-0.17	-0.09	0.48	0.62
		14	3.81	0.99	-0.88	0.49	0.78	0.74	3.41	0.78	-0.14	0.06	0.51	0.61
		15	3.82	0.92	-0.61	0.02	0.56	0.78	3.54	0.88	-0.47	0.03	0.51	0.61
		16	3.45	0.84	-0.44	-0.19	0.57	0.78	3.16	0.72	-0.31	0.46	0.41	0.64
Coordination	Unit relations with other units	17	3.50	0.83	-0.83	0.35	0.56	0.75	3.10	0.77	-0.46	0.21	0.42	0.73
		18	3.56	0.93	-0.78	0.13	0.54	0.76	3.29	0.90	-0.56	-0.27	0.56	0.66
		19	3.62	0.89	-0.56	0.20	0.62	0.72	3.24	0.89	-0.35	-0.23	0.54	0.67
		20	3.79	0.90	-0.79	0.33	0.66	0.70	3.39	0.85	-0.49	-0.02	0.60	0.63
Communication	Within-group Communication Openness	21	4.03	0.79	-0.74	0.46	0.70	0.72	3.15	0.95	-0.39	-0.56	0.66	0.67
		22	3.78	0.96	-0.78	0.30	0.70	0.72	2.97	0.91	-0.20	-0.54	0.57	0.72
		23	4.05	0.73	-0.51	0.24	0.61	0.76	3.58	0.75	-0.65	0.79	0.61	0.71
		24	4.19	0.64	-0.60	1.14	0.52	0.81	3.55	0.84	-0.74	0.38	0.48	0.76
	Within-group Communication Accuracy	25	3.34	0.95	-0.19	-0.62	0.62	0.68	3.11	0.91	0.19	-0.69	0.53	0.62
		26	3.56	0.90	-0.51	-0.11	0.59	0.70	3.31	0.87	-0.26	-0.58	0.56	0.61
		27	3.35	0.97	-0.78	-0.04	0.59	0.70	3.10	0.86	-0.23	-0.50	0.49	0.65
		28	3.14	0.97	-0.09	-0.76	0.46	0.76	2.86	0.91	0.14	-0.63	0.40	0.70
	Between-group Communication Openness	29	3.92	0.76	-0.71	0.87	0.69	0.63	2.89	0.98	-0.15	-0.76	0.76	0.79
		30	3.71	0.79	-0.72	0.86	0.50	0.74	2.96	0.93	-0.27	-0.70	0.74	0.80
		31	3.86	0.62	-0.34	0.58	0.58	0.70	3.04	0.85	-0.49	-0.02	0.66	0.83
		32	3.92	0.64	-1.05	2.91	0.50	0.74	3.19	0.92	-0.46	-0.58	0.65	0.84
	Between-group Communication Accuracy	33	2.95	0.93	0.23	-0.71	0.65	0.63	3.55	0.84	-0.32	-0.24	0.57	0.58
		34	3.05	0.86	-0.10	-0.73	0.63	0.66	3.46	0.88	-0.30	-0.47	0.57	0.57
		35	2.58	0.86	0.36	-0.31	0.53	0.76	3.20	0.84	-0.12	-0.45	0.46	0.71
	Communication Timeliness	36	4.09	0.56	-0.45	2.16	0.51	0.44	3.80	0.62	-1.16	2.24	0.55	0.34
		37	3.94	0.71	-0.64	0.84	0.55	0.33	3.50	0.74	-0.66	0.14	0.50	0.39
		38	3.73	0.68	-0.83	1.25	0.28	0.74	3.70	0.64	-0.96	1.35	0.25	0.74
Conflict Management	Within-group Avoiding Conflict Strategy	39	3.77	0.89	-0.48	-0.15	0.69	0.56	3.67	0.81	-0.57	0.71	0.64	0.55
		40	3.92	0.76	-0.54	0.25	0.53	0.74	3.68	0.72	-0.45	0.40	0.52	0.69
		41	3.79	0.97	-0.57	-0.13	0.57	0.71	3.62	0.91	-0.51	0.19	0.53	0.70
	Within-group Problem-solving Conflict Strategy	42	3.62	0.86	-0.48	0.05	0.71	0.76	3.49	0.85	-0.36	-0.09	0.60	0.76
		43	3.66	0.88	-0.40	-0.09	0.73	0.75	3.40	0.88	-0.32	-0.21	0.71	0.70
		44	2.68	0.88	0.39	-0.31	0.56	0.83	2.72	0.84	0.30	-0.29	0.49	0.81
		45	3.51	0.82	-0.33	-0.09	0.63	0.80	3.21	0.84	-0.22	-0.19	0.65	0.73
	Between-group Avoiding Conflict Strategy	46	3.80	0.76	-0.33	-0.08	0.75	0.76	3.73	0.79	-0.52	0.40	0.71	0.64
		47	3.95	0.78	-0.54	0.13	0.71	0.79	3.81	0.70	-0.52	0.65	0.64	0.73
		48	3.73	0.88	-0.50	-0.09	0.70	0.81	3.67	0.86	-0.41	-0.01	0.58	0.79
	Between-group Problem-solving Conflict Strategy	49	3.59	0.78	-0.24	-0.31	0.73	0.77	3.45	0.80	-0.24	-0.08	0.70	0.80
		50	3.60	0.83	-0.46	0.00	0.78	0.74	3.39	0.84	-0.22	-0.30	0.79	0.75
		51	2.79	0.87	0.14	-0.39	0.50	0.87	2.85	0.84	0.26	-0.19	0.52	0.87
		52	3.50	0.75	-0.43	-0.32	0.69	0.79	3.33	0.81	-0.18	-0.31	0.73	0.78
Unit Effectiveness	Perceived Effectiveness at Recruiting and Retaining Nurses	53	3.03	0.92	-0.14	-0.67	0.46	0.80	2.84	0.75	-0.31	0.25	0.38	0.67
		54	2.72	0.98	0.07	-0.70	0.59	0.73	2.53	0.97	0.12	-0.73	0.52	0.59
		55	3.10	0.81	0.01	0.30	0.60	0.73	3.01	0.74	-0.10	0.94	0.37	0.67
		56	2.91	0.88	-0.04	0.19	0.73	0.66	2.69	0.80	-0.20	0.23	0.61	0.52
	Perceived Effectiveness at Recruiting and Retaining Physicians	57	2.98	0.85	-0.03	0.01	0.44	0.77	3.01	0.78	-0.18	-0.01	0.41	0.70
		58	3.04	0.97	-0.29	-0.79	0.56	0.72	2.97	0.77	-0.31	0.55	0.48	0.65
		59	3.21	0.93	-0.16	-0.18	0.58	0.70	3.07	0.63	-0.07	1.85	0.51	0.63
		60	3.11	0.85	-0.10	0.13	0.70	0.64	2.98	0.61	-0.26	2.87	0.60	0.58
	Absolute Technical Quality of Care	61	3.56	0.71	-1.18	1.21	0.47	0.74	3.54	0.65	-0.80	-0.05	0.43	0.71
		62	3.45	0.77	-0.61	0.17	0.58	0.71	3.54	0.66	-0.49	0.23	0.48	0.69
		63	3.55	0.77	-0.88	0.63	0.55	0.72	3.57	0.68	-0.82	0.55	0.51	0.68
		64	3.61	0.87	-0.80	0.64	0.53	0.73	3.22	0.83	-0.55	0.09	0.52	0.68
		65	3.54	0.80	-0.63	0.29	0.55	0.72	3.38	0.79	-0.48	0.34	0.54	0.67
	Relative Technical Quality of Care	66	3.72	0.79	-0.23	-0.13	0.82	0.84	3.54	0.74	-0.02	-0.03	0.79	0.84
		67	3.75	0.88	-0.36	-0.23	0.83	0.81	3.65	0.82	-0.25	-0.19	0.83	0.80
		68	3.60	0.95	-0.39	-0.38	0.75	0.90	3.52	0.85	-0.28	0.00	0.74	0.89
	Perceived Effectiveness at Meeting Family Member Needs	69	3.62	0.67	-1.12	1.04	0.34		3.43	0.72	-0.69	0.06	0.44	
		70	3.59	0.77	-0.02	-0.14	0.34		3.33	0.77	-0.19	0.26	0.44	
Authority	Nursing Director Budgeting Authority	71	2.80	1.04	-0.18	-0.62	0.64	0.65	3.11	0.96	-0.35	-0.27	0.67	0.63
		72	3.21	1.10	-0.43	-0.45	0.57	0.73	3.09	1.07	-0.32	-0.57	0.57	0.75
		73	2.93	1.02	-0.20	-0.54	0.60	0.69	3.14	0.95	-0.43	-0.20	0.60	0.71
	Medical Director Budgeting Authority	74	3.90	0.96	-0.87	0.63	0.63	0.66	3.52	0.91	-0.35	0.05	0.63	0.60
		75	3.56	1.20	-0.56	-0.63	0.52	0.81	3.26	0.96	-0.25	-0.12	0.55	0.70
		76	3.96	0.88	-0.90	0.97	0.70	0.61	3.81	0.84	-0.63	0.52	0.55	0.69
	Nursing Director Patient Care Authority	77	3.05	1.08	-0.39	-0.72	0.59		3.11	1.07	-0.39	-0.62	0.68	
		78	3.13			-0.21	0.57	0.59		0.94	-0.18	-0.37	0.68	
	Medical Director Patient Care Authority	79	3.89	0.96	-1.05	0.92	0.70		3.85	0.88	-0.83	0.79	0.63	
		80	3.67	0.98	-0.76	0.07	0.70		3.72	0.81	-0.62	0.81	0.63	
Job Satisfaction		81	3.55	0.88	-0.66	-0.11			2.88	0.90	-0.19	-0.64		

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13	Factor 14	Factor 15	Factor 16	Communalities
38	0.62																0.69
40	0.62																0.67
45	0.78																0.75
46	0.75																0.72
47	0.77																0.74
41		0.58															0.75
42		0.68															0.74
43		0.68															0.60
44		0.68															0.64
48		0.57															0.72
49		0.65															0.74
51		0.64															0.72
10			0.68														0.67
11			0.50														0.52
13			0.53														0.57
14			0.85														0.81
15			0.69														0.61
16			0.64														0.58
2				0.58													0.58
3				0.65													0.61
4				0.57													0.60
5				0.69													0.70
6				0.79													0.73
7				0.65													0.58
8				0.48													0.58
21					0.73												0.69
22					0.77												0.74
23					0.68												0.60
24					0.54												0.57
60						0.75											0.71
61						0.69											0.68
62						0.58											0.61
68						0.63											0.58
70							0.80										0.75
71							0.66										0.63
72							0.74										0.65
76							0.62										0.71
77							0.67										0.74
65								0.86									0.79
66								0.90									0.85
29									0.79								0.74
30									0.56								0.58
31									0.77								0.68
32									0.71								0.61
17										0.69							0.60
18										0.77							0.66
19										0.69							0.67
20										0.75							0.68
25											0.74						0.73
26											0.70						0.67
27											0.66						0.63
28											0.41						0.50
52												0.46					0.66
53												0.64					0.69
54												0.74					0.74
55												0.79					0.80
57													0.77				0.72
58													0.59				0.71
59													0.80				0.78
73														0.83			0.75
74														0.68			0.64
75														0.86			0.78
33															0.74		0.72
34															0.73		0.70
35															0.68		0.61
78																0.85	0.78
79																0.80	0.78
Contribution of factor	3.99	3.80	3.74	3.40	3.19	2.82	2.77	2.67	2.65	2.63	2.47	2.44	2.37	2.36	2.28	1.98	
Percent of contribution	5.95	5.67	5.58	5.08	4.76	4.21	4.13	3.99	3.96	3.93	3.69	3.64	3.54	3.52	3.40	2.95	

Appendix 3. Principal-components Factor Analysis (Nurse)

