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Original Article

Assessing the concordance: A comparative study of REBA and PTAI in ergonomic risk assessment for nursing staff of intensive care unit

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Abstract

Musculoskeletal disorders (MSDs) are prevalent among nursing staff of intensive care units, exacerbated by patient handling activities. Ergonomic risk assessments like the Rapid Entire Body Assessment (REBA) and Patient Transfer Assessment Instrument (PTAI) are pivotal in mitigating these risks. This study investigates the agreement between these two tools in a critical care setting. A cross-sectional study was conducted on 154 nurses in four intensive care units, using REBA and PTAI to assess ergonomic risks during five specific patient handling tasks: (1) adjusting patient position in bed, (2) repositioning patient towards the head of the bed, (3) lateral patient transfer, (4) bathing patients in a sitting position, and (5) making an occupied bed. Data were analyzed using weighted Kappa statistics to evaluate the agreement between the tools. A near-perfect agreement was found between REBA and PTAI scores, with weighted Kappa values of 0.8418 and 0.7186 for right and left sides respectively, indicating a concordance in ergonomic risk assessment. The findings suggest that both REBA and PTAI can be used interchangeably for postural risk assessment in healthcare settings, with REBA requiring more training and experience to administer. The study enhances the understanding of ergonomic risk assessments, which is essential for designing safer patient handling protocols.

Keywords: ergonomics, REBA, PTAI, agreement, nurses

1. Introduction

Musculoskeletal Disorders (MSDs) are conditions affecting the musculoskeletal system, ranging from mild discomfort to severe disability that can impact employment (Margham, 2011; Perna & Proietti, 2023; Walker-Bone & Linaker, 2016). Work-related MSDs are influenced by job-related factors, personal characteristics, and psychosocial aspects (Hignett *et al*., 2014).

Healthcare workers, especially nurses, face a higher risk of MSDs due to physical demands posed by patient handling (Hämmig, 2020; Hignett *et al*., 2014; Vinstrup *et al*., 2020, Jakobsen, Madeleine, & Andersen, 2020). A meta-analysis showed an annual MSD prevalence of 75.9-77.9% among nurses, primarily affecting the lower back, neck, and shoulders (Sun *et al*., 2023).

Patient care activities, especially those involving physical exertion like patient transfers, significantly contribute to MSDs in nursing (Aeni, Banowati, & Nur'alinda, 2020; Andersen, Vinstrup, Villadsen, Jay, & Jakobsen, 2019; Hellmers *et al*., 2022; Mebarki, Zaoui, Mokdad, & Mebarki, 2023). Psychosocial factors such as work-related stress and heavy workload further exacerbate these issues, affecting nurses' performance and ultimately impacting healthcare quality (Lang, Ochsmann, Kraus, & Lang, 2012; Luan *et al*., 2018). Consequently, conducting ergonomic risk assessments is crucial for evaluating and mitigating these risks among nursing staff.

ISO's Technical Report 12296:2012 suggests various tools for ergonomic risk assessment in healthcare,

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including REBA and PTAI (Hignett *et al*., 2014). PTAI evaluates patient transfer workload (Karhula *et al*., 2006), while REBA assesses work posture risks (Hignett & McAtamney, 2000).

Patient Transfer Assessment Instrument (PTAI) (Hignett *et al*., 2014; Karhula *et al*., 2006) evaluates workload in patient transfers, with or without assistive devices, at both individual and ward levels. It comprises 15 items assessed through observation and interviews, covering factors like organizational management, environment, equipment use, and personal characteristics of both healthcare workers and patients. Rapid Entire Body Assessment (REBA) (Hignett & McAtamney, 2000) method evaluates the risk associated with work postures, assessing body parts including the neck, trunk, upper arms, forearms, wrists, and legs. The assessment is based on observing the posture of the individual being evaluated.

These tools are undeniably important for identifying and mitigating risks associated with manual patient handling, a pressing concern in healthcare settings due to the prevalent musculoskeletal disorders among healthcare workers. This study aims to investigate the agreement between REBA and PTAI in assessing ergonomic risks in intensive care units. The results of this study can contribute to improving patient handling protocols by guiding the selection of useful assessment tools. This can lead to simpler yet informative risk assessments and, consequently, safer patient handling practices in healthcare settings.

