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A Bell-Shaped Association between both the Objective and Perceived Nursing Workload and Workload Satisfaction of Intensive Care Nurses

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Abstract

Background: Nursing workload is an important issue in ICU management. However, not much is known about the association between nursing workload and satisfaction of nurses with their workload.
Objective: The aim of this study is to assess the association of the objective, time and activity-based nursing workload and the perceived nursing workload with the satisfaction of nurses about their workload on the Intensive Care.
Methods: We measured the objective nursing workload with the Nursing Activities Score and the perceived nursing workload measured with the NASA-TLX during 226 shifts in eight different Intensive Cares Units (ICUs). Nurses were asked to rate their satisfaction about the nursing workload during that shift on a scale from 0 (not satisfied at all) till 10 (maximum satisfaction). We used logistic regression models to analyze the association between both the Nursing Activities Score and the NASA-TLX with workload satisfaction (satisfied (>=6) or not (<6)) of nurses about the workload.
Results: In our study we showed that a Nursing Activities Score between 73.9 - < 83.7 points per nurse leads to a significant higher chance of a nurse being satisfied about his/her nursing workload (OR = 2.92 (1.01 – 8.45)). An increase of the overall workload with a NASA-TLX score of ≥ 27 is leading to a significant higher chance of a nurse being satisfied about the nursing workload (NASA-TLX 27 - <32: OR(CI)=3.26 (1.23 – 8.64); NASA-TLX ≥ 32: OR(CI) = 3.04 (1.11-7.98). Analyzing the subcategories of the NASA-TLX showed a significant higher chance of a nurse being satisfied about the workload in case of a high demand in the subcategories 'mental demand', 'physical demand' and 'effort'.
Conclusion: Our study showed that nurses are most satisfied on their workload when the Nursing Activity Score is around 80, and when the perceived overall workload as measured with the NASA-TLX is high (above 27). Especially a perceived high mental demand, physical demand or effort contributes to a higher chance of the nurse being satisfied. A further increase of the objective or perceived nursing workload to a very high demand or a low objective or perceived nursing workload diminish these positive associations. Managers responsible for capacity planning should take these results into consideration to avoid burn-out and bore- out of ICU nurses.

Keywords: Capacity; Intensive Care; Nursing; Workload

Introduction

The Intensive Care is a labor-intensive environment for nurses. The care for ICU patients is demanding due to the severity of illness of ICU patients and the often technical complexity of the treatment [1,2]. The support and care for the patient and his or her relatives, confronted with a critical and life-threatening situation, can be emotionally burdensome. Because of the relatively high mortality risk of ICU patients, ICU nurses are regularly confronted with end-of-life care which also can have a high impact on their mental workload.

The physical care can be demanding because most ICU patients are completely dependent of the nursing care, but also because of specific ICU nursing care as mobilization of ventilated patients or turning patients into prone position. That this work often has to be done in limited space and in ergonomic uncomfortable positions add to this physical demand [3].

Therefore, the mental and physical demand on ICU nurses is high [4,5]. Research has shown that all those factors: intensity of nursing activities, severity of illness, complexity of care and mental demand, attribute to the nursing workload [6-11]. This becomes particularly important as it has been shown that nursing workload is related to job satisfaction, burn-out and an intention to leave the current job [12,13]. Given the shortage of ICU nurses in Netherlands but also in many other western countries [14,15], it is important to keep nurses motivated and satisfied with their job. In an earlier study we assessed the association of time and activity based (objective) workload with the perceived nursing workload and concluded that it is important to take both the number of patients and the nursing workload into consideration when planning nursing capacity [11]. However, both the objective and the perceived workload did not give insight in the workload satisfaction of nurses. We therefore extended on our previous research with the aim to gain insight in the workload satisfaction of ICU nurses. To the best of our knowledge there are no studies published on the association of nurses' workload satisfaction with the objective or perceived nursing workload.