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10	Factor 11	Factor 12	Factor 13	Factor 14	Factor 15	Communalities
47	0.77															0.66
48	0.75															0.76
50	0.74															0.69
40	0.73															0.59
41	0.68															0.70
42	0.63															0.48
43	0.59															0.65
44		0.77														0.71
45		0.77														0.66
46		0.70														0.57
37		0.67														0.64
38		0.64														0.57
39		0.60														0.56
28			0.83													0.76
29			0.80													0.72
30			0.76													0.66
31			0.75													0.63
58				0.69												0.52
59				0.68												0.58
60				0.66												0.57
61				0.63												0.58
62				0.51												0.44
66				0.43												0.61
68					0.76											0.72
69					0.76											0.60
70					0.75											0.60
74					0.69											0.72
75					0.63											0.73
53						0.84										0.57
57						0.84										0.57
63						0.64										0.77
64						0.59										0.79
67						0.50										0.54
20							0.76									0.68
21							0.73									0.58
22							0.67									0.62
23							0.57									0.48
24								0.68								0.57
25								0.68								0.61
26								0.64								0.56
27								0.56								0.45
16									0.61							0.44
17									0.75							0.63
18									0.68							0.59
19									0.73							0.64
9										0.69						0.64
14										0.68						0.54
15										0.62						0.62
52											0.69					0.63
54											0.67					0.71
56											0.56					0.47
71												0.77				0.67
72												0.71				0.65
73												0.70				0.64
4													0.69			0.58
5													0.61			0.60
6													0.58			0.55
32														0.71		0.66
33														0.70		0.63
34														0.59		0.53
76															0.79	0.75
77															0.78	0.75
Contribution of factor	4.29	3.55	3.04	2.93	2.84	2.74	2.61	2.34	2.32	2.27	2.10	1.98	1.84	1.82	1.72	
Percent of contribution	6.92	5.72	4.91	4.72	4.58	4.42	4.21	3.78	3.75	3.67	3.39	3.19	2.97	2.94	2.78	

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	manuscript page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 5, 6
Bias	9	Describe any efforts to address potential sources of bias	Page 5
Study size	10	Explain how the study size was arrived at	Page 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 6, 7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	Page 5
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7, 8
		(b) Indicate number of participants with missing data for each variable of interest	Page 8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 9-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Use of the ICU Nurse–Physician Questionnaire (ICU N-P-Q): testing reliability and validity in neonatal intensive care units in Japan

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Use of the ICU Nurse-Physician Questionnaire (ICU N-P-Q): testing reliability and validity in neonatal intensive care units in Japan

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ABSTRACT

Objective: Although communication among health providers has become a critical part of improving quality of care, few studies on this topic have been conducted in Japan. This study aimed to examine the reliability and validity of the ICU Nurse–Physician Questionnaire (ICU N-P-Q) for use among nurses and physicians in neonatal intensive care units (NICUs) in Japan.

Methods: A Japanese translation of the ICU N-P-Q was administered to physicians and nurses working at 40 NICUs across Japan, which were participating in the Team Approach Cluster randomized controlled trial (INTACT). We used the principal components analysis to evaluate the factor structure of the instruments. Convergent validity was assessed by examining correlations between the subscales of Communication and Conflict Management of the ICU N-P-Q, and the subscales and total score of the Nurse-Physician Collaboration Scale (NPCS). Correlations between the subscales of Communication and Conflict Management by correlation with scales that refer to performance, including Job satisfaction and Unit effectiveness, were calculated to test the criterion validity.

Results: In total, 2006 questionnaires were completed by 316 physicians and 1690 nurses. The exploratory factor analysis revealed fifteen factors in the physicians' questionnaire and twelve in the nurses' questionnaire. Convergent validity was confirmed, except for 'Between-group Accuracy' and 'Cooperativeness' in the physicians' scale, and for 'Between-group Accuracy' and 'Sharing of Patient Information' in the nurses' scale. Correlations between the subscales of communication and outcomes were confirmed in the nurses' questionnaire but were not fully supported in the physicians' questionnaire.

Conclusion: Although the psychometric property behaved somewhat differently by occupation, the present findings provide preliminary support for the utility of the common item structure with the original scale, to measure the degree and quality of communication and collaboration among staff at NICUs and similar healthcare settings in Japan.

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STRENGTHS AND LIMITATIONS OF THIS STUDY

■ This is the first study to reveal the psychometric properties of the ICU N-P-Q in a Japanese sample with a large number of working units.

■ The present findings provided preliminary support for the Japanese ICU N-P-Q, which can be used to measure the extent and quality of communication/collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

■ Examining the questionnaires for physicians and nurses separately may have revealed the psychometric properties more accurately than the original study, which had a combined nurse–physician sample.

■ Some items were deleted from the questionnaire due to copyright restrictions. Therefore, the data in this study cannot fully compare with the psychometric property of the original study.

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INTRODUCTION

Good relationships among staff in healthcare organizations are an essential factor to provide safe and high quality care. Previous studies have observed that better communication and collaboration among healthcare providers is associated with higher technical quality of care,[1] lower length of stay,[2] superior clinical care in disease,[3] and risk-adjusted morbidity.[4] Communication and collaboration among health professionals has been shown to make an impact on patient outcomes. A Cochrane systematic review[5] found that practice-based interprofessional collaboration interventions enhanced healthcare processes and outcomes; however, generalizing the core components of interprofessional collaboration interventions and its effectiveness remains an ongoing challenge.

The aspects of communication include the degree to which physicians or nurses can carry out discussions without fear of repercussions or misunderstanding, the degree to which they believe in the consistent accuracy of the information conveyed by others, and the degree to which patient care information is relayed promptly to the people who need to be informed.[6] Collaboration can be defined as the process where nurses and physicians work together in the delivery of quality care, jointly contributing in a balanced relationship characterized by mutual trust.[7] There is a great deal of overlap between communication and collaboration; as Shortell et al.[8] described, collaboration involves open and timely communication, integration of individual's varied work activities, and ensuring that all available expertise is brought together to support problem solving and conflict resolution. To advance our understanding of the impact and effectiveness of communication and collaboration on patient outcomes, it is critical to accurately assess the degree and quality of communication and collaboration among health professionals. A recent systematic review of survey instruments for measuring teamwork in healthcare settings identified 36 scales which met the study criteria.[9] Twelve out of 36 scales documented relationships between teamwork and objective outcomes of interest in peer-reviewed studies[9]. Another systematic review[10] of survey instruments for assessing collaboration in healthcare settings found five instruments that met the study criteria for psychometric validity. The ICU Nurse-Physician Questionnaire (ICU N-P-Q)[8] was one of the two scales identified by both reviews as a useful valid scale for future research.

The ICU N-P-Q was originally developed using a large national sample to measure collaboration at the intensive care unit level and organizational components that facilitate a collaborative clinical interaction. The scale has been used to assess perceptions of nurse–physician collaboration in critical and non-critical care in the United States (US)[11-14] and the United Kingdom.[15] A part of the scale was

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also used to assess leadership, disagreements, and authority within the context of a neonatal intensive care unit (NICU).[16] The biggest difference between ICU and NICU is the body size of patients. Medication dosages of neonatal patients depend on their weight, and a large NICU is likely to have a much wider variety of diagnoses as compared with a small NICU. The number of beds is slightly larger in NICUs than that in ICUs in Japan.[17] Therefore, inter-professional communication in NICUs could be different from general ICUs and other healthcare groups, even in Japan. In this study, we aimed to examine the reliability and validity of the translated ICU N-P-Q among nurses and physicians from neonatal intensive care units (NICUs) across Japan.

METHODS

Translation process

Permission to use the ICU N-P-Q and create a Japanese version was obtained from the original authors. A professional translator of Japanese translated the original English version into Japanese, after which a different professional translator conducted back translation of the scale. However, two components of the scale (workplace and facility safety scales/culture) were not translated or included because of copyright restrictions. In order to maintain quality control, the back translation was shared with Dr. Stephen M. Shortell, Principal Investigator of the original study.[8] After two authors (HS and RM) assessed the expressions used in the Japanese ICU N-P-Q, a pretest was performed on 30 physicians and 124 nurses from three pre-intervention facilities, which were participating in a trial known as the Improvement of NICU Practice and Team Approach Cluster randomized controlled trial (INTACT). The pretest aimed to assess whether the Japanese ICU N-P-Q was appropriate and easily understandable for nursing and physician personnel. The Japanese ICU N-P-Q was finalized after some modifications were made to the wording in response to pretest feedback.

Ethical statement

Participation in this study was voluntary and written consent was obtained from each participant. Anonymity and confidentiality of the data was assured to all participants. Ethical approval was obtained on 15 July 2011 from the independent review board of INTACT (UMIN000007064), which has its administrative office in Tokyo Women's Medical University. This study was also approved by the Ethics Committee of the Kyoto University Graduate School and Faculty of Medicine on 28 March 2014.

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Sample and data

In this study, we used baseline data from a questionnaire distributed to physicians and nurses working at 40 NICUs that were participating in INTACT and located in different areas of Japan. Questionnaires were distributed to 345 physicians and 1800 nurses. The unlinked anonymous survey was administered from December 2011 to March 2012. We excluded data from the analysis if there were missing values for any variables in the ICU N-P-Q, and if all or almost all of the items in each subscale were scored with the same number (e.g. scored '1' in all values).

Instrument

ICU Nurse–Physician Questionnaire (ICU N-P-Q)

The original ICUN-P-Q is a 120-item scale derived from the Organizational Culture Inventory with response items ranked on a 5-point Likert scale ranging from 1=strongly disagree to 5=strongly agree.[18] A revised and shortened version of the instrument is also available as an 81-item scale. In this study, we used the shorter version. Although a separate test for reliability and validity has not been completed for the shorter version, the authors who developed the ICU N-P-Q believed that the shorter version was easier to administer and was therefore able to achieve better survey compliance while ensuring good validity and reliability.[18] Two components of the scale (workplace and facility safety scales/culture) were excluded because of copyright restrictions.[19] The subscales of the ICU N-P-Q consist of Leadership, Communication, Coordination, Conflict Management, Unit Effectiveness, and Authority, and a single item on Job Satisfaction. The scale includes separate questionnaires for physicians and nurses. Shortell et al.[8] reported that Cronbach's alpha reliabilities ranged from 0.61 to 0.88 for subscales. Other researchers have reported reliabilities from 0.66 to 0.92. [11 13 14 20]

Nurse-Physician Collaboration Scale (NPCS)

The NPCS [21] was developed to measure collaboration between nurses and physicians in Japan. The questionnaire is a 27-item scale and consists of three subscales: Joint Participation in Care, Sharing of Patient Information, and Cooperativeness. Participants rate how often they experience these positive work-related states using a 7-point Likert scale ranging from 1='never' to 7='always/every day'. Cronbach's alpha reliabilities for nurses' responses to the subscales ranged from 0.80 to 0.92

and that of physicians' responses ranged from 0.84 to 0.93. Psychometric testing showed that the NPCS was reliable and valid with high internal consistency and the results for test-retest reliability were adequate. Similar to the ICU N-P-Q, the NPCS focuses on nurses' and physicians' collaborative and problem-solving skills.[21] In this study, the NPCS was administered to test convergent validity of the Japanese ICU N-P-Q.

Conceptual framework

The conceptual framework of this study was based on the analytic framework of managerial and organizational factors affecting ICU performance, which was developed by Shortell et al.[8] This concept focuses on the identification of main managerial practices and organizational processes that might influence effective performance. The important consideration is that these practices and processes are under the control of managers. According to this theory, organizational culture, leadership, communication, coordination, and problem-solving should be included in these practices and processes. Specifically, a complex environment, such as that observed in intensive care units, requires effective teamwork. More open, accurate, and timely communication, and more open collaborative problem solving approaches would produce more effective patient care and improve health providers' occupational satisfaction.[4 22] The ICU N-P-Q consists of the Leadership and Authority scales assessing organizational factors, Communication and Conflict Management scales measuring the degree and quality of communication and collaboration within and between groups, and Unit Effectiveness and Job Satisfaction scales indicating outcomes of communication and collaboration. This study mainly focused on validating the Communication and Conflict Management scales of the ICU N-P-Q.

Statistical analysis

All statistical analyses were undertaken in SPSS version 21.0 (IBM Corporation, USA). The P value of ≤0.05 was considered as statistically significant.

Item analysis and reliability

First, the normality of the distribution of the scores was checked for each item using means, standard deviations, and skewness and kurtosis, and then the corrected item-total correlations and corrected item-subscale Cronbach's alpha were calculated separately for the physicians' and nurses' scales of

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the ICU N-P-Q. Items with corrected item-total correlations <0.3,[23] and items with corrected item-subscale Cronbach's alpha >0.8 were identified for possible exclusion from the scale.

Factor analysis

An exploratory factor analysis was conducted using a maximum likelihood solution method with promax rotation. The latent root criterion was used to decide the number of factors extracted, and factors having eigenvalues greater than 1 were considered significant. The Kaiser-Meyer-Olkin (KMO) was applied to measure the strength of the relationship among variables. KMO values greater than 0.7 are acceptable and values between 0.8 and 0.9 indicate a strong relationship.[24] Factor loadings >0.4 were retained. If the items load on more than one factor, indicating the items are not clearly influenced by one dimension, we dropped the items from the scales. Finally, means, standard deviations, and internal consistency of the items were calculated for the factors that result from factor analysis. We also calculated inter-factor correlations.

