Original Article

Psychometric Assessment of Physiologic and Behavioral Pain Indicators in Polish Versions of the Pain Assessment Scales

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Abstract:

Background: There is an urgent need to prepare a reliable and accurate tool for pain assessment in patients who are unable to self-report. Translating pain assessment scales into foreign languages requires further validation testing. Aim: The aim of the study was to carry out psychometric assessment of behavioral and physiological indicators of pain included in two Polish versions of pain assessment scales, the Behavioral Pain Scale (BPS) and the original Adult Non-Verbal Pain Scale (NVPS). Design: A prospective repeated-measure descriptive study was conducted. Settings and participants: Twenty-eight adult non-communicative mechanically ventilated ICU patients were included in the study. The study took place in five hospitals in Poland, one 15-bed general ICU of a university teaching hospital and four 6-bed medical ICUs of district hospitals. Methods: Pain assessment was conducted at rest, during non-painful and painful procedures independently by two observers. Results: Internal consistency of the Polish version of the scales was below the expected 0.7 value (Cronbach's alpha for the BPS 0.6883 and NVPS 0.6697). Principal component analysis showed that for the Polish version of the BPS, all three domains formed one separate factor (63.9%), while in the case of the NVPS two separate factors were found, one covering four domains of the NVPS (47.1%) and the other exclusively covering the category of Vital sign (20.2%). There was a

significant difference between the pain scores with the NVPS ($\chi^2 = 228.95$ $p < .001$) and the BPS ($\chi^2 = 236.46$ $p < .001$) during three observation phases. There were no significant differences between scores obtained by different raters. The analysis of variance demonstrated a statistically significant difference in the values of physiological indicators of pain (SBP, DBP, MAP) between observation phases. Conclusions: The Polish version of the BPS has better psychometric properties than the Polish version of the NVPS. It is necessary to define precisely the descriptors used in the scales and to implement a staff training program.

Clinical practice guidelines for the management of pain, agitation, and delirium in adult patients in intensive care units (ICUs) developed by the task force of American College of Critical Care Medicine (ACCM) state that adult patients in ICUs routinely experience pain both at rest and with routine ICU care, indicating that procedural pain is common in adult ICU patients (Barr et al., 2013). Effective analgesia is an important element of patient treatment at the ICU. Although scientific evidence points to benefits of effective pain management and negative consequences of ineffective pain management (Chanques et al., 2006; Gélinas & Arbour, 2009; Payen et al., 2009; Schelling et al., 1998), many studies indicate that ICU patients suffer (Barr et al., 2013). Additionally, pain in ICU patients unable to self-report remains underestimated by health care providers (Randen, Lerdal, & Bjørk, 2013). What is more, effective pain treatment is important not only for medical but also for ethical reasons. All health care professionals are obligated by ethical principles of beneficence and nonmalfeasance to provide pain management and comfort to all patients (Herr et al., 2011) because it is recognized as a fundamental human right (International Association for the Study of Pain, 2011). As a consequence of a growing international body of evidence, a number of societies have developed practice guidelines to effectively treat pain in patients unable to self-report.

The American Society for Pain Management Nursing recommends using a hierarchy of pain assessment techniques as a framework to conduct an assessment of pain in patients unable to self-report (Herr et al., 2011). The first step of the technique is to obtain self-report, then to search for potential causes of pain, observe the patient's behavior, obtain proxy reporting of pain, and attempt an analgesic trial.