Objective

The aim of this study is to assess the association of workload satisfaction with both the objective nursing workload, measured with Nursing Activities Score, and the perceived nursing workload, measured with the NASA-TLX. We hypothesized that both a too low and too high workload could lead to dissatisfaction of the nurse. To further understand the association between nursing satisfactions with the perceived nursing workload we also assessed the association of nursing workload satisfaction with the different subcategories of the perceived nursing workload as measured with the NASA-TLX.

Methods

Study Design and Setting

We invited 15 Dutch ICUs already recording workload scores or with an intention to participate in the capacity module of the NICE quality registry [16] that includes a workload registration, to participate in this study on a voluntary basis. The nurses of the participating hospitals were informed about the study in a newsletter. From October 1st, 2016, and November 30th, 2017, we prospectively measured the objective nursing workload, the perceived nursing workload, and the satisfaction of the ICU nurses with the workload during their shift. Nurses were approached by the researcher to participate in this study on a voluntary basis.

Variables

Objective nursing workload

For the measurement of the objective nursing workload we used the Nursing Activities Score (appendix 1). The Nursing Activities Score represents a total of 23 nursing activities in direct and indirect care (e.g. hygiene procedures, mobilization and positioning or administration tasks) with a translation into a score, representing the mean nursing time needed for this activity [17,18]. A total Nursing Activities Score of 100 has been defined equally to the time spend by 1 Full Time Equivalent (FTE) nurse per shift. The Nursing Activities Score is validated with time measurements [17,18]. Research has shown that the Nursing Activities Score explains 59 - 81% of the actual nursing time [17,19]. The interrater reliability of the Nursing Activities Score showed variable results (Kappa 0.02 – 0.69) [20-22]. The Nursing Activities Score is the most common system for measuring nursing workload all over the world [18,23].

Perceived nursing workload

For the perceived nursing workload, we used the NASA-Task Load Index (NASA-TLX). The NASA-TLX is a validated questionnaire originally developed to measure the perceived workload in aviation [24] (appendix 2). The NASA TLX has been shown to be reliable for the measurement of the perceived workload in different settings, including health care [25,26]. It is a commonly used system to assess the perceived nursing workload on the ICU [27,28]. The NASA-TLX is a six-item scale representing six aspects of perceived workload: mental demand, physical demand, temporal demand, effort, performance, and frustration. Every subscale of the NASA-TLX is rated on a scale of zero to ten points with

zero as a minimal perceived workload and ten as a maximum perceived workload in that subcategory. For this study we used both the total NASA-TLX score and the NASA-TLX score per subscale. The subscales of the NASA-TLX represents a score from 0 till 100 points, with 0 points representing a minimum demand and 100 points representing a maximum demand on the workload in that specific subcategory. The total NASA-TLX score represents a mean score of the cumulative score of all six subscales with a score from 0 till 100; with 100 points representing a maximum overall workload.

Satisfaction with nursing workload

To measure how satisfied the nurses were with the work they had performed we asked the ICU nurses to grade their satisfaction with the workload during that shift on a scale from zero till ten (zero for not satisfied at all and ten for maximal satisfied) at the end of the shift.

Ethical Approval

All data were collected and analyzed anonymously. The Institutional Research Board of the Amsterdam University Medical Centre reviewed the research proposal and waived the need for informed consent (IRB protocol W17_366).

Data Collection

We used the Nursing Activities Score data of the capacity module in the Dutch National Intensive Care Evaluation (NICE) registry. The nursing workload data in the capacity module of the NICE registry consists of all nursing activities within the Nursing Activities Score with updated data definitions [18], and the sum-score of the Nursing Activities Score per patient.

Nurses using the capacity module are trained in the use of the Nursing Activities Score and the data definitions. The Nursing Activities Score data are collected by the ICU nurse in the Electronic Health Record, at the end of each shift. In our study we used the Nursing Activities Score per nurse. In case of two or more patients the Nursing Activities Score per nurse is the sum score of the Nursing Activities Score of all patients the nurse had to take care for during that shift. For the purpose of the study, we asked the ICU nurses to fill in the NASA-TLX subscales at the end of the shift on a web-based digital form, after the handover of the patient(s) to the colleague of the next shift. We also asked the ICU nurses to rate their workload satisfaction in that shift from zero (not satisfied) till ten (maximal satisfied) in the same web-based digital form. The nurses also had the opportunity to comment on the workload or the questionnaire in a free text field. During and after the shift the researcher was available for questions about the Nursing Activities Score and the questionnaires.