2. Materials and Methods

The study, a cross-sectional analysis, was conducted in four adult intensive care units at a university hospital in Southern Thailand, including the Surgical Intensive Care Unit (SICU), Medical Intensive Care Unit (MICU), Cardiac Care Unit (CCU), and Cardiovascular Thoracic Intensive Care Unit (CVT) from March to June 2022.

2.1 Subjects and eligibility

The research focused on 154 full-time nurses working in these units, involved in patient transfer activities, with at least 12 months of experience in the adult critical care department. Inclusion criteria required voluntary participation of the nurses. Exclusion criteria encompassed nurses diagnosed with specific chronic musculoskeletal and autoimmune diseases, including but not limited to rheumatoid arthritis, systemic lupus erythematosus (SLE) with arthritis, gout, or those who had a bone fracture within the previous year.

To achieve the desired statistical significance, a total of 180 evaluations would be required, based on the calculations for an anticipated Kappa of 0.70 against a null hypothesis Kappa of 0.40, with an 80% power level and a proportion of positive ratings of 0.90 (Sim & Wright, 2005).

2.2 Nursing activities

The evaluation focuses on nursing activities related to manual patient handling in the adult intensive care units at a university hospital in Southern Thailand. Five specific nursing activities are assessed: 1. adjusting or changing the patient's position on the bed, such as from left to right or onto their side, 2. adjusting or repositioning the patient's location towards the head of the bed, 3. transferring the patient laterally, such as from one stretcher to another or from bed to bed, 4. Bathing patients in a sitting position, and 5. making the bed while the patient is still on it. These activities encompass a range of patient handling tasks that nurses frequently perform, presenting various degrees of ergonomic challenges and risks.

2.3 The instruments used for data collection

2.3.1 Patient transfer assessment instrument (PTAI)

(Hignett *et al*., 2014; Karhula *et al*., 2006):

The tool consists of 15 items. Each assessment item includes three sub-questions, the answers to which are combined to form a load index.

The PTAI index was calculated using a specific formula. This formula accounts for the adequacy of the factors assessed in the patient handling process. It includes the total number of factors meeting the ideal criteria, a weighted count of factors that meet two criteria, and a lesser weight for factors meeting only one criterion. The formula is structured to provide a percentage representation of the ergonomic adequacy in patient handling activities. Specifically, the PTAI index is calculated as:

PTAI index (%) = [*Number of Adequate Factors* + (*0.67* × *Number of Factors Meeting 2 Criteria*) + (*0.33* × *Number of factors Meeting 1 criteria*)] × *100* ÷ *Total Number of Assessed Factors*

The results are interpreted in three levels:

- More than 80% (green, low risk) indicates that ergonomics in patient transfer is at a good standard. Current practices should be maintained, with potential for future improvements.
- 60% to 80% (yellow, medium risk) signifies a relatively high workload in patient transfers, suggesting a need for improvements as identified in the assessment.
- Less than 60% (red, high risk) indicates an immediate need for ergonomic improvements in work practices.

For this study, we specifically concentrated on items 5 to 8 of PTAI, which directly relate to the posture of healthcare workers during patient transfers. These items were selected for their relevance in assessing the ergonomic aspects of patient handling. Item 5: distance and height of transfer (no steps, knee-elbow level, no reaching), assessing spatial factors critical to ergonomic safety. Item 6: load on upper limbs and trunk (holding up, elbows and shoulders, wrists and fingers), while item 7: load on lower back (flexion, rotation, body control). Lastly, item 8: Load on lower limbs (knees-feet alignment, no squatting/on knees). This targeted approach allows for a detailed investigation into the postural demands placed on healthcare workers during the critical task of patient handling using PTAI.

2.3.2 Rapid entire body assessment (REBA)

(Hignett & McAtamney, 2000):

This tool is a quick postural analysis for whole body activities, both static and dynamic. The assessment of the right and left hands must be conducted independently and this method does not incorporate the duration and frequency of tasks.

The body is divided into two groups for assessment. Group A: this group includes the assessment of the neck, back, and legs; and group B: this group involves the assessment of the upper arm, lower arm, and wrist. The scoring is based on the planes of movement, along with considerations for the force exerted (weight lifted) and repetitive movements (more than 4 times per minute). The outcome is a total REBA score, which is then used to determine the risk level, indicating the urgency of managing the risk of musculoskeletal injuries from work activities. The risk levels are divided into five categories: Very Low Risk (total score of 1): Minimal risk, but improvements may still be beneficial. Low Risk (total score of 2-3): Low risk, however, some adjustments are recommended. Medium Risk (total score of 4-7): Moderate risk requiring further analysis and should be improved. High Risk (total score of 8-10): High risk necessitating additional analysis and urgent improvement. Very High Risk (total score of ≥ 11): Extremely high risk requiring immediate modification.