The Society of Critical Care Medicine recommends that pain be routinely monitored in all adult ICU patients using the Behavioral Pain Scale (BPS) or the Critical-Care Pain Observation Tool (CPOT) in a defined group of patients (Barr et al., 2013). The CPOT (Gelinas et al., 2006) and the BPS (Payen et al., 2001) are behavioral scales with confirmed beneficial psychometric characteristics used for assessing pain in critical patients who are not able to evaluate their pain on their own. At the same time, authors of clinical practice guidelines do not suggest that vital signs be used alone for pain assessment in adult ICU patients (Barr et al., 2013). In spite of those recommendations, the observation scales used for pain assessment in patients who are unable to self-report pain are not commonly used. The basis for assessing pain intensity in many facilities is clinical evaluation, including changes in vital signs (Chen et al., 2011). To date, literature on the subject does not present any report of validation studies concerning Polish versions of the observation scales used for assessing pain in adult patients unable to self-report. A preliminary study conducted in Poland shows, however, that in the opinion of Polish nurses, vital signs and physiologic indicators of pain are the most important and most commonly used parameters in the assessment of pain in patients who are unable to self-report. Patients' behavioral reactions were mentioned as the second-most important feature (Gutysz-Wojnicka et al., 2014). This indicates that in Poland there is an urgent need to prepare a reliable and accurate tool for pain assessment in patients who are unable to self-report and to educate the staff in this matter. Having taken the results of the study into consideration, it was decided to analyze the BPS (Payen et al., 2001) and the original Adult Nonverbal Pain Scale (NVPS) (Odhner et al., 2003) to adapt and introduce them into clinical practice. The BPS comprises three behavioral domains: BPS-1, facial expression; BPS-2, upper limb; and BPS-3, compliance with ventilation; in each domain there are four descriptors rated 1 to 4. The possible total score of the BPS ranges from 3 to 12 (Payen et al., 2001). The BPS was culturally adapted and validated in other language versions (Al Sutari et al., 2014; Azevedo-Santos et al., 2016; Chen et al., 2011; Morete et al., 2014; Pudas-Tahka et al., 2014). The original NVPS comprises five domains: NVPS-1, face; NVPS-2, activity (movement); NVPS-3, guarding; NVPS-4, physiologic I (vital signs); and NVPS-5, physiologic II (skin). Each domain consists of three descriptors rated on a scale of 0 to 2, with a possible total score ranging from 0 to 10 (Odhner et al., 2003).

AIM

The aim of the study was to carry out a psychometric assessment and evaluation of behavioral and physiologic indicators of pain in nonverbal patients. Behavioral and physiologic descriptors included in two pain assessment scales (the BPS and the NVPS) as well as other parameters established by competent assessors were analyzed in the study. The study also aimed to establish which of the scales has the most favorable psychometric properties and should be recommended for use in intensive care units in Poland.

MATERIALS AND METHODS

A prospective repeated-measure descriptive study of mechanically ventilated patients hospitalized in intensive therapy units was conducted in five hospitals in Poland, one 15-bed general ICU of a university teaching hospital and four 6-bed medical ICUs of district hospitals. The authors of both scales have agreed to their adaptation and use in Poland.

The study protocol was approved by the Bioethical Commission of the University of Warmia and Mazury in Olsztyn, Poland (approval no. 13/2011) and by the institutional research ethics board of each hospital. Because of the health condition of the participants, written informed consent was obtained from the family representatives of patients included in the study, and a letter with information was provided to them.

Study Protocol

The study was carried out in four stages:

- The BPS and NVPS were adapted. Both scales were translated by two independent translators, and a team of authors agreed on the final version of the translation of each scale. There was a facade equivalence of the scales, which comprises a number and sequence of answer categories, instructions, and score calculation. Graphic forms, however, had to be modified because certain categories were included in the general observation sheet.
- Content validation by competent assessors was conducted. The competent assessors consisted of a group of nurses working at an ICU and having long-term experience in providing care for sedated and mechanically ventilated patients. The most important nonverbal pain indicators were identified, and the highest scores were given, in a decreasing order, for increased heart rate, increased blood pressure, presence of frowning, turning in bed, whole body tension, upper limb flexion, eyelids tightly closed, and increased respiratory rate. The BPS and NVPS were chosen for further psychometric assessment and evaluation and linguistic adaptation.
- Preparation of an observation form containing indicators included in both original pain assessment scales (BPS and NVPS) and other parameters established by the competent assessors.
- The observation form was used for pain assessment in sedated and mechanically ventilated adult patients hospitalized at selected ICUs.