Validity

Convergent validity of the Communication and Conflict Management scales of the N-P-Q was assessed by means of the scales and total score of the NPCS, in which items are thought to reflect the fundamental aspects of the nurse-physician relationships. The Communication and Conflict Management scales of the N-P-Q included 'Within-group Accuracy', 'Between-group Accuracy', 'Between-group Avoiding Conflict Strategy', and 'Between-group Problem-solving Conflict Strategy' because the NPCS only examines the relationships between physicians and nurses. We assumed that the NPCS would have a positive correlation with the Japanese ICU N-P-Q. We also tested the criterion validity of the Communication and Conflict Management scales by examining their correlation with scales that refer to performance, including Job satisfaction and Unit effectiveness.

RESULTS

Description of sample

A total of 2006 questionnaires were completed by 316 physicians (response rate = 92 %) and 1690 nurses (response rate = 94 %). After excluding missing values and values scored with the same numbers, 1762 questionnaires were used in the analysis, including those of 285 physicians and 1475

nurses. Of the 285 participating physicians, 57 (20%) were head physicians, 200 (70.2%) were physicians, 24 (8.4%) were residents, and there were 3 missing values. Of the 1475 participating nurses, 130 (8.8%) were head nurses, 1328 (90.0%) were nurses, 2 (1.0%) were assistant nurses, and there were 15 missing values (1.0%). The highest number of practice years in one's own unit was 5 to 9 years for nurses and less than 1 year for physicians (Table 1).

Table 1: Sample characteristics

	Physicians (N=285)	Nurses (N=1475)
	n (%)	n (%)
SEX		
Male	195 (68.4)	25 (1.7)
Female	87 (30.5)	1430 (96.9)
Missing	3 (1.1)	20 (1.4)
STATUS		
Head physician	57 (20.0)	—
Physician	200 (70.2)	—
Resident	24 (8.4)	—
Missing	4 (1.4)	—
Head nurse	—	130 (8.8)
Nurse	—	1328 (90.0)
Assistant nurse	—	2 (1.0)
Missing	—	15 (1.0)
YEARS OF PRACTICE		
Less than 1 year	79 (27.7)	281 (19.0)
1 to 2 years	49 (17.2)	330 (22.4)
3 to 4 years	55 (19.3)	304 (20.6)
5 to 9 years	53 (18.6)	336 (22.8)
More than 10 years	46 (16.1)	208 (14.1)
Missing	3 (1.1)	16 (1.1)

Item analysis and reliability

Sixteen items were identified for possible exclusion from the physicians' scale. These included three items with corrected item-total correlations <0.3 (number 1, 9, and 38), and thirteen items with

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corrected item-subscale Cronbach's alphas >0.8 (number 1, 9, 12, 24, 44, 45, 48, 51, 53, 66, 67, 68 and 75). Similarly, fourteen items were identified for possible exclusion from the nurses' scale. These included five items with corrected item-total correlations <0.3 (number 1, 4, 9, 12, and 38), and nine items with corrected item-subscale Cronbach's alphas >0.8 (number 30, 31, 32, 44, 49, 51, 66, 67 and 68) (Appendix 1). Three out of four items in the 'Between-group Communication Openness' were dropped due to Cronbach's alphas >0.8, and therefore the remaining item (number 29) was deleted for the factor analysis.

Factor analysis

The factor analysis for the physicians' scale returned to fifteen factors (KMO=0.83, p<0.001) (Appendix 2). These sixteen factors explained 56.3% of the observed variance. Nine items were dropped because three of them loaded less than 0.4. The following items that originally belonged to separate subscales were combined into one factor: 2 items on 'Within-group Avoiding Conflict Strategy' and 3 items on 'Between-group Avoiding Conflict Strategy', 2 items on 'Within-group Problem-solving Conflict Strategy' and 3 items on 'Between-group Problem-solving Conflict Strategy', 3 items on 'Absolute Technical Quality of Care' and 1 item on 'Perceived Effectiveness at Meeting Family Member Needs', and 3 items on 'Nursing Director Budgeting Authority' and 2 items on 'Nursing Director Patient Care Authority'.

The factor analysis revealed twelve factors in the nurses' scale (KMO=0.88, p<0.001) (Appendix 3). The twelve-factor solution accounted for 45.8% of the total variance. Nine items with factor loadings less than 0.4 were deleted. The following items that originally belonged to separate subscales were combined into one factor: 3 items on 'Within-group Avoiding Conflict Strategy' and 3 items on 'Between-group Avoiding Conflict Strategy'; 3 items on 'Within-group Problem-solving Conflict Strategy' and 2 items on 'Between-group Problem-solving Conflict Strategy'; 1 item on 'Perceived Effectiveness at Recruiting and Retaining Nurses', 1 item on 'Perceived Effectiveness at Recruiting and Retaining Physicians', 2 items on 'Absolute Technical Quality of Care', and 1 item on 'Perceived Effectiveness at Meeting Family Member Needs'. Other items of both physicians' and nurses' scales were loaded same as the factor structure reported in the original study.

Validity

Convergent and criterion validity

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Correlations of the Communication and Conflict Management subscales of the ICU N-P-Q with the subscales and total score of the nurse–physician collaboration scale (NPCS) have been shown in Table 2. Since the factor solutions did not reveal clear within-groups and between-groups distinctions for 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy', these scales were not included in the correlation matrix. A positive correlation was observed between the physicians' scale and the NPCS, except for 'Between-group Accuracy' and 'Cooperativeness' (r=0.081, P=0.173). Similarly, a positive correlation was observed between the nurses' scale and the NPCS, except for 'Between-group Accuracy' and 'Sharing of Patient Information' (r=0.036, P=0.162).

The correlations between the subscales on communication/collaboration (Communication, Coordination, and Conflict Management) and the subscales on performance (Job satisfaction and Unit effectiveness) in the ICU N-P-Q have been shown in Table 3. Positive correlations were observed for the physicians' subscales, except for 'Within-group Openness' and 'Perceived Effectiveness at Recruiting and Retaining Nurses' (r=0.096, P=0.11),. There were positive correlations for all the subscales of the nurses' scale.

Description of the scales

The lowest score was given for 'Between-group Communication Accuracy' (physician: mean=2.86, SD=0.73) and 'Perceived Effectiveness at Recruiting and Retaining' (nurse: mean=3.00, SD=0.56). The highest scores were given for "Within-group Communication Openness" (physician: mean=3.95, SD=0.71) and "Avoiding Conflict Strategy" (nurse: mean=3.70, SD=0.60). Almost all of the subscales demonstrated good to high reliability for physicians ranged from 0.54 to 0.89 and for nurses ranged from 0.51 to 0.87. The lowest alpha value was found in "Perceived Effectiveness at Recruiting and Retaining" for physicians with 0.54 and for nurses with 0.51. The inter-factor correlation ranged from -0.03 to 0.58 in physicians and from -0.01 to 0.54 in nurses. Negative inter-factor correlations were found between Factor 1 and Factor 13, Factor 3 and Factor 13, Factor 4 and Factor 13, Factor 7 and Factor 13, Factor 11 and Factor 13, and Factor 12 and Factor 13 for physicians. Inter-factor correlation between Factor 1 and Factor 11, and between Factor 11 and Factor 12 was negative correlation for nurses (Appendix 4 & 5).

DISCUSSION

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Main findings

This is the first study to reveal the psychometric property of the ICU N-P-Q in a Japanese sample with a large number of working units. Fifteen out of the 21 scales for physicians, and twelve out of 21 scales for nurses, were retained as a result of the factor analysis. The factor structure and inter-factor correlations were in the theoretically unexpected directions for both scales, where there was no distinction between the within-group and between-group factor solutions on 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy'. Convergent validity was confirmed by assessing correlations between the NPCS and the Communication and Conflict Management subscales of the ICU N-P-Q, except for 'Between-group Accuracy' and 'Cooperativeness' from the physicians' scale and 'Between-group Accuracy' and 'Sharing of Patient Information' from the nurses' scale. With reference to concurrent validity, the predicted relationships between the subscales of communication and outcomes were confirmed in the nurses' questionnaire but were not fully supported in the physicians' questionnaire.

Explanation and interpretation

The number of factors in the physicians' scale was not identical with that in the nurses' scale, where the 'Absolute Technical Quality of Care' was combined with 'Perceived Effectiveness at Meeting Family Member Needs' in both scales. This suggests that the items in these two subscales may not group well. There was no distinction between the within-group and between-group factor solutions on 'Avoiding Conflict Strategy' and 'Problem-solving Conflict Strategy'. This may be because the conflicts between nurses and physicians are due to the overlapping nature of their domains and the lack of clarity regarding their roles,[25] and they differ in terms of their beliefs about responsibility, barriers to progress, and possible solutions to the problem.[26] In some NICUs, indeed nurses fulfil a part of the physicians' role in Japan.

'Cooperativeness' in the NPCS did not correlate with the 'Between-group Accuracy' of the ICU N-P-Q for physicians, while 'Sharing of Patient Information' in the NPCS did not associate with the 'Between-group Accuracy' of the ICU N-P-Q for nurses. Although there are correlations between 'Cooperativeness' and 'Between-group Accuracy' for nurses, and 'Sharing of Patient Information' and 'Between-group Accuracy' for physicians, these correlations are weak. 'Cooperativeness' and 'Sharing of Patient Information' in the NPCS may not have reflected concepts similar to the 'Between-group Accuracy' subscale in the ICU N-P-Q.

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Table 2: Correlation coefficients (Pearson r) for the subscales on communication/collaboration of the ICU Nurse-Physician Questionnaire with the subscales and total score of the Nurse-Physician collaboration scale (NPCS)

		Nurse-physician collaboration scale (NPCS)														
		joint participation in care				sharing of patient information				cooperativeness				total			
		Dr		Ns		Dr		Ns		Dr		Ns		Dr		Ns	
	subscales	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p
ICU Nurse-Physician Questionnaire	Between-group Openness	.270**	<0.01	NA		.248**	<0.01	NA		.525**	<0.01	NA		.402**	<0.01	NA	
	Between-group Accuracy	.224**	<0.01	.154**	<0.01	.117*	<0.05	.036	0.16	.080	0.17	.073**	<0.01	.155**	<0.01	.098**	<0.01

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Table 3: Correlations between the subscales on communication/collaboration and the outcomes

Subscales of outcome		Unit relations with other units		Within group Openness		Within group Accuracy		Between group Openness		Between group Accuracy		Avoiding Conflict		Problem solving Conflict	
		Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p	Correlation	p
Perceived Effectiveness Nurses	Dr	.162**	<0.01	.096	0.11	.202**	<0.01	.155**	<0.01	.256**	<0.01	.216**	<0.01	.257**	<0.01
	Ns	.225**	<0.01	.107**	<0.01	.148**	<0.01	NA		.115*	<0.01	.183**	<0.01	.230**	<0.01
Absolute Technical Quality of Care/Effectiveness at Meeting Family Member Needs	Dr	.228**	<0.01	.341**	<0.01	.325**	<0.01	.168**	<0.01	.261**	<0.01	.263**	<0.01	.444**	<0.01
	Ns	.318**	<0.01	.207**	<0.01	.243**	<0.01	NA		.214**	<0.01	.298**	<0.01	.432**	<0.01
Satisfaction	Dr	.231**	<0.01	.395**	<0.01	.250**	<0.01	.192**	<0.01	.117**	<0.052	.192**	<0.01	.343**	<0.01
	Ns	.324**	<0.01	.440**	<0.01	.198**	<0.01	NA		.106**	<0.01	.230**	<0.01	.276**	<0.01

Subscales of communication/collaboration

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Although Cronbach's alpha coefficients for both the nurses' and physicians' questionnaires were mostly acceptable, they were not fully comparable with the original validation study[8] and previous studies using the ICU N-P-Q,[11-14] which had a combined nurse–physician sample. The lowest reliability was found in the subscale "Perceived Effectiveness at Recruiting and Retaining" for both questionnaires. To enhance the subscale's consistency, the items could be refined by several additional statements. It is important to consider these aspects when administering the scale.

Two issues need to be examined in future studies. First, the construct validity of the original English version needs to be examined more closely because though the ICU N-P-Q is one of the well-known measures on the organizational culture and communication in health care settings,[27] the questionnaire has been used only partially.[4 11 12 19] This also restricts comparison across studies and countries. Secondly, the findings of the present study revealed that several subscales are different constructs of the original scales. We did not rename or eliminate these subscales in this study because further validity would clarify why several subscales that originally belonged to separate scales were combined in this study, and how these can be distinct constructs.