The REBA tool is crucial for identifying and mitigating risks associated with poor workplace ergonomics. By categorizing the level of risk, it helps organizations prioritize and implement necessary changes to improve workplace safety and reduce the likelihood of musculoskeletal injuries among workers.

2.4 Data collection

After receiving referrals from the Coordination of Nursing to the units, the researcher will spend one week in each ward to collect data. Nurses who have been informed about the study and have given their consent will be video recorded during the execution of all five nursing activities. This will also include recording the standing positions of each participating volunteer. For both REBA and PTAI assessments, we employed an event-based method to select postures for evaluation. Specifically, we analyzed long-shot video recordings of nursing activities and focused on the most common and potentially worst postures observed during the five predefined nursing tasks in ICUs.

The selected postures were then independently assessed by a team of three evaluators: an ergonomist, an occupational medicine physician, and a physiotherapist. Each evaluator independently scored the REBA and PTAI for each recorded activity. In cases where their scores or interpretations of the tasks differed, a consensus meeting was convened to discuss and decide on the final score.

Although the original REBA has 5 risk levels, to allow for direct comparison with PTAI, we regrouped the REBA scores into 3 levels as follows: Low risk: REBA scores 1-3, Medium risk: REBA scores 4-7, and High risk: REBA scores 8-15. This regrouping allows for a straightforward comparison of risk assessment results between REBA and PTAI while maintaining the meaning of the risk levels.

2.5 Data analysis

Data were recorded using KoboToolBox and analyzed utilizing R software. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were employed to describe the demographic and organizational characteristics of the subjects. The concordance between the REBA and PTAI assessment scores was evaluated using the Weighted Kappa statistic with quadratic weights assigned as 1 for exact matches, 0.75 for one level of disagreement, and 0 for two levels of disagreement. The degree of agreement was interpreted according to the guidelines provided by Landis and Koch (1977) and Sim and Wright (2005) where a Kappa value less than or equal to 0.00 indicates poor agreement; 0.01 – 0.20 suggests slight agreement; 0.21 – 0.40 indicates fair agreement; 0.41 – 0.60 denotes moderate agreement; 0.61 – 0.80 represents substantial agreement; and 0.81 – 1.00 signifies almost perfect agreement.

2.6 Research ethics in human subjects

This research has been approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC.64-543-9-4). The researchers informed the participants about the research objectives, data collection methods, and provided consent forms. Participants were assured of their right to accept or decline participation and were able to withdraw from the study at any time without any adverse consequences.

3. Results and Discussion

3.1 Participants

In this study, 93 out of 154 nurses in various intensive care units were videotaped, resulting in a 60.4% participation rate. Specific response rates for each ward were: 85.7% in CCU, 63.9% in CVT ICU, 61.5% in MICU, and 44.4% in SICU. The majority of participants, 95.7%, were female. The average age among the nurses was 31.6 years (SD = 7.9). Regarding BMI, 52.7% had a BMI ranging from 18.5 to 22.9 kg/m². The median work experience in the field was 5.0 years (Table 1).

3.2 Rapid upper body assessment (REBA)

The REBA assessments for the right and left sides across all wards predominantly classified instances as medium risk. This was followed by high risk and then low risk categories. The overall results showed that for the right side, 65.6% were medium risk, 28.3% high risk, and 6.1% low risk. For the left side, the results were similar with 64.4% medium risk, 30.6% high risk, and 5.0% low risk (Table 2 and 3).

3.3 Patient transfer assessment index (PTAI)

The PTAI assessments across all wards predominantly classified instances as medium risk. This was followed by high risk and then low risk categories. The overall results showed that 68.9% were medium risk, 26.1% high risk, and 5.0% low risk (Table 4).