Overt nonparticipant simultaneous observations by two raters were performed. The standard observation form contained physiologic parameters such as systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR), respiratory rate, pulse oximetry, end-tidal expiratory carbon dioxide concentration, central venous pressure, intracranial pressure, and cerebral perfusion pressure; Bispectral Index parameters described facial expressions: eye opening, frowning, brow lowering, eye watering, lifting/shaking the head, closing eyelids tightly, tube biting, occasional grimacing, and intensive grimacing; and parameters of the components of the BPS and NVPS, including their descriptors—activity (movement) and guarding—and changes in physiologic parameters: physiologic I (vital signs), physiologic II, upper limbs, and compliance with ventilation. The observation form contained 45 pain indicators in total.

Pain assessment of patients unable to self-report was not a standard procedure in the participating hospitals. In every ward, two full-time nurses who only worked the day shifts and who agreed to participate in the study were thoroughly trained in the study protocol, and they conducted patient observations. Before they started collecting data, the nurses were given 2 hours of theoretical and practical training in the field of behavioral pain alerts. The raters recorded the behavioral and physiologic parameters of the patients. The total score on each scale was calculated by the investigators based on the completed observation forms. Pain assessment was carried out in eligible patients at rest and during routine nursing procedures: *painful-nociceptive*, tracheal suctioning or turning the patient in bed; and *nonpainful–non-nociceptive,* noninvasive blood pressure measurement or a dressing change.

The patient assessment procedure did not interfere with the adopted treatment plan, nursing, or the rehabilitation of patients. All individual doctor recommendations, including pain control, diagnostic procedures, and nursing, were carried out according to the previously established schedule as per patient.

Study Group

The following inclusion criteria were adopted for the participants: adult age (18 years or older); hospitalization at an intensive care unit; noncommunicative; need for analgesia and sedation; on mechanical ventilation; hemodynamically stable—normal tissue perfusion, heart rate

<100 beats per minute, SBP >90 mm Hg, and/or MAP >65 mm Hg without catecholamines or after treatment with catecholamines in maintenance doses; noradrenalin maximum 3 μg/kg of body weight per hour; dopamine maximum 15 μg/kg of body weight per hour; and no need for frequent modification of dosing (assessment at least 6 hours from dose modification). Patients who did not meet these criteria and patients with upper and/or lower limb paresis/paralysis, receiving neuromuscular blocking drugs, with confirmed brain death, and who had a modified dosing regimen of analgesics within the last 48 hours were excluded from the study.

A register of all patients meeting the inclusion criteria was kept at each intensive care unit. Patients included in the study were given an identification number compliant with their number in the register. The patient's ID number was included in the observation form. Registers of patients participating in the study were kept private. Protected health information was held in accordance with confidentiality regulations.

Twenty-eight patients participated in the study. Characteristics of the study group are presented in Table 1.

Table 1.
Characteristics of the Study Group

Variable	Indicator	No.
Sex	Female	11 (41%)
	Male	17 (59%)
Age	Years	Mean 68.1 (SD, 15.17)
Primary diagnosis	Medical	
	Recent cardiac arrest	4
	Cardiac failure	2
	Acute respiratory failure	13
	Sepsis	1
	Trauma	
	Multiorgan trauma	3
	Neurologic	
	Brain hemorrhage	4
	Brain stroke	1
Ventilation	Mode	
	Synchronized intermittent mandatory ventilation (SIMV)	26
	Intermittent positive-pressure ventilation (IPPV)	1
	Spontaneous	1
	Intubation mouth	14
	Tracheostomy	13
Days of mechanical ventilation	Days	Mean 18.5 (range 1-55)
Analgesia only	Morphine	1
	Metamizole	4
	Tramadol	6
	Paracetamol	2
Sedation only	Midazolam	1
Analgesia and sedation	Morphine and thiopental	1
	Morphine and midazolam	4
	Fentanyl and midazolam	2
	Tramadol and midazolam	3

SD = standard deviation.