This study examined the questionnaires for physicians and nurses separately. Therefore, the present results may have revealed the psychometric properties more accurately than the original study, which had a combined nurse-physician sample, and highlighted some points for further research concerning the difference between perceptions of physicians and nurses. Considering the burden of administration time and the response rate to the short version of the 81-item scale, it might be a better approach to use only selected parts of the scales depending on the purpose of individual studies and researchers' specific interests, as previous studies have done [11-13 19].

Limitations

The present study has a few limitations. First, two components (workplace and facility safety scales/ culture) of the original instrument were not available because of copyright restrictions. Second, some items and subscales (e.g. 'Team Cohesion', 'Understanding', 'Satisfaction with Nurse Communication', 'Satisfaction with Physician Communication', 'Within-group Forcing', 'Between-group Forcing', 'Within-group Arbitration', and 'Between-group Arbitration') were not included in the shorter version of the physician and nurse questionnaires. Therefore, the data in this study cannot fully compare with the psychometric property of the original study. Third, the NPCS measures the cooperation between physicians and nurses, and therefore, examination of the scale

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correlations only with the two subscales assessing openness and accuracy of between groups was appropriate for testing the convergent validity. Finally, the present study could not determine whether the differences in the factorial structure are caused by the sample characteristics or cultural differences, since the original study did not perform an item analysis or factor analysis.

CONCLUSION

Although the psychometric property of the Japanese ICU N-P-Q acted slightly differently in this study according to occupation, the present findings provide preliminary support for the utility of the common item structure of the original scale to measure the extent and quality of communication and collaboration among medical and nursing staff at NICUs and similar healthcare settings in Japan.

Contributors

HS administered the survey, acquired the data, performed the statistical analysis, and prepared the draft. NY provided supervision of the study design, the data analysis and interpretation. RM supervised the design of the study. TNi and SK managed the whole research process. TNa supervised the data analysis and critically revised the manuscript for important intellectual content. All authors were involved in critical commentary and approved the final version of the manuscript.

Competing interests None declared.

Patient consent Not obtained.

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Data sharing statement   No additional data available.

REFERENCES

1. Shortell SM, Zimmerman JE, Rousseau DM, *et al*. The performance of intensive care units: does good management make a difference? *Medical Care* 1994:508-25.

2. Narasimhan M, Eisen LA, Mahoney CD, *et al*. Improving nurse-physician communication and satisfaction in the intensive care unit with a daily goals worksheet. *American Journal of Critical Care* 2006;**15**(2):217-22.

3. Bower P, Campbell S, Bojke C, *et al*. Team structure, team climate and the quality of care in primary care: an observational study. *Quality and Safety in Health Care* 2003;**12**(4):273-79.

4. Davenport DL, Henderson WG, Mosca CL, *et al*. Risk-adjusted morbidity in teaching hospitals correlates with reported levels of communication and collaboration on surgical teams but not with scale measures of teamwork climate, safety climate, or working conditions. *Journal of the American College of Surgeons* 2007;**205**(6):778-84.

5. Zwarenstein M, Goldman J, Reeves S. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. *The Cochrane Database of Systematic Reviews* 2009;**3**(CD000072).

6. Roberts, K. H., & O'Reilly, C. A. Measuring organizational communication. *Journal of applied psychology* 1974; 59.3: 321.

7. Alt-White, A. C., Charns, M., & Strayer, R. Personal, organizational and managerial factors related to nurse-physician collaboration. *Nursing Administration Quarterly* 1983; 8.1: 8-18.

8. Shortell SM, Rousseau DM, Gillies RR, *et al*. Organizational assessment in intensive care units (ICUs): construct development, reliability, and validity of the ICU nurse-physician questionnaire. *Medical Care* 1991;**29**(8):709-26.

9. Valentine MA, Nembhard IM, Edmondson AC. Measuring teamwork in health care settings: A review of survey instruments. *Medical Care* 2015;**53**(4):e16-e30.

10. Dougherty MB, Larson E. A review of instruments measuring nurse‐physician collaboration. *Journal of Nursing Administration* 2005;**35**(5):244-53.

11. Manojlovich M, DeCicco B. Healthy work environments, nurse-physician communication, and patients' outcomes. *American Journal of Critical Care* 2007;**16**(6):536-43.

12. Miller PA. Nurse-physician collaboration in an intensive care unit. *American Journal of Critical Care* 2001;**10**(5):341-50.

13. Manojlovich M, Antonakos CL, Ronis DL. Intensive care units, communication between nurses and physicians, and patients' outcomes. *American Journal of Critical Care* 2009;**18**(1):21-30.

14. Manojlovich M. Linking the practice environment to nurses' job satisfaction through

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nurse‑physician communication. *Journal of Nursing Scholarship* 2005;**37**(4):367-73.

15. Reader TW, Flin R, Mearns K, *et al*. Interdisciplinary communication in the intensive care unit. *British Journal of Anaesthesia* 2007;**98**(3):347-52.

16. Baker, G. R., King, H., MacDonald, J. L., & Horbar, J. D. Using organizational assessment surveys for improvement in neonatal intensive care. *Pediatrics* 2003; 111.Supplement E1: e419-e425.

17. Hospital Accreditation Standards Databook. *Japan Council for Quality Health Care.* 2010.

18. Shortell SMaR, D.M. The Organization and Management of Intensive Care Units. ICU Nurse Questionnaire (Short Version). 1989.

19. Cooke RA LJ. Level V: Organizational Culture Inventory: Plymouth, Mich: Human Synergistics, 1987.

20. Hansen HE, Biros MH, Delaney NM, *et al*. Research utilization and interdisciplinary collaboration in emergency care. *Academic Emergency Medicine* 1999;**6**(4):271-9.

21. Ushiro R. Nurse–Physician Collaboration Scale: development and psychometric testing. Journal of Advanced Nursing 2009;65(7):1497-508.

22. Blegen, M. A. Nurses' job satisfaction: a meta-analysis of related variables. *Nursing research* 1993; 42(1), 36-41.22. Pesudovs, K., Garamendi, E., Keeves, J. P., & Elliott, D. B. The Activities of Daily Vision Scale for cataract surgery outcomes: re-evaluating validity with Rasch analysis. *Investigative ophthalmology & visual science* 2003; 44(7), 2892-2899.

23. Field, A. Discovering statistics using SPSS. *Sage publications* 2009

24. Hutcheson, G. D., & Sofroniou, N. The multivariate social scientist: Introductory statistics using generalized linear models. *Sage* 1999

25. Weiss, S. J. Role differentiation between nurse and physician: implications for nursing. *Nursing research* 1983; 32(3), 133-139.

26. Rosenstein, A. H., & O'Daniel, M. Original Research: Disruptive Behavior and Clinical Outcomes: Perceptions of Nurses and Physicians: Nurses, physicians, and administrators say that clinicians' disruptive behavior has negative effects on clinical outcomes. *The American Journal of Nursing* 2005; 105(1), 54-64.

27. Dougherty, M. B., & Larson, E. A Review of Instruments Measuring Nurse☐Physician Collaboration. *Journal of Nursing Administration* 2005; 35(5), 244-253.

Appendixes

Appendix 1: Descriptive statistics of the ICU Nurse-Physician Questionnaire <ATTACHED SEPARATELY>

Appendix 2: Exploratory Factor Analysis (Physician) <ATTACHED SEPARATELY>

Appendix 3: Exploratory Factor Analysis (Nurse) <ATTACHED SEPARATELY>

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Appendix4: Mean, SD and inter-factor correlations of the ICU Nurse-Physician Questionnaire (Physician N=285) <ATTACHED SEPARATELY>

Appendix5: Mean, SD and inter-factor correlations of the ICU Nurse-Physician Questionnaire (Nurse N=1477) <ATTACHED SEPARATELY>

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Appendix1: Item Analysis of the ICU Nurse-Physician Questionnaire