Statistical Analyses

We used univariate logistic regression analysis with nursing workload satisfaction divided into two categories: not satisfied (0 – 5) and satisfied (6 – 10) as the outcome variable. The independent variables, the Nursing Activities Score and the overall workload NASA-TLX score, were divided into quintiles, using the first quintile as the reference value. For our secondary analyses we used as independent variables each of the six subscales of the NASA- TLX divided into four categories: very low (<40), low (40–50), high (60-0) and very high (≥ 70) with very low as the reference value. We used the Odds Ratio (OR) and the 95%- Confidence Interval (CI) to determine if the association between workload satisfaction and objective or perceived workload is statistically significant (confidence interval does not include 1) or not significant (confidence interval does include 1). All analyses were performed using the R statistical environment (version 3.6.1) (R Foundation for Statistical Computing, Vienna, Austria).

Results

During the study period we collected NASA-TLX data from 229 nurses in 226 different shifts of 8 different hospitals. During these shifts, the ICU nurses were taking car for 389 different patients. Eight patients missed NAS-data and were excluded. The data of two nurses were excluded because of a missing satisfaction rate. Therefore, finally we included 381 patients, 227 nurses and 226 shifts. Table 1 shows the baseline characteristics of the included patients, nurses, type of hospitals and type of shifts.

	Included ICUs, nurses, and patients
Patient factors	
ICU admission type: Unplanned patients – n (%)	245 (68)
Planned patients – n (%)	117 (32)
Comorbidities: Diabetes Mellitus – n (%)	68 (17.8)

Renal insufficiency – n (%)	24 (6.3)
Cardiovascular insufficiency – n (%)	16 (4.2)
Respiratory insufficiency – n (%)	7 (2.4)
APACHE IV Acute Physiology Score – Median (IQR)	68 [47.25 – 96.5]
Age – Median (IQR)	66 [56 – 76]
BMI – Median (IQR)	25.95 [23.6 – 28.7]
In hospital mortality – n (%)	85 (22.3)
Length of ICU stay in days– Median (IQR)	3.2 [0.9 – 14.8]
Nursing Activities Score per patient (IQR)	31 (25.5 – 38.9)
Numbers of patients per nurse	
1 patient per nurse – n (%)	95 (41.4)
>1 patients per nurse – n (%)	134 (58.5)
Education level and level of experience nurses	
Student nurse – n (%)	20 (8.7)
Certified ICU nurse – n (%)	209 (91.3)
Type of hospital	
Academic or teaching hospital – n (%)	6 (75.0)
Non-teaching hospital– n (%)	2 (25.0)
Type of shift	
Day – n (%)	84 (37.2)
Evening – n (%)	77 (34.0)
Night – n (%)	65 (28.8)

Table 1: Baseline characteristics.

The median Nursing Activities Score per nurse, the objective nursing workload, was 69.6 (IQR 49.3 – 80.5) with a minimum of 20.6 points per nurse and a maximum of 134 points per nurse. The overall perceived workload based on NASA-TLX per nurse was 43.3 (IQR 30-50) with a minimum sum-score of 33 and a maximum score of 75. Overall, the nurses were satisfied with the workload with a median satisfaction rate of 8 on a scale of 0 till 10 (IQR 6 – 8) (Table 2). Thirteen nurses took the opportunity to leave free text in the questionnaire. Those comments can be found in the last row in Table 2.