Table 1. Demographic characteristics of nurses by ward

	CCU (n=18)	MICU (n=32)	SICU (n=20)	CVT (n=23)	Total (n=93)
Sex: female (n,%)	18 (100.0)	30 (93.8)	19 (95.0)	22 (95.7)	89 (95.7)
Age (years) (mean, SD)	30.5 (7.5)	30.7 (7.0)	32.2 (8.7)	33.2 (8.8)	31.6 (7.9)
Body mass index (n,%)					
< 18.5 kg/m^2	2 (11.1)	3 (9.4)	3 (15.0)	3 (13.0)	11 (11.8)
18.5 - 22.9 kg/m^2	12 (66.7)	15 (46.9)	10 (50.0)	12 (52.2)	49 (52.7)
>= 23 kg/m^2	4 (22.2)	14 (43.8)	7 (35.0)	8 (34.8)	33 (35.5)
Work duration in ICU (Median [IQR])	3.0 [1.0, 28.0]	7.0 [1.0, 30.0]	8.0 [1.0, 36.0]	3.0 [1.0, 33.0]	5.0 [1.0, 36.0]

Table 2. REBA risk assessment outcomes for the right side across wards

REBA	Ward				
	CCU (N=55)	CVT (N=38)	MICU (N=50)	SICU (N=37)	Overall (N=180)
low	1 (1.8%)	6 (15.8%)	0 (0%)	4 (10.8%)	11 (6.1%)
medium	38 (69.1%)	23 (60.5%)	33 (66.0%)	24 (64.9%)	118 (65.6%)
high	16 (29.1%)	9 (23.7%)	17 (34.0%)	9 (24.3%)	51 (28.3%)

Table 3. REBA risk assessment outcomes for the left side across wards

REBA	Ward				
	CCU (N=55)	CVT (N=38)	MICU (N=50)	SICU (N=37)	Overall (N=180)
low	1 (1.8%)	4 (10.5%)	0 (0%)	4 (10.8%)	9 (5.0%)
medium	39 (70.9%)	25 (65.8%)	32 (64.0%)	20 (54.1%)	116 (64.4%)
high	15 (27.3%)	9 (23.7%)	18 (36.0%)	13 (35.1%)	55 (30.6%)

Table 4. PTAI risk assessment outcomes across wards

PTAI	Ward				
	CCU (N=55)	CVT (N=38)	MICU (N=50)	SICU (N=37)	Overall (N=180)
low	2 (3.6%)	3 (7.9%)	1 (2.0%)	3 (8.1%)	9 (5.0%)
medium	38 (69.1%)	26 (68.4%)	34 (68.0%)	26 (70.3%)	124 (68.9%)
high	15 (27.3%)	9 (23.7%)	15 (30.0%)	8 (21.6%)	47 (26.1%)

3.4 Concordance between REBA and PTAI in ergonomic risk assessment

The agreement between REBA and PTAI scores was evaluated using the Kappa statistic. For the right side, the unweighted Kappa was 0.8114 (ASE 0.04464, Z-score 18.18, $p < 0.001$), indicating significant agreement. The weighted Kappa was higher at 0.8418 (ASE 0.03790, Z-score 22.21, $p < 0.001$), suggesting even stronger agreement. Similarly, the left side showed a significant agreement with an unweighted Kappa of 0.7186 (ASE 0.05296, Z-score 13.57, $p < 0.001$) and a weighted Kappa of 0.7614 (ASE 0.04625, Z-score 16.46, $p < 0.001$) as shown in Table 5.

The current study aimed to assess the agreement between REBA and PTAI scores, as both REBA and PTAI are recommended by ISO's Technical Report 12296:2012 for ergonomic risk assessment in healthcare settings (Hignett *et al.*, 2014). The results obtained are intended to assist in selecting the most appropriate ergonomic assessment tool. This selection is crucial for evaluating and monitoring ergonomic risks, which in turn facilitates the adaptation of future workstations to enhance ergonomics and worker safety.

This study's findings indicate almost perfect agreement between REBA and PTAI for postural analysis in ergonomic evaluations. For the right side, the weighted Kappa was 0.8418, indicating almost perfect agreement. The left side had a weighted Kappa of 0.7186, demonstrating substantial agreement.

The variation in agreement levels between the right and left sides in this study can be attributed to the differences

Table 5. The REBA and PTAI risk level agreement

PTAI	REBA					
	Right			Left		
	Low (n=11)	Medium (n=118)	High (n=51)	Low (n=9)	Medium (n=116)	High (n=55)
Low	7 (63.6%)	2 (1.7%)	0 (0%)	6 (66.7%)	3 (2.6%)	0 (0%)
Medium	4 (36.4%)	113 (95.8%)	7 (13.7%)	3 (33.3%)	108 (93.1%)	13 (23.6%)
High	0 (0%)	3 (2.5%)	44 (86.3%)	0 (0%)	5 (4.3%)	42 (76.4%)

in assessment methods of REBA and PTAI. REBA evaluates the sides of the body separately, while PTAI does not differentiate sides but instead focuses on the overall posture. Observations revealed that the right side tends to have higher ergonomic risk in the tasks assessed. In PTAI, the most problematic posture is chosen for evaluation, which correlates with the higher risk found in the right side by REBA. Hence, the right side's assessments in REBA align more closely with PTAI's overall posture risk evaluation.