Scales	Items	Description	Physician (N=285)						Nurse (N=1477)					
			Mean	SD	Skewness	Kurtosis	Corrected Item-Total Correlations	Corrected Item-Subscale Cronbach's	Mean	SD	Skewness	Kurtosis	Corrected Item-Subscale Correlations	Corrected Subscale Cronbach's
Leadership														
Nursing leadership	1	ICU NURSING LEADERSHIP EMPHASIZES STANDARDS OF EXCELLENCE TO THE STAFF.	3.07	0.86	-0.03	-0.21	0.21	0.81	3.13	0.83	-0.33	-0.13	0.13	0.66
	2	ICU NURSING LEADERSHIP IS SUFFICIENTLY SENSITIVE TO THE DIFFERENT NEEDS OF UNIT MEMBERS.	3.59	0.81	-0.95	0.71	0.57	0.75	3.38	0.85	-0.80	0.12	0.45	0.58
	3	THE ICU NURSING LEADERSHIP FAILS TO MAKE CLEAR WHAT THEY EXPECT FROM UNIT MEMBERS.	3.37	0.82	-0.39	-0.24	0.57	0.75	3.32	0.82	-0.42	-0.28	0.43	0.58
	4	ICU NURSING LEADERSHIP DISCOURAGES PHYSICIANS FROM TAKING INITIATIVE.	3.92	0.83	-0.73	0.62	0.41	0.77	3.52	0.88	-0.27	-0.30	0.04	0.69
	5	UNIT PHYSICIANS ARE UNCERTAIN WHERE THEY STAND WITH THE ICU NURSING LEADERSHIP.	3.87	0.81	-0.70	0.74	0.46	0.77	3.67	0.75	-0.04	-0.36	0.40	0.59
	6	THE ICU NURSING LEADERSHIP IS OUT OF TOUCH WITH PHYSICIAN PERCEPTIONS AND CONCERNS.	3.71	0.84	-0.72	0.50	0.73	0.72	3.57	0.75	-0.25	0.30	0.47	0.58
	7	ICU NURSING LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT PHYSICIANS.	4.01	0.87	-0.93	1.06	0.56	0.75	4.18	0.70	-0.55	0.20	0.43	0.59
	8	ICU NURSING LEADERSHIP EFFECTIVELY ADAPTS ITS PROBLEM-SOLVING STYLE TO CHANGING CIRCUMSTANCES.	3.24	0.85	-0.25	-0.18	0.45	0.77	3.26	0.78	-0.52	0.31	0.41	0.59
Physician leadership	9	ICU PHYSICIAN LEADERSHIP EMPHASIZES STANDARDS OF EXCELLENCE TO THE STAFF.	3.38	0.93	-0.27	-0.56	0.13	0.84	3.28	0.84	-0.36	-0.26	0.07	0.71
	10	ICU PHYSICIAN LEADERSHIP IS SUFFICIENTLY SENSITIVE TO THE DIFFERENT NEEDS OF UNIT MEMBERS.	3.72	0.80	-0.93	0.88	0.65	0.76	3.14	0.86	-0.44	-0.25	0.48	0.62
	11	THE ICU PHYSICIAN LEADERSHIP FAILS TO MAKE CLEAR WHAT THEY EXPECT FROM UNIT MEMBERS.	3.49	0.91	-0.46	-0.40	0.56	0.78	3.14	0.80	-0.18	-0.34	0.38	0.64
	12	ICU PHYSICIAN LEADERSHIP DISCOURAGES PHYSICIANS FROM TAKING INITIATIVE.	3.88	0.85	-0.91	0.99	0.39	0.80	3.46	0.83	-0.22	-0.28	0.14	0.70
	13	UNIT PHYSICIANS ARE UNCERTAIN WHERE THEY STAND WITH THE ICU PHYSICIAN LEADERSHIP.	3.85	0.87	-0.69	0.45	0.56	0.78	3.51	0.81	-0.17	-0.09	0.48	0.62
	14	THE ICU PHYSICIAN LEADERSHIP IS OUT OF TOUCH WITH PHYSICIAN PERCEPTIONS AND CONCERNS.	3.81	0.99	-0.88	0.49	0.78	0.74	3.41	0.78	-0.14	0.06	0.51	0.61
	15	ICU PHYSICIAN LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT PHYSICIANS.	3.82	0.92	-0.61	0.02	0.56	0.78	3.54	0.88	-0.47	0.03	0.51	0.61
	16	ICU PHYSICIAN LEADERSHIP EFFECTIVELY ADAPTS ITS PROBLEM-SOLVING STYLE TO CHANGING CIRCUMSTANCES.	3.45	0.84	-0.44	-0.19	0.57	0.78	3.16	0.72	-0.31	0.46	0.41	0.64
Coordination														
Unit relations with other units	17	OUR UNIT HAS CONSTRUCTIVE WORK RELATIONSHIPS WITH OTHER GROUPS IN THIS HOSPITAL.	3.50	0.83	-0.83	0.35	0.56	0.75	3.10	0.77	-0.46	0.21	0.42	0.73
	18	OUR UNIT DOES NOT RECEIVE THE COOPERATION IT NEEDS FROM OTHER HOSPITAL UNITS.	3.56	0.93	-0.78	0.13	0.54	0.76	3.29	0.90	-0.56	-0.27	0.56	0.66
	19	OTHER HOSPITAL SUBUNITS SEEM TO HAVE A LOW OPINION OF US.	3.62	0.89	-0.56	0.20	0.62	0.72	3.24	0.89	-0.35	-0.23	0.54	0.67
	20	INADEQUATE WORKING RELATIONSHIPS WITH OTHER HOSPITAL GROUPS LIMIT OUR EFFECTIVENESS.	3.79	0.90	-0.79	0.33	0.66	0.70	3.39	0.85	-0.49	-0.02	0.60	0.63
Communication														
Within-group Communication Openness	21	IT IS EASY FOR ME TO TALK OPENLY WITH THE [NURSE/PHYSICIAN]S OF THIS ICU.	4.03	0.79	-0.74	0.46	0.70	0.72	3.15	0.95	-0.39	-0.56	0.66	0.67
	22	COMMUNICATION BETWEEN [NURSE/PHYSICIAN]S IN THIS UNIT IS VERY OPEN.	3.78	0.96	-0.78	0.30	0.70	0.72	2.97	0.91	-0.20	-0.54	0.57	0.72
	23	I FIND IT ENJOYABLE TO TALK WITH OTHER [NURSE/PHYSICIAN]S OF THIS UNIT.	4.05	0.73	-0.51	0.24	0.61	0.76	3.58	0.75	-0.65	0.79	0.61	0.71
Within-group Communication Accuracy	24	IT IS EASY TO ASK ADVICE FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	4.19	0.64	-0.60	1.14	0.52	0.81	3.55	0.84	-0.74	0.38	0.48	0.76
	25	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	3.34	0.95	-0.19	-0.62	0.62	0.68	3.11	0.91	0.19	-0.69	0.53	0.62
	26	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	3.56	0.90	-0.51	-0.11	0.59	0.70	3.31	0.87	-0.26	-0.58	0.56	0.61
	27	THE ACCURACY OF INFORMATION PASSED AMONG [NURSE/PHYSICIAN]S OF THIS UNIT LEAVES MUCH TO BE DESIRED.	3.35	0.97	-0.78	-0.04	0.59	0.70	3.10	0.86	-0.23	-0.50	0.49	0.65
	28	I FEEL THAT CERTAIN [NURSE/PHYSICIAN]S DON'T COMPLETELY UNDERSTAND THE INFORMATION THEY RECEIVE.	3.14	0.97	-0.09	-0.76	0.46	0.76	2.86	0.91	0.14	-0.63	0.40	0.70
Between-group Communication Openness	29	IT IS EASY FOR ME TO TALK OPENLY WITH THE [NURSE/PHYSICIAN]S OF THIS ICU.	3.92	0.76	-0.71	0.87	0.69	0.63	2.89	0.98	-0.15	-0.76	0.76	0.79
	30	COMMUNICATION BETWEEN NURSES AND PHYSICIANS OF THIS UNIT IS VERY OPEN.	3.71	0.79	-0.72	0.86	0.50	0.74	2.96	0.93	-0.27	-0.70	0.74	0.80
	31	I FIND IT ENJOYABLE TO TALK WITH [NURSE/PHYSICIAN]S OF THIS UNIT.	3.86	0.62	-0.34	0.58	0.58	0.70	3.04	0.85	-0.49	-0.02	0.66	0.83
Between-group Communication Accuracy	32	IT IS EASY TO ASK ADVICE FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	3.92	0.64	-1.05	2.91	0.50	0.74	3.19	0.92	-0.46	-0.58	0.65	0.84
	33	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	2.95	0.93	0.23	-0.71	0.65	0.63	3.55	0.84	-0.32	-0.24	0.57	0.58
	34	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [NURSE/PHYSICIAN]S IN THIS UNIT.	3.05	0.86	-0.10	-0.73	0.63	0.66	3.46	0.88	-0.30	-0.47	0.57	0.57
	35	I FEEL THAT CERTAIN ICU [NURSE/PHYSICIAN]S DON'T COMPLETELY UNDERSTAND THE INFORMATION THEY RECEIVE.	2.58	0.86	0.36	-0.31	0.53	0.76	3.20	0.84	-0.12	-0.45	0.46	0.71
Communication Timeliness	36	I GET INFORMATION ON THE STATUS OF PATIENTS WHEN I NEED IT.	4.09	0.56	-0.45	2.16	0.51	0.44	3.80	0.62	-1.16	2.24	0.55	0.34
	37	WHEN A PATIENT'S STATUS CHANGES, I GET RELEVANT INFORMATION QUICKLY.	3.94	0.71	-0.64	0.84	0.55	0.33	3.50	0.74	-0.66	0.14	0.50	0.39
	38	IN MATTERS PERTAINING TO PATIENT CARE, NURSES CALL PHYSICIANS IN A TIMELY MANNER.	3.73	0.68	-0.83	1.25	0.28	0.74	3.70	0.64	-0.96	1.35	0.25	0.74
Conflict Management														
Within-group Avoiding Conflict Strategy	39	WHEN [NURSE/PHYSICIAN]S DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	3.77	0.89	-0.48	-0.15	0.69	0.56	3.67	0.81	-0.57	0.71	0.64	0.55
	40	[NURSE/PHYSICIAN]S WILL WITHDRAW FROM THE CONFLICT.	3.92	0.76	-0.54	0.25	0.53	0.74	3.68	0.72	-0.45	0.40	0.52	0.69
	41	DISAGREEMENTS BETWEEN [NURSE/PHYSICIAN]S WILL BE IGNORED OR AVOIDED.	3.79	0.97	-0.57	-0.13	0.57	0.71	3.62	0.91	-0.51	0.19	0.53	0.70
Within-group Problem-solving Conflict Strategy	42	ALL POINTS OF VIEW WILL BE CAREFULLY CONSIDERED IN ARRIVING AT THE BEST SOLUTION OF THE PROBLEM.	3.62	0.86	-0.48	0.05	0.71	0.76	3.49	0.85	-0.36	-0.09	0.60	0.76
	43	ALL THE [NURSE/PHYSICIAN]S WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	3.66	0.88	-0.40	-0.09	0.73	0.75	3.40	0.88	-0.32	-0.21	0.71	0.70
	44	THE [NURSE/PHYSICIAN]S INVOLVED WILL NOT SETTLE THE DISPUTE UNTIL ALL ARE SATISFIED WITH THE DECISION.	2.68	0.88	0.39	-0.31	0.56	0.83	2.72	0.84	0.30	-0.29	0.49	0.81
	45	EVERYONE CONTRIBUTES FROM THEIR EXPERIENCE AND EXPERTISE TO PRODUCE A HIGH QUALITY SOLUTION.	3.51	0.82	-0.33	-0.09	0.63	0.80	3.21	0.84	-0.22	-0.19	0.65	0.73
Between-group Avoiding Conflict Strategy	46	WHEN NURSES AND PHYSICIANS DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	3.80	0.76	-0.33	-0.08	0.75	0.76	3.73	0.79	-0.52	0.40	0.71	0.64
	47	BOTH PARTIES WILL WITHDRAW FROM THE CONFLICT.	3.95	0.78	-0.54	0.13	0.71	0.79	3.81	0.70	-0.52	0.65	0.64	0.73
	48	DISAGREEMENTS BETWEEN NURSES AND PHYSICIANS WILL BE IGNORED OR AVOIDED.	3.73	0.88	-0.50	-0.09	0.70	0.81	3.67	0.86	-0.41	-0.01	0.58	0.79
Between-group Problem-solving Conflict Strategy	49	ALL POINTS OF VIEW WILL BE CAREFULLY CONSIDERED IN ARRIVING AT THE BEST SOLUTION OF THE PROBLEM.	3.59	0.78	-0.24	-0.31	0.73	0.77	3.45	0.80	-0.24	-0.08	0.70	0.80
	50	THE NURSES AND PHYSICIANS WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	3.60	0.83	-0.46	0.00	0.78	0.74	3.39	0.84	-0.22	-0.30	0.79	0.75
	51	BOTH PARTIES INVOLVED WILL NOT SETTLE THE DISPUTE UNTIL ALL ARE SATISFIED WITH THE DECISION.	2.79	0.87	0.14	-0.39	0.50	0.87	2.85	0.84	0.26	-0.19	0.52	0.87
	52	EVERYONE CONTRIBUTES FROM THEIR EXPERIENCE AND EXPERTISE TO PRODUCE A HIGH QUALITY SOLUTION.	3.50	0.75	-0.43	-0.32	0.69	0.79	3.33	0.81	-0.18	-0.31	0.73	0.78
Unit Effectiveness														
Perceived Effectiveness at Recruiting and Retaining Nurses	53	WE ARE ABLE TO RECRUIT THE BEST ICU NURSES.	3.03	0.92	-0.14	-0.67	0.46	0.80	2.84	0.75	-0.31	0.25	0.38	0.67
	54	WE DO A GOOD JOB OF RETAINING ICU NURSES IN THE UNIT.	2.72	0.98	0.07	-0.70	0.59	0.73	2.53	0.97	0.12	-0.73	0.52	0.59
	55	RECRUITING ICU NURSES. (relative to other ICUs)	3.10	0.81	0.01	0.30	0.60	0.73	3.01	0.74	-0.10	0.94	0.37	0.67
	56	RETAINING NURSES. (relative to other ICUs)	2.91	0.88	-0.04	0.19	0.73	0.66	2.69	0.80	-0.20	0.23	0.61	0.52
Perceived Effectiveness at Recruiting and Retaining Physicians	57	WE ARE ABLE TO RECRUIT THE BEST ICU PHYSICIANS.	2.98	0.85	-0.03	0.01	0.44	0.77	3.01	0.78	-0.18	-0.01	0.41	0.70
	58	WE DO A GOOD JOB OF RETAINING ICU PHYSICIANS IN THE UNIT.	3.04	0.97	-0.29	-0.79	0.56	0.72	2.97	0.77	-0.31	0.55	0.48	0.65
	59	RECRUITING ICU PHYSICIANS. (relative to other ICUs)	3.21	0.93	-0.16	-0.18	0.58	0.70	3.07	0.63	-0.07	1.85	0.51	0.63
	60	RETAINING ICU PHYSICIANS. (relative to other ICUs)	3.11	0.85	-0.10	0.13	0.70	0.64	2.98	0.61	-0.26	2.87	0.60	0.58
Absolute Technical Quality of Care	61	OUR UNIT ALMOST ALWAYS MEETS ITS PATIENT CARE TREATMENT GOALS.	3.56	0.71	-1.18	1.21	0.47	0.74	3.54	0.65	-0.80	-0.05	0.43	0.71
	62	GIVEN THE SEVERITY OF THE PATIENTS WE TREAT, OUR UNIT'S PATIENTS EXPERIENCE VERY GOOD OUTCOMES.	3.45	0.77	-0.61	0.17	0.58	0.71	3.54	0.66	-0.49	0.23	0.48	0.69
	63	OUR UNIT DOES A GOOD JOB OF APPLYING THE MOST RECENTLY AVAILABLE TECHNOLOGY TO PATIENT CARE NEEDS.	3.55	0.77	-0.88	0.63	0.55	0.72	3.57	0.68	-0.82	0.55	0.51	0.68
	64	OVERALL, OUR UNIT FUNCTIONS VERY WELL TOGETHER AS A TEAM.	3.61	0.87	-0.80	0.64	0.53	0.73	3.22	0.83	-0.55	0.09	0.52	0.68
	65	OUR UNIT IS VERY GOOD AT RESPONDING TO EMERGENCY SITUATIONS.	3.54	0.80	-0.63	0.29	0.55	0.72	3.38	0.79	-0.48	0.34	0.54	0.67
Relative Technical Quality of Care	66	MEETING ITS PATIENT CARE TREATMENT GOALS.	3.72	0.79	-0.23	-0.13	0.82	0.84	3.54	0.74	-0.02	-0.03	0.79	0.84
	67	PATIENT CARE OUTCOMES, TAKING INTO ACCOUNT PATIENT SEVERITY.	3.75	0.88	-0.36	-0.23	0.83	0.81	3.65	0.82	-0.25	-0.19	0.83	0.80
	68	APPLYING THE MOST RECENTLY AVAILABLE TECHNOLOGY TO PATIENT CARE NEEDS.	3.60	0.95	-0.39	-0.38	0.75	0.90	3.52	0.85	-0.28	0.00	0.74	0.89
Perceived Effectiveness at Meeting Family Member Needs	69	OUR UNIT DOES A GOOD JOB OF MEETING FAMILY MEMBER NEEDS.	3.62	0.67	-1.12	1.04	0.34		3.43	0.72	-0.69	0.06	0.44	
	70	MEETING FAMILY MEMBER NEEDS. (relative to other ICUs)	3.59	0.77	-0.02	-0.14	0.34		3.33	0.77	-0.19	0.26	0.44	
Authority														
Nursing Director Budgeting Authority	71	BUDGETING	2.80	1.04	-0.18	-0.62	0.64	0.65	3.11	0.96	-0.35	-0.27	0.67	0.63
	72	HIRING AND FIRING STAFF	3.21	1.10	-0.43	-0.45	0.57	0.73	3.09	1.07	-0.32	-0.57	0.57	0.75
	73	EQUIPMENT PURCHASES	2.93	1.02	-0.20	-0.54	0.60	0.69	3.14	0.95	-0.43	-0.20	0.60	0.71
Medical Director Budgeting Authority	74	BUDGETING	3.90	0.96	-0.87	0.63	0.63	0.66	3.52	0.91	-0.35	0.05	0.63	0.60
	75	HIRING AND FIRING PHYSICIAN STAFF	3.56	1.20	-0.56	-0.63	0.52	0.81	3.26	0.96	-0.25	-0.12	0.55	0.70
	76	EQUIPMENT PURCHASES	3.96	0.88	-0.90	0.97	0.70	0.61	3.81	0.84	-0.63	0.52	0.55	0.69
Nursing Director Patient Care Authority	77	ADMITTING AND DISCHARGING PATIENTS	3.05	1.08	-0.39	-0.72	0.59		3.11	1.07	-0.39	-0.62	0.68	
	78	TREATMENT PROTOCOLS	3.42	1.00	0.21	-0.57	0.59		3.76	0.924	-0.18	-0.37	0.68	
Medical Director Patient Care Authority	79	ADMITTING AND DISCHARGING PATIENTS	3.89	0.96	-1.05	0.92	0.70		3.85	0.88	-0.83	0.79	0.63	
	80	TREATMENT PROTOCOLS	3.67	0.98	-0.76	0.07	0.70		3.72	0.81	-0.62	0.81	0.63	
Job Satisfaction	81	OVERALL, HOW SATISFIED ARE YOU IN YOUR JOB?	3.55	0.88	-0.66	-0.11			2.88	0.90	-0.19	-0.64		