	Median (IQR)
Nursing Activities Score per nurse – Median (IQR)	69.9 (50.0 – 80.5)
NASA-TLX Overall workload - Median (IQR)	43.3 (30 – 50)
NASA-TLX Mental demand- Median (IQR)	50 (30 – 70)
NASA-TLX Physical demand- Median (IQR)	50 (20 – 70)
NASA-TLX Temporal demand- Median (IQR)	30 (10 – 50)
NASA-TLX Overall performance- Median (IQR)	20 (20 – 30)
NASA-TLX Frustration level- Median (IQR)	30 (20 – 70)
NASA-TLX Effort- Median (IQR)	40 (20 – 70)
Satisfaction with workload – Median (IQR)	8 (6 – 8)
Satisfaction < 6 (N (%))	49 (21.6%)

Satisfaction [3] 6 (N (%))	178 (78.4%)
workload satisfaction score	**Comments of nurses**
9	1. peak was in the first half of the shift, manageable and very easy to do
10	2. Just got back from vacation, had to get going
10	3. Was a very quiet service
8	4. Because of my own fatigue (breastfeeding at night) I feel broke, so I have difficulty thinking and so on
3	5. The workload is too low for me to experience this shift? as pleasant
3	6. not a challenging shift?
3	7. Very quiet shift. Not very challenging. 1 patient who was very stable.
7	8. The shift started very restlessly, 1 nurse too few, who were brought in from the other unit, which made me, switch patients. This made it a troubled start-up. In addition, physically demanding because of an obese / troubled patient.
3	9. Too quiet rather than too busy
7	10. Quiet shift, where I was able to do everything I had to do and what I wanted to do. But it could be a bit busier.
2	11. Only 1 stable patient to take care of, especially attention to basic care, mobilization, etc.
8	12. Very quiet shift
9	13. workload is subjective, sometimes it feels more pleasant to have a busier shift

Table 2: Results nursing workload per nurse and satisfaction.

Table 3 shows the Odds Ratios of the objective nursing workload (Nursing Activities Score) and the perceived nursing workload (NASA-TLX). Only the fourth quintile of the Nursing Activities Score (73.9 - < 83.7) showed a significant higher workload satisfaction compared to the reference category (OR = 2.92 (1.01 – 8.45)). The two highest quintiles of the overall NASA-TLX score (≥ 27) were both significantly associated with a higher workload satisfaction (NASA-TLX 27 - <32: OR = 3.26 (1.23 – 8.64); NASA-TLX ≥ 32: OR = 3.04 (1.11-7.98)).

Variable	Odds	95% CI
Nursing Activities Score per nurse		
Q1: < 47.10	(ref)	(ref)
Q2: 47.10 - < 65.08	1.35	0.54-3.41
Q3: 65.08 - < 73.90	1.75	0.67-4.59
Q4: 73.90 - < 83.74	2.92	1.01-8.45
Q5: ≥ 83.74	1.8	0.69-4.71
NASA-TLX - Overall workload per nurse		
Q1: < 16	(ref)	(ref)
Q2: 16 - < 23	2.67	1.0 – 7.14
Q3: 23 - < 27	2.54	0.91 – 7.11
Q4: 27 - < 32	3.26	1.23 – 8.64
Q5: ≥ 32	3.04	1.11 – 7.89
NASA-TLX - Mental demand		

< 40, very low	(ref)	(ref)
40 – 50, low	0.66	0.3 – 1.47
60 – 70, high	2.72	1.05 – 7.06
≥70, very high	2.07	0.79 – 5.43
NASA-TLX – Physical demand		
< 40, very low	(ref)	(ref)
40 – 50, low	1.16	0.54 – 2.46
60 – 70, high	5.4	1.53 – 19.15
≥70, very high	1.32	0.53 – 3.31
NASA-TLX – Temporal demand		
< 40, very low	(ref)	(ref)
40 – 50, low	0.72	0.33 – 1.55
60 – 70, high	1.47	0.56 – 3.88
≥70, very high	1.04	0.21 – 5.19
NASA-TLX – Overall performance		
< 40, very low	(ref)	(ref)
40 – 50, low	1.23	0.44 – 3.44
60 – 70, high	0.15	0.04 – 0.67
≥70, very high	0.77	0.08 – 7.61
NASA-TLX – Frustration level		
< 40, very low	(ref)	(ref)
40 – 50, low	6.27	0.81 – 48.55
60 – 70, high	0.41	0.15 – 1.10
≥70, very high	0.92	0.44 – 1.96
NASA-TLX – Effort		
< 40, very low	(ref)	(ref)
40 – 50, low	1.52	0.69 – 3.35
60 – 70, high	2.73	1.03 – 7.24
≥70, very high	1.52	0.55 – 4.19