In our investigation, the REBA scores on both sides predominantly fell into the medium risk category, with 65% of cases, followed by high risk at 29.4%, and low risk at 5.6%. This distribution aligns with previous research by Carneiro, Villarroya, Colim, Torres, and Arezes (2019), Mahmoudifar and Seyedamini (2017), and Mohammadi, Halvani, Mehrparvar, Jambarsang, and Sadat Anoosheh (2020), which confirms that the risk spectrum identified in our study is consistent with established findings.

The reason behind the similarity in most of the REBA and PTAI assessments (for the purposes of this study) is that both ask about the posture of the trunk, and upper and lower extremities. However, PTAI inquires in a less detailed manner, such as whether the wrists are excessively bent or twisted or if the worker's back maintains a natural (neutral) posture. This similarity in questioning could explain why the results tend to converge. The differences arise from distinct cutoff points—for example, PTAI considers whether the back is straight or bent at an angle less than 45 degrees during patient transfer, whereas REBA categorizes the angle into five ranges, like 0-20 degrees and 20-60 degrees. Furthermore, REBA inquires about the force used, the grip on objects, and the motion characteristics of the task. Additionally, REBA scores are composite, which can dilute or amplify risk levels due to other domains.

The REBA assessment involves a total of 13 steps, and assessors should undergo training and have a considerable amount of experience in order to evaluate accurately and quickly. It has been reported that inter-observer reliability of REBA scoring ranged between 62 and 85 percent (Hignett & McAtamney, 2000). In contrast, the items in the PTAI assessment are not complex and can be learned quickly, with an Intraclass Correlation Coefficient of 0.80 (Abedini, Choobineh, & Hasanzadeh, 2013). Therefore, in settings where there are few ergonomists or where there is a high volume of work that cannot be managed in time, PTAI could feasibly be used to assist in ergonomic postural assessment in place of REBA.

3.5 Strength

This study reinforces the consistency of ergonomic assessments using distinct tools and provides data to integrate risk assessment information into regular patient care activities in intensive care units.

3.6 Limitation

This study has several limitations that should be considered when interpreting the results. Firstly, the generalizability of the findings is limited due to the focus on ICU nurses. The physical and ergonomic demands in the ICU may differ significantly from those in other hospital departments, potentially limiting the applicability of these results to nurses in different healthcare settings.

Secondly, potential biases may have influenced the study outcomes. The observational nature of the ergonomic assessments could introduce variability in the risk assessment scores due to differences in nurses' postures during patient handling tasks. Additionally, individual factors such as physical fitness levels and years of experience, which were not controlled for in this study, might have impacted the results.

Furthermore, the lack of comparative research regarding kappa values between REBA and PTAI is a significant limitation. The absence of benchmark studies in this field makes it challenging to contextualize our research findings within existing literature. While our results contribute novel insights to the body of knowledge on ergonomic risk assessments in healthcare, they also highlight the need for additional comparative studies to validate and expand upon our findings.

Future research should address these limitations by including nurses from other departments, controlling for potential confounding factors, and conducting larger-scale, longitudinal studies. Such efforts would not only strengthen the validity of these findings but also contribute to a more comprehensive understanding of ergonomic risk assessments in nursing practice across diverse healthcare settings.

4. Conclusions

Our study undertook a comparative analysis of the REBA and PTAI tools in assessing ergonomic risks among nurses in intensive care units. The findings revealed a high level of agreement between these two methods, particularly

for the right side, indicating that both tools are reliable for ergonomic risk assessment in healthcare settings. Both REBA and PTAI as valuable tools in identifying and mitigating risks associated with patient handling. While REBA offers a more comprehensive assessment, requiring detailed training and experience from the evaluator, PTAI presents a simpler and quicker alternative, making it a feasible option in settings with limited ergonomic expertise. These tools are essential in designing safer patient handling protocols, ultimately protecting nursing staff from musculoskeletal disorders, and enhancing the overall quality of healthcare services.

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