Appendix2: Exploratory Factor Analysis (Physician)

Items	Description	Factor 1 Avoiding Conflict Strategy	Factor 2 Physician leadership	Factor 3 Nursing leadership	Factor 4 Within-group Communication Openness	Factor 5 Absolute Technical Quality of Care/Meeting Family Member Needs	Factor 6 Nursing Director Budgeting / Patient Care Authority	Factor 7 Perceived Effectiveness at Recruiting and Retaining	Factor 8 Unit relations with other units	Factor 9 Between-group Communication Openness	Factor 10 Within-group Communication Accuracy	Factor 11 Problem-solving Conflict Strategy	Factor 12 Between-group Communication Accuracy	Factor 13 Medical Director Budgeting Authority	Factor 14 Medical Director Patient Care Authority	Factor 15 Communication Timeliness	Communalities
40	[PHYSICIAN]S WILL WITHDRAW FROM THE CONFLICT.	**0.836**	-0.056	-0.061	-0.062	0.063	-0.142	-0.007	0.074	0.047	-0.069	-0.134	-0.002	0.022	0.118	-0.037	0.641
39	WHEN [PHYSICIAN]S DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	**0.762**	0.002	0.012	0.324	-0.032	0.041	0.027	-0.068	-0.124	0.049	-0.064	0.056	-0.004	-0.071	-0.041	0.724
47	BOTH PARTIES WILL WITHDRAW FROM THE CONFLICT.	**0.664**	0.105	0.027	-0.306	-0.133	0.000	-0.026	0.025	0.119	0.018	0.173	-0.083	-0.046	0.026	0.029	0.681
46	WHEN NURSES AND PHYSICAINS DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	**0.660**	0.032	-0.016	-0.071	0.029	0.021	0.098	0.022	0.097	-0.026	0.128	0.075	-0.011	0.018	-0.079	0.734
48	DISAGREEMENTS BETWEEN NURSES AND PHYSICIANS WILL BE IGNORED OR AVOIDED.	**0.555**	0.081	0.037	0.231	0.021	0.067	-0.093	-0.069	-0.060	-0.026	0.027	-0.034	0.058	-0.087	-0.039	0.615
15	ICU PHYSICIAN LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT PHYSICIANS.	0.158	**0.668**	0.012	0.019	-0.091	-0.005	-0.009	0.028	0.027	-0.010	-0.047	0.058	-0.075	-0.046	-0.036	0.501
10	ICU PHYSICIAN LEADERSHIP IS SUFFICIENTLY SENSITIVE TO THE DIFFERENT NEEDS OF UNIT PHYSICIANS.	-0.056	**0.633**	-0.133	0.133	0.007	0.027	0.005	0.094	-0.007	0.040	0.022	-0.106	-0.110	0.111	-0.025	0.576
16	ICU PHYSICIAN LEADERSHIP EFFECTIVELY ADAPTS ITS PROBLEM-SOLVING STYLE TO CHANGING CIRCUMSTANCES.	-0.073	**0.596**	0.031	0.076	-0.031	0.080	0.089	0.015	0.002	-0.088	0.030	-0.057	-0.044	0.072	0.035	0.461
13	UNIT PHYSICIANS ARE UNCERTAIN WHERE THEY STAND WITH THE ICU PHYSICIAN LEADERSHIP.	0.046	**0.434**	0.183	0.097	0.017	-0.034	-0.085	-0.036	0.009	0.001	0.008	0.014	0.129	0.003	0.037	0.494
14	THE ICU PHYSICIAN LEADERSHIP IS OUT OF TOUCH WITH PHYSICIAN PERCEPTIONS AND CONCERNS.	0.107	**0.425**	0.039	-0.066	0.139	0.036	0.008	-0.023	-0.024	0.099	0.004	-0.024	-0.081	0.073	0.076	0.476
5	UNIT PHYSICIANS ARE UNCERTAIN WHERE THEY STAND WITH THE ICU NURSING LEADERSHIP.	-0.021	-0.126	**0.860**	-0.056	-0.024	-0.079	-0.137	0.030	0.089	0.074	0.012	-0.115	0.050	0.032	0.034	0.595
6	THE ICU NURSING LEADERSHIP IS OUT OF TOUCH WITH PHYSICIAN PERCEPTIONS AND CONCERNS.	-0.034	0.071	**0.831**	-0.047	0.066	0.049	0.029	-0.018	0.028	-0.048	-0.018	-0.031	-0.011	-0.001	0.008	0.684
4	ICU NURSING LEADERSHIP DISCOURAGES PHYSICIANS FROM TAKING INITIATIVE.	0.034	0.019	**0.659**	-0.074	-0.021	-0.083	-0.125	0.054	0.055	-0.059	-0.044	0.045	0.011	-0.004	0.063	0.424
7	ICU NURSING LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT PHYSICIANS.	0.076	0.160	**0.645**	-0.043	0.017	-0.054	0.024	-0.003	-0.065	0.016	0.003	0.090	0.048	-0.057	-0.034	0.498
3	THE ICU NURSING LEADERSHIP FAILS TO MAKE CLEAR WHAT THEY EXPECT FROM UNIT MEMBERS.	-0.097	-0.009	**0.498**	0.030	-0.086	0.053	0.103	-0.021	-0.001	0.103	0.026	0.018	-0.111	-0.015	-0.079	0.508
2	ICU NURSING LEADERSHIP IS SUFFICIENTLY SENSITIVE TO THE DIFFERENT NEEDS OF UNIT MEMBERS.	-0.002	-0.062	**0.396**	-0.073	-0.118	0.089	0.171	-0.003	-0.025	0.095	0.063	-0.027	-0.031	0.090	-0.017	0.492
22	COMMUNICATION BETWEEN [PHYSICIAN]S IN THIS UNIT IS VERY OPEN.	0.070	0.087	-0.075	**0.855**	-0.053	-0.040	-0.015	-0.033	0.036	-0.004	-0.080	0.004	0.004	-0.040	0.064	0.716
21	IT IS EASY FOR ME TO TALK OPENLY WITH THE [PHYSICIAN]S OF THIS ICU.	0.012	0.063	0.025	**0.761**	0.029	-0.035	-0.058	-0.056	0.057	0.028	-0.040	-0.058	0.026	-0.011	0.094	0.632
23	I FIND IT ENJOYABLE TO TALK WITH OTHER [PHYSICIAN]S OF THIS UNIT.	-0.037	0.026	-0.127	**0.640**	0.005	0.050	-0.055	0.071	0.151	0.099	-0.015	-0.077	0.006	-0.009	-0.005	0.460
61	OUR UNIT ALMOST ALWAYS MEETS ITS PATIENT CARE TREATMENT GOALS.	-0.032	-0.136	0.089	0.004	**0.900**	0.005	-0.137	0.002	-0.069	0.021	0.052	0.014	0.052	0.032	-0.017	0.590
62	GIVEN THE SEVERITY OF THE PATIENTS WE TREAT, OUR UNIT'S PATIENTS EXPERIENCE VERY GOOD OUTCOMES.	0.033	-0.011	-0.027	-0.081	**0.780**	-0.022	-0.014	-0.131	-0.006	-0.037	0.003	0.120	0.009	0.005	-0.016	0.600
69	OUR UNIT DOES A GOOD JOB OF MEETING FAMILY MEMBER NEEDS.	0.096	0.011	-0.027	-0.007	**0.610**	0.051	0.021	0.117	0.056	0.122	-0.071	-0.047	0.033	-0.014	0.029	0.440
63	OUR UNIT DOES A GOOD JOB OF APPLYING THE MOST RECENTLY AVAILABLE TECHNOLOGY TO PATIENT CARE NEEDS.	-0.099	0.165	-0.166	0.092	**0.521**	-0.050	0.018	0.025	0.104	0.031	-0.050	0.037	0.046	0.080	-0.099	0.505
71	BUDGETING	-0.125	0.078	-0.069	-0.101	-0.036	**0.803**	-0.075	0.081	0.048	0.004	0.065	0.064	0.099	-0.099	-0.007	0.720
72	HIRING AND FIRING STAFF	0.103	0.025	-0.059	-0.122	0.047	**0.656**	-0.094	-0.024	0.050	0.103	-0.035	-0.117	0.199	-0.063	0.046	0.485
73	EQUIPMENT PURCHASES	-0.101	0.117	-0.010	0.005	-0.033	**0.648**	-0.092	-0.031	0.015	0.001	0.167	0.033	0.151	-0.125	-0.043	0.486
78	TREATMENT PROTOCOLS	-0.052	-0.099	0.092	0.155	0.009	**0.634**	0.039	-0.007	0.041	-0.072	0.003	-0.034	-0.162	0.235	-0.006	0.611
77	ADMITTING AND DISCHARGING PATIENTS	0.183	-0.131	-0.047	0.094	0.028	**0.569**	0.110	0.018	0.057	-0.114	-0.158	0.042	-0.165	0.163	-0.037	0.520
55	RECRUITING ICU NURSES. (relative to other ICUs)	-0.001	-0.035	-0.072	0.030	-0.103	-0.096	**0.742**	-0.005	-0.008	-0.011	0.044	0.075	0.099	0.003	-0.024	0.611
54	WE DO A GOOD JOB OF RETAINING ICU NURSES IN THE UNIT.	0.058	-0.012	0.019	-0.058	0.053	0.065	**0.722**	-0.009	0.048	0.058	-0.109	-0.015	0.032	-0.124	0.046	0.663
20	INADEQUATE WORKING RELATIONSHIPS WITH OTHER HOSPITAL GROUPS LIMIT OUR EFFECTIVENESS.	0.025	-0.028	0.046	0.084	-0.074	-0.007	-0.008	**0.822**	-0.013	-0.056	-0.142	0.041	0.105	-0.023	0.023	0.777
19	OTHER HOSPITAL SUBUNITS SEEM TO HAVE A LOW OPINION OF US.	-0.177	0.144	0.044	0.028	0.136	-0.080	0.047	**0.682**	0.020	0.023	0.063	0.000	-0.066	0.016	-0.074	0.674
18	OUR UNIT DOES NOT RECEIVE THE COOPERATION IT NEEDS FROM OTHER HOSPITAL UNITS.	0.115	-0.076	0.046	-0.094	-0.047	0.110	-0.055	**0.675**	0.049	0.016	0.009	0.030	-0.006	-0.051	0.048	0.493
17	OUR UNIT HAS CONSTRUCTIVE WORK RELATIONSHIPS WITH OTHER GROUPS IN THIS HOSPITAL.	0.053	0.053	-0.077	-0.046	-0.048	0.006	-0.007	**0.564**	0.077	0.042	0.045	-0.016	-0.054	-0.026	0.044	0.451
29	IT IS EASY FOR ME TO TALK OPENLY WITH THE [NURSE]S OF THIS ICU.	-0.024	-0.035	0.067	0.216	-0.064	-0.019	0.002	0.028	0.736	-0.057	0.074	-0.085	0.096	0.047	-0.008	0.688
31	I FIND IT ENJOYABLE TO TALK WITH [NURSE]S OF THIS UNIT.	-0.019	-0.044	0.015	0.045	0.072	0.000	0.086	-0.091	0.686	0.041	0.046	-0.072	-0.144	-0.046	0.081	0.566
32	IT IS EASY TO ASK ADVICE FROM [NURSE]S IN THIS UNIT.	0.105	0.017	0.051	-0.097	0.027	0.034	0.026	0.030	0.662	-0.056	-0.170	0.153	-0.001	-0.022	0.065	0.495
30	COMMUNICATION BETWEEN NURSES AND PHYSICIANS OF THIS UNIT IS VERY OPEN.	-0.059	-0.032	0.008	0.445	-0.067	-0.011	-0.022	0.037	0.559	0.019	0.141	0.060	0.063	-0.004	-0.133	0.561
26	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [PHYSICIAN]S IN THIS UNIT.	-0.081	-0.016	-0.051	-0.059	0.173	0.008	0.023	-0.058	-0.007	**0.767**	-0.040	0.027	-0.084	-0.036	0.067	0.610
25	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [PHYSICIAN]S IN THIS UNIT.	-0.042	-0.149	0.026	0.046	-0.129	-0.067	0.036	0.069	0.019	**0.692**	0.093	0.130	0.036	0.127	-0.102	0.686
27	THE ACCURACY OF INFORMATION PASSED AMONG [PHYSICIAN]S OF THIS UNIT LEAVES MUCH TO BE DESIRED.	0.110	-0.047	0.045	0.235	0.022	0.012	0.001	0.020	-0.041	**0.534**	-0.085	-0.027	0.000	-0.016	0.001	0.515
28	I FEEL THAT CERTAIN ICU [PHYSICIAN]S DON'T COMPLETELY UNDERSTAND THE INFORMATION THEY RECEIVE.	0.045	0.190	0.099	0.207	-0.046	0.061	0.039	0.022	0.096	**0.406**	-0.031	0.144	-0.008	0.021	0.051	0.418
50	THE NURSES AND PHYSICIANS WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	0.002	0.002	-0.033	-0.015	-0.074	0.022	-0.020	-0.046	0.042	-0.022	**0.929**	0.104	-0.001	-0.012	-0.049	0.805
52	EVERYONE CONTRIBUTES FROM THEIR EXPERIENCE AND EXPERTISE TO PRODUCE A HIGH QUALITY SOLUTION.	0.098	-0.009	0.013	-0.137	0.149	0.067	0.052	0.041	0.019	0.037	**0.684**	0.004	0.011	0.001	0.010	0.667
49	ALL POINTS OF VIEW WILL BE CAREFULLY CONSIDERED IN ARRIVING AT THE BEST SOLUTION OF THE PROBLEM.	0.225	0.002	0.069	-0.097	0.011	0.057	-0.047	-0.046	0.061	0.009	**0.684**	-0.007	-0.014	0.021	0.051	0.732
43	ALL THE [PHYSICIAN]S WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	0.184	0.003	-0.089	0.264	-0.005	-0.017	0.046	0.043	0.121	-0.064	**0.576**	-0.014	-0.041	0.045	0.044	0.739
42	ALL POINTS OF VIEW WILL BE CAREFULLY CONSIDERED IN ARRIVING AT THE BEST SOLUTION OF THE PROBLEM.	0.280	-0.128	0.031	0.242	0.104	-0.116	0.044	0.099	0.079	-0.002	**0.456**	-0.090	0.007	0.001	0.031	0.732
33	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [NURSE]S IN THIS UNIT.	0.026	0.017	-0.015	-0.071	-0.032	-0.013	-0.031	0.082	0.054	0.077	0.035	**0.795**	0.025	-0.001	0.015	0.685
34	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [NURSE]S IN THIS UNIT.	0.004	0.017	-0.033	-0.140	0.018	-0.008	-0.008	-0.081	0.081	0.183	0.063	**0.682**	-0.006	0.044	0.012	0.579
35	I FEEL THAT CERTAIN ICU [NURSE]S DON'T COMPLETELY UNDERSTAND THE INFORMATION THEY RECEIVE.	-0.049	-0.092	0.040	0.059	0.206	0.027	0.121	0.058	-0.018	-0.106	0.056	**0.608**	-0.113	-0.005	0.031	0.529
74	BUDGETING	0.007	-0.088	0.143	0.083	0.039	0.069	0.147	-0.020	0.023	-0.001	-0.091	-0.062	**0.873**	0.073	-0.034	0.743
76	EQUIPMENT PURCHASES	-0.005	-0.017	-0.117	-0.031	0.065	0.092	0.101	0.025	0.014	-0.061	0.073	0.022	**0.816**	0.077	0.034	0.702
80	TREATMENT PROTOCOLS	-0.003	0.087	0.009	0.014	0.050	-0.066	-0.024	-0.065	0.004	0.011	-0.001	0.023	0.120	**0.854**	-0.003	0.800
79	ADMITTING AND DISCHARGING PATIENTS	0.041	0.079	-0.013	-0.097	0.013	0.014	-0.084	-0.009	0.009	0.051	0.017	0.011	0.044	**0.807**	0.067	0.670
36	I GET INFORMATION ON THE STATUS OF PATIENTS WHEN I NEED IT.	-0.110	0.007	-0.005	0.064	-0.047	0.005	0.090	0.068	0.001	0.035	0.019	-0.054	-0.037	0.062	**0.888**	0.791
37	WHEN A PATIENT'S STATUS CHANGES, I GET RELEVANT INFORMATION QUICKLY.	0.013	-0.002	0.039	0.126	-0.016	-0.062	-0.069	-0.043	0.081	-0.058	-0.038	0.174	0.055	0.007	**0.602**	0.539
	Contribution of factor	7.019	6.875	5.708	7.222	6.663	3.793	5.305	4.748	5.525	5.305	8.219	4.086	1.905	2.691	2.427	