Table 3: Odds Ratios of Nursing Activities Score and NASA-TLX, including the subscales, on workload satisfaction.

Analyzing the subcategories of the NASA-TLX showed a significant increase of the chance of a nurse being satisfied with the workload in the highest quartiles of subcategories 'mental demand', 'physical demand' and 'effort'. If the nurse scored a high mental demand (quartile 3) the odds ratio was 2.72 (CI 1.05 – 7.06). If the nurse scored a high physical demand the odds ratio was 5.40 (CI 1.53 – 19.15). In case of a high effort the OR was 2.73 (CI 1.03 – 7.24).

Discussion

With this study we showed an association between workload satisfaction and the objective and perceived workload of ICU nurses. The fourth quintile of the objective workload, measured by the Nursing Activities Score (between 74-84), was significantly associated with a higher workload satisfaction, this effect was absent in the other and hence also the fifth quintile. This confirms our hypothesis that regarding workload satisfaction there is an optimum in the Nursing Activities Score per nurse. However, the Nursing Activities Score is developed with the suggestion that 1 FTE ICU nurse corresponds with a Nursing Activities Score of 10017. This score per nurse was never validated as an optimum score per nurse. In most studies the mean Nursing Activities Score per nurse is lower than the 100 NAS-points per nurse. Moghadam, et al. reported a mean Nursing Activities Score per nurse of 72,845. Earlier research of our research group comparing the COVID-19 ICU patients with non-COVID ICU patients showed a mean Nursing Activities Score per nurse of 46.6 [29]. In an observational study about the updated

guidelines of the Nursing Activities Score from Padilha, et al. in 19 ICUs in seven different countries they found a mean Nursing Activities Score of 72.8 with the lowest mean Nursing Activities Score of 44.5 in Spain and the highest mean Nursing Activities Score of 101.8 in Norway [18]. Our research shows that regarding the workload satisfaction of ICU nurses an optimal Nursing Activities Score per nurse would be around 80. In an earlier study of our group we showed a significant increase in hospital mortality if the Nursing Activities Score per nurse exceeded 78 per nurse [30]. Based on those results we already suggested that one registered ICU nurse should provide no more than a Nursing Activities Score of 78 per shift. Our present results seem to fit with these observations.

We also investigated the association of workload satisfaction with the perceived workload. The two highest quintiles of the perceived nursing workload measured by the NASA-TLX were associated with a higher workload satisfaction. This is also represented in 3 of the 6 subscales of the NASA-TLX; the mental and physical demand and the effort. In all three subcategories we found a higher workload satisfaction in the highest but one quintile (score 60 - 70). This implicates that both a perceived under- and over-prestation has an influence on how satisfied nurses are about the workload. Comparing the mean NASA-TLX in our study (NASA-TLX 43.3) with the results of other studies, the overall perceived workload with the NASA-TLX was relatively low. A study of Hoonakker, et al. in 757 ICU nurses in 7 hospitals and 17 different ICUs showed a mean overall workload of 70.427. Those ICUs included however also workload of nurses on a burn-unit, pediatric or neonatal unit. But also other studies showed NASA-TLX scores between 59.95 and 70.24,5. A possible explanation for our lower NASA-TLX score is the high number of postoperative patients in our study group (32%); the workload of a planned postoperative ICU patient is relatively low compared to unplanned surgical or medical patients [11]. The low nursing workload and the negative impact of this workload on nurses is also confirmed in different remarks we found in the free text comments. Nine out of the thirteen nurses left a comment about a quiet shift stating: 'very quiet' or 'too quiet', 'little or no challenge', 'workload too low to be pleasant', 'sometimes it feels more pleasant to have a busier shift'. Only one nurse left a comment about a busy (restless) shift with too few nurses for the work to be done. The results of the satisfaction about workload of the nine nurses with comments due to a quiet shift showed a wide range in the satisfaction rate (2 till 10). This shows that there is dissatisfaction with the workload at both a very high and very low workload. These qualitative results seem to support that there is an optimal point in the nursing workload. This optimal point is important because of the impact of nursing workload on job satisfaction, burn-out or intention to leave [12,13]. Planning the nursing staff should not be based on the number of patients per nurse, but on both the objective and perceived nursing workload.

Strength and Limitations

To the best of our knowledge this study is the first one that assessed the relationship between workload satisfaction and both the objective as well as the perceived nursing workload. Many studies described nursing workload or job satisfaction, but none of those studies analyzed the association between these concepts. Therefore, this study contributes to a better understanding of nursing workload and how to use the concept of workload as a human resource tool. Strength of this study is the completeness of data. During this study both the Nursing Activities Score and the NASA-TLX was filled in by almost all the nurses. We included data in a period of 13 months and therefore the data are representative for workload all over the year. Because we asked the nurse to fill in the questionnaire at the end of the shift and after the handover the study it did not affect the measured nursing workload.

Some limitations of our study need to be taken into consideration. Whereas workload satisfaction is a very complex concept we used a simple one-dimensional question for the satisfaction of nurses about workload. As the Nursing Activity Score and the NASA-TLX questionnaire already contain many items to be scored we opted for the simple one- dimensional question to avoid adding more registration load. This question was unambiguous in asking for the satisfaction rate on the nursing workload during the last shift and it simply used a scale between zero and ten that nurses are used to in all kinds of daily life varying from school grades as well as review rates of consumer products and travel services.

Although our study is one of the larger studies in adult ICUs comparing workload data with both the Nursing Activities Score and the NASA-TLX, the number of observations is still relatively low and this might cause lack of power to prove an association between workload satisfaction and Nursing Activities Score or NASA-TLX, especially on the subscales of NASA- TLX. To generalize the results of our study a larger study population and studies in different ICUs and in different countries are needed. It seems to be important to focus on a further validation of the optimal Nursing Activities Score per nurse.

Recommendations and New Research Questions

It seems to be important to focus on a further validation of the optimal Nursing Activities Score per nurse. Whereas the developers of the NAS defined a total Nursing Activities Score of 100 points equal to the time spend by one Full

Time Equivalent (FTE) nurse per shift, our research shows an optimum not exceeding 80 NAS points per nurse. It is therefore important to focus on a further validation and recalibration of the NAS. This improves the application of NAS in daily practice of the nurse and in ICU-management.

Our research showed also that it is important to focus on both the objective nursing workload and the perceived nursing workload. However, the existing registry does not consist of items to measure the perceived nursing workload like the NASA-TLX. Keeping the workload of registration of extra items in mind, it should be considered to measure the perceived workload and the satisfaction of nurses about the workload not on daily basis, but on a regular basis, for instance, by one week of data collection once or twice a year or during extreme situations like the COVID-pandemic.

Conclusion

We showed that both the objective nursing workload as measured with Nursing Activities Score and the perceived nursing workload as measured with the NASA-TLX are associated with the satisfaction with nursing workload. A Nursing Activities Score per nurse between 74 and 84 points per nurse and a total NASA-TLX of > 27 points are significantly associated with a higher workload satisfaction. This indicates that there is an optimum in the nursing workload. Further research is needed to validate the optimum Nursing Activities Score per nurse.

Competing Interests

The author M.E. Hoogendoorn and co-authors S. Brinkman, J.J. Spijkstra, R.J. Bosman and N.F. de Keizer and are members of the board of NICE. The funding by the NICE foundation does not alter the authors' adherence to the policies of Critical Care Nursing on sharing data and materials.

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