Items	Description	Factor 1 Avoiding Conflict Strategy	Factor 2 Problem-solving Conflict Strategy	Factor 3 Absolute Technical Quality of Care/Meeting Family Member Needs	Factor 4 Within-group Communication Openness	Factor 5 Nursing Director Budgeting Authority	Factor 6 Perceived Effectiveness at Recruiting and Retaining	Factor 7 Unit relations with other units	Factor 8 Nursing leadership	Factor 9 Physician leadership	Factor 10 Within-group Communication Accuracy	Factor 11 Medical Director Budgeting Authority	Factor 12 Between-group Communication Accuracy	Communalities
47	BOTH PARTIES WILL WITHDRAW FROM THE CONFLICT.	**0.876**	0.011	0.031	-0.034	-0.005	-0.042	0.027	-0.049	-0.079	-0.044	0.021	0.050	0.654
46	WHEN NURSES AND PHYSICAINS DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	**0.827**	0.004	0.011	-0.018	-0.030	0.010	-0.012	0.008	-0.030	0.035	-0.009	-0.044	0.708
40	[NURSE]S WILL WITHDRAW FROM THE CONFLICT.	**0.624**	-0.057	0.023	-0.003	-0.037	0.011	0.045	-0.045	-0.011	-0.087	0.023	0.018	0.458
39	WHEN [NURSE]S DISAGREE, THEY WILL IGNORE THE ISSUE, PRETENDING IT WILL "GO AWAY."	**0.554**	-0.003	0.014	-0.017	-0.052	-0.010	-0.008	0.058	0.012	0.014	0.055	-0.005	0.621
48	DISAGREEMENTS BETWEEN NURSES AND PHYSICIANS WILL BE IGNORED OR AVOIDED.	**0.523**	0.021	-0.060	0.043	0.067	0.042	-0.016	0.047	0.074	0.016	-0.031	0.010	0.533
41	DISAGREEMENTS BETWEEN [NURSE]S WILL BE IGNORED OR AVOIDED.	**0.396**	0.059	-0.091	0.112	0.054	0.005	-0.018	0.051	0.059	0.046	-0.053	-0.030	0.536
52	EVERYONE CONTRIBUTES FROM THEIR EXPERIENCE AND EXPERTISE TO PRODUCE A HIGH QUALITY SOLUTION.	-0.007	**0.891**	0.019	0.033	-0.036	0.015	-0.054	0.018	-0.020	-0.049	0.027	0.032	0.707
50	THE NURSES AND PHYSICIANS WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	0.062	**0.834**	-0.016	-0.012	-0.022	-0.031	0.009	-0.065	0.054	0.026	0.018	-0.034	0.710
45	EVERYONE CONTRIBUTES FROM THEIR EXPERIENCE AND EXPERTISE TO PRODUCE A HIGH QUALITY SOLUTION.	-0.043	**0.716**	0.001	-0.020	-0.013	-0.009	0.006	0.089	-0.040	-0.019	0.007	0.002	0.596
43	ALL THE [NURSE]S WILL WORK HARD TO ARRIVE AT THE BEST POSSIBLE SOLUTION.	-0.040	**0.682**	-0.061	-0.010	0.005	-0.009	0.056	-0.015	-0.012	0.017	-0.031	0.012	0.678
42	ALL POINTS OF VIEW WILL BE CAREFULLY CONSIDERED IN ARRIVING AT THE BEST SOLUTION OF THE PROBLEM.	0.140	**0.430**	0.083	0.019	0.100	0.022	-0.056	0.011	0.011	0.026	-0.049	-0.011	0.592
63	OUR UNIT DOES A GOOD JOB OF APPLYING THE MOST RECENTLY AVAILABLE TECHNOLOGY TO PATIENT CARE NEEDS.	-0.020	0.008	**0.702**	-0.046	-0.008	-0.001	0.000	0.107	-0.001	0.025	-0.001	-0.120	0.462
69	OUR UNIT DOES A GOOD JOB OF MEETING FAMILY MEMBER NEEDS.	0.007	-0.050	**0.679**	-0.014	-0.082	-0.057	0.001	-0.004	0.058	0.064	0.044	-0.072	0.493
62	GIVEN THE SEVERITY OF THE PATIENTS WE TREAT, OUR UNIT'S PATIENTS EXPERIENCE VERY GOOD OUTCOMES.	-0.035	0.019	**0.653**	-0.010	0.073	0.018	0.038	-0.075	0.013	-0.058	0.009	0.081	0.382
61	OUR UNIT ALMOST ALWAYS MEETS ITS PATIENT CARE TREATMENT GOALS.	0.068	-0.049	**0.586**	0.069	0.046	-0.079	-0.063	-0.067	-0.017	-0.070	-0.041	0.159	0.338
65	OUR UNIT IS VERY GOOD AT RESPONDING TO EMERGENCY SITUATIONS.	-0.017	0.051	**0.411**	-0.008	0.006	0.019	0.012	0.130	-0.015	0.024	-0.052	0.001	0.349
70	MEETING FAMILY MEMBER NEEDS. (relative to other ICUs)	0.021	0.016	**0.408**	0.025	-0.007	0.227	-0.015	-0.056	0.001	0.106	-0.038	-0.148	0.350
21	IT IS EASY FOR ME TO TALK OPENLY WITH THE [NURSE]S OF THIS ICU.	-0.006	-0.018	-0.026	**0.829**	-0.062	0.025	-0.026	-0.021	-0.028	-0.037	0.039	-0.038	0.655
22	COMMUNICATION BETWEEN [NURSE]S IN THIS UNIT IS VERY OPEN.	-0.016	-0.008	0.043	**0.717**	-0.014	-0.027	-0.037	-0.085	0.074	0.002	0.002	0.022	0.512
23	I FIND IT ENJOYABLE TO TALK WITH OTHER [NURSE]S OF THIS UNIT.	0.017	0.023	-0.025	**0.714**	0.016	-0.009	0.044	0.018	0.012	-0.006	0.006	-0.011	0.509
24	IT IS EASY TO ASK ADVICE FROM [NURSE]S IN THIS UNIT.	0.006	0.011	0.010	**0.455**	0.058	0.029	0.028	0.095	-0.045	0.098	-0.024	-0.003	0.349
73	EQUIPMENT PURCHASES	-0.017	-0.001	0.011	0.008	**0.757**	-0.014	0.018	0.029	-0.021	-0.036	-0.080	0.055	0.565
72	HIRING AND FIRING STAFF	-0.014	-0.023	0.006	-0.025	**0.669**	-0.008	0.041	-0.057	0.009	0.033	0.060	-0.051	0.469
71	BUDGETING	-0.010	-0.017	0.032	-0.022	**0.639**	0.014	-0.042	0.005	0.033	0.000	0.187	-0.016	0.684
60	RETAINING ICU PHYSICIANS. (relative to other ICUs)	0.018	-0.034	-0.047	-0.024	-0.018	**0.571**	-0.073	-0.071	-0.008	0.002	0.021	0.031	0.595
55	RECRUITING ICU NURSES. (relative to other ICUs)	0.020	0.064	0.076	-0.039	0.035	**0.466**	0.075	0.012	-0.047	0.046	-0.015	-0.069	0.370
20	INADEQUATE WORKING RELATIONSHIPS WITH OTHER HOSPITAL GROUPS LIMIT OUR EFFECTIVENESS.	0.049	0.025	-0.004	-0.036	-0.064	-0.013	**0.739**	0.003	0.065	0.027	0.042	-0.027	0.571
18	OUR UNIT DOES NOT RECEIVE THE COOPERATION IT NEEDS FROM OTHER HOSPITAL UNITS.	0.029	-0.032	-0.011	-0.061	0.064	0.031	**0.684**	0.051	-0.039	-0.039	-0.034	0.037	0.449
19	OTHER HOSPITAL SUBUNITS SEEM TO HAVE A LOW OPINION OF US.	-0.057	0.023	-0.022	0.086	-0.068	0.011	**0.653**	-0.067	0.014	0.045	0.042	0.018	0.492
17	OUR UNIT HAS CONSTRUCTIVE WORK RELATIONSHIPS WITH OTHER GROUPS IN THIS HOSPITAL.	0.015	-0.038	0.030	0.033	0.117	-0.019	**0.454**	0.013	-0.025	-0.062	-0.074	-0.018	0.258
8	ICU NURSING LEADERSHIP EFFECTIVELY ADAPTS ITS PROBLEM-SOLVING STYLE TO CHANGING CIRCUMSTANCES.	0.000	0.053	0.039	-0.064	-0.011	-0.010	-0.026	**0.684**	-0.120	-0.081	0.046	0.008	0.399
2	ICU NURSING LEADERSHIP IS SUFFICIENTLY SENSITIVE TO THE DIFFERENT NEEDS OF UNIT MEMBERS.	-0.054	-0.038	0.072	0.105	-0.006	0.015	0.041	**0.641**	-0.156	-0.050	0.024	0.059	0.472
3	THE ICU NURSING LEADERSHIP FAILS TO MAKE CLEAR WHAT THEY EXPECT FROM UNIT MEMBERS.	-0.016	0.043	-0.063	-0.016	0.008	0.003	0.061	**0.514**	0.023	0.081	-0.022	-0.069	0.344
6	THE ICU NURSING LEADERSHIP IS OUT OF TOUCH WITH NURSE PERCEPTIONS AND CONCERNS.	0.048	-0.015	-0.127	-0.017	0.036	0.022	-0.044	**0.513**	0.249	0.036	-0.056	-0.034	0.374
7	ICU NURSING LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT NURSES.	0.036	-0.006	0.039	-0.020	-0.062	-0.003	-0.015	**0.460**	0.177	0.042	0.023	0.043	0.341
13	UNIT NURSES ARE UNCERTAIN WHERE THEY STAND WITH THE ICU PHYSICIAN LEADERSHIP.	-0.035	-0.023	-0.007	-0.005	-0.029	-0.006	-0.006	0.000	**0.748**	-0.055	-0.007	-0.069	0.483
14	THE ICU PHYSICIAN LEADERSHIP IS OUT OF TOUCH WITH NURSE PERCEPTIONS AND CONCERNS.	-0.025	0.008	0.035	0.030	0.048	-0.046	-0.015	-0.013	**0.693**	-0.007	-0.005	0.021	0.470
15	ICU PHYSICIAN LEADERSHIP OFTEN MAKES DECISIONS WITHOUT INPUT FROM UNIT NURSES.	0.015	0.024	0.025	-0.010	-0.001	0.015	0.057	-0.124	**0.556**	0.012	0.028	0.043	0.366
26	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [NURSE]S IN THIS UNIT.	-0.018	-0.029	-0.023	0.010	0.048	-0.006	-0.040	-0.012	-0.025	**0.808**	0.002	0.035	0.604
25	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [NURSE]S IN THIS UNIT.	-0.045	0.019	-0.016	0.004	-0.046	0.003	-0.041	-0.005	-0.034	**0.613**	-0.014	0.078	0.434
27	THE ACCURACY OF INFORMATION PASSED AMONG [NURSE]S OF THIS UNIT LEAVES MUCH TO BE DESIRED.	-0.002	-0.014	0.040	0.032	-0.009	-0.009	0.071	-0.033	-0.026	**0.532**	-0.006	0.009	0.357
74	BUDGETING	0.027	-0.014	0.022	0.025	-0.079	0.009	-0.030	0.042	0.009	-0.023	**0.890**	0.014	0.755
75	HIRING AND FIRING PHYSICIAN STAFF	-0.015	0.003	-0.049	-0.032	0.167	0.019	0.016	-0.044	0.026	0.028	**0.585**	-0.027	0.457
76	EQUIPMENT PURCHASES	0.014	0.042	-0.012	0.059	0.111	-0.020	0.013	0.037	-0.053	0.010	**0.479**	-0.008	0.469
33	I CAN THINK OF A NUMBER OF TIMES WHEN I RECEIVED INCORRECT INFORMATION FROM [PHYSICIAN]S IN THIS UNIT.	-0.036	0.064	-0.011	0.009	-0.003	0.017	0.030	-0.036	0.015	0.007		**0.757**	0.557
34	IT IS OFTEN NECESSARY FOR ME TO GO BACK AND CHECK THE ACCURACY OF INFORMATION I HAVE RECEIVED FROM [PHYSICIAN]S IN THIS UNIT.	0.022	-0.042	-0.009	-0.017	-0.023	-0.013	-0.011	0.042	0.006	0.125	0.018	**0.669**	0.541
35	I FEEL THAT CERTAIN ICU [PHYSICIAN]S DON'T COMPLETELY UNDERSTAND THE INFORMATION THEY RECEIVE.	0.053	-0.038	0.015	-0.037	0.019	0.016	0.007	-0.069	0.034	0.021	-0.053	**0.509**	0.368
	Contribution of factor	5.338	6.609	5.340	3.854	3.659	3.582	4.579	5.548	4.279	4.255	2.673	3.204	

Appendix4: Mean, SD and inter-factor correlations of the ICU Nurse-Physician Questionnaire (Physician N=285)

	Mean	SD	Cronbach's α	Factor 1 Avoiding Conflict Strategy	Factor 2 Physician leadership	Factor 3 Nursing leadership	Factor 4 Within-group Communication Openness	Factor 5 Absolute Technical Quality of Care/Meeting Family Member Needs	Factor 6 Nursing Director Budgeting / Patient Care Authority	Factor 7 Perceived Effectiveness at Recruiting and Retaining	Factor 8 Unit relations with other units	Factor 9 Between-group Communication Openness	Factor 10 Within-group Communication Accuracy	Factor 11 Problem-solving Conflict Strategy	Factor 12 Between-group Communication Accuracy	Factor 13 Medical Director Budgeting Authority	Factor 14 Medical Director Patient Care Authority	Factor 15 Communication Timeliness
Factor 1	3.83	0.65	0.85	1.00														
Factor 2	3.73	0.68	0.83	0.32	1.00													
Factor 3	3.75	0.59	0.80	0.31	0.38	1.00												
Factor 4	3.95	0.71	0.81	0.44	0.42	0.21	1.00											
Factor 5	3.55	0.55	0.75	0.32	0.44	0.29	0.51	1.00										
Factor 6	2.88	0.76	0.78	0.11	0.14	0.17	0.11	0.25	1.00									
Factor 7	2.91	0.75	0.54	0.24	0.21	0.35	0.25	0.36	0.33	1.00								
Factor 8	3.62	0.70	0.79	0.31	0.37	0.33	0.33	0.31	0.12	0.18	1.00							
Factor 9	3.85	0.54	0.76	0.20	0.08	0.18	0.14	0.07	0.02	0.09	0.05	1.00						
Factor 10	3.35	0.73	0.77	0.23	0.35	0.26	0.40	0.31	0.17	0.21	0.35	0.00	1.00					
Factor 11	3.59	0.69	0.89	0.58	0.40	0.32	0.53	0.53	0.27	0.36	0.38	0.18	0.35	1.00				
Factor 12	2.86	0.73	0.77	0.19	0.25	0.43	0.16	0.21	0.18	0.28	0.16	0.04	0.41	0.19	1.00			
Factor 13	3.93	0.84	0.81	-0.11	0.03	-0.13	-0.08	-0.08	0.04	-0.21	0.00	0.07	0.03	-0.04	-0.17	1.00		
Factor 14	3.78	0.90	0.82	0.06	0.14	0.09	0.15	0.24	0.30	0.12	0.01	-0.03	0.13	0.25	0.16	0.00	1.00	
Factor 15	4.02	0.57	0.74	0.23	0.11	0.18	0.16	0.18	-0.05	0.02	0.11	0.27	0.10	0.18	0.14	0.11	0.04	1.00

Appendix5: Mean, SD and inter-factor correlations of the ICU Nurse-Physician Questionnaire (Nurse N=1477)

	Mean	SD	Cronbach's α	Factor 1 Avoiding Conflict Strategy	Factor 2 Problem-solving Conflict Strategy	Factor 3 Absolute Technical Quality of Care/Meeting Family Member Needs	Factor 4 Within-group Communication Openness	Factor 5 Nursing Director Budgeting Authority	Factor 6 Perceived Effectiveness at Recruiting and Retaining	Factor 7 Unit relations with other units	Factor 8 Nursing leadership	Factor 9 Physician leadership	Factor 10 Within-group Communication Accuracy	Factor 11 Medical Director Budgeting Authority	Factor 12 Between-group Communication Accuracy
Factor 1	3.70	0.60	0.85	1.00											
Factor 2	3.36	0.69	0.87	0.54	1.00										
Factor 3	3.46	0.48	0.75	0.31	0.50	1.00									
Factor 4	3.31	0.67	0.76	0.19	0.27	0.22	1.00								
Factor 5	3.11	0.83	0.78	0.20	0.25	0.27	0.07	1.00							
Factor 6	3.00	0.56	0.51	0.23	0.27	0.38	0.09	0.21	1.00						
Factor 7	3.26	0.64	0.74	0.29	0.38	0.39	0.33	0.20	0.24	1.00					
Factor 8	3.54	0.52	0.69	0.39	0.49	0.37	0.39	0.32	0.19	0.41	1.00				
Factor 9	3.49	0.65	0.70	0.41	0.36	0.35	0.10	0.20	0.28	0.34	0.40	1.00			
Factor 10	3.17	0.70	0.70	0.31	0.38	0.29	0.35	0.07	0.19	0.36	0.39	0.30	1.00		
Factor 11	3.53	0.74	0.75	-0.02	0.07	0.16	0.12	0.47	0.14	0.09	0.14	0.05	0.04	1.00	
Factor 12	3.40	0.68	0.71	0.28	0.24	0.27	0.04	0.02	0.17	0.25	0.24	0.41	0.47	-0.01	1.00

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	manuscript page number
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, 2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 4
Methods			
Study design	4	Present key elements of study design early in the paper	Page 4-6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Page 4
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, 6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 5, 6
Bias	9	Describe any efforts to address potential sources of bias	Page 5
Study size	10	Explain how the study size was arrived at	Page 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 6, 7
		(*b*) Describe any methods used to examine subgroups and interactions	N/A
		(*c*) Explain how missing data were addressed	Page 5
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	N/A
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 7, 8
		(b) Indicate number of participants with missing data for each variable of interest	Page 8
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	N/A
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 9-11

Discussion

Key results	18	Summarise key results with reference to study objectives	Page 11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 13,14
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 14

Other information

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.