Statistical Analysis

The Shapiro-Wilk test was used to assess the normality of data distribution. Despite a near-normal distribution of scores, the analysis with the Shapiro-Wilk test indicated that the hypothesis on the normality of distribution for the scales should be rejected ($p < .001$), and further analysis was carried out using nonparametric statistical methods.

Discriminant validity and internal consistency were analyzed separately for each scale. In three phases of the study (rest, nonpainful, painful), 657 assessments were made and their results were used to create a general description of pain in the studied patients and to evaluate the internal consistency of the scales using the Cronbach α coefficient. Paired assessments were conducted by two nurses in 468 assessments (71.23%). Detailed statistical analyses including the evaluation of inter-rater reliability and Friedman analysis of variance (ANOVA) for ranks; the Mann-Whitney *U* test and Spearman rank correlation coefficient were carried out only for the data from paired assessments (78 assessments × 2 assessors × 3 assessment phases). The internal consistency of every scale was measured using the Cronbach α method. Cronbach α was measured for assessments carried out in three phases: rest, nonpainful, and painful. The value of this coefficient should be at least .7 for group comparisons to reflect a satisfactory internal consistency (Peterson, 1994). Construct validity analysis was performed using principal component analysis. Discriminant validity for each scale was performed by analyzing the significance of differences between scores from three assessment phases—rest, nonpainful, and painful. Friedman ANOVA for ranks and Kruskal-Wallis tests were used for multiple comparisons between phases. In the case of Mann-Whitney *U* test, hypotheses were based on a bilateral distribution of test statistics. On the other hand, the analysis of Kruskal-Wallis and Friedman ANOVA

TABLE 2.
Comparison of Pain Scores Assessed in the BPS and NVPS: Spearman Rank Correlation Coefficient

Paired Variables	Phase of Observation	N	R	T (N-2)	*p*
NVPS & BPS	Rest	219	0.74	16.36270	<.001
NVPS & BPS	Nonpainful	219	0.82	20.87315	<.001
NVPS & BPS	Painful	219	0.78	18.24183	<.001

NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003); BPS = Behavioral Pain Scale (Payen et al., 2001).

hypotheses were based on the statistics that had asymptotic χ^2 distribution.

The inter-rater reliability of the two scales was measured by the analysis of median (Med), minimum, and maximum values for scores from individual assessors, testing the significance of differences between the scores from two assessors using the Mann-Whitney *U* test and evaluation of inter-rater reliability using Fleiss κ and Krippendorff α coefficients. Cohen κ and Scott π were used to evaluate inter-rater reliability assuming that the scores were expressed by the assessors on a nominal scale. Fleiss κ makes it possible to calculate the coefficient for more than two assessors. Krippendorff α additionally allows one to consider values on non-nominal scales. Spearman rank correlation coefficient was used to compare scores obtained from two scales and evaluate the significance of differences.

RESULTS

Pain Assessment

The pain assessment in the nonpainful phase was performed with an indirect measurement of blood pressure with an arm cuff in all patients because hospital procedures limit the use of changing bandages as a non-nociceptive stimulus. The painful phase assessment was done during tracheal suctioning (n = 148, 69%) or turning the patient in bed (n = 68, 31%). Tracheal suctioning and turning the patient in bed were previously identified by Puntillo et al. (2001) as nociceptive procedures. The authors reported mean pain intensity scores of 3.94 (standard deviation [SD], 3.32) for tracheal suctioning and 4.93 (SD, 3.09) for turning (scale 0-10). These results suggest that both procedures are equally comparable.

On the BPS scale (range 3-12), patients at rest experienced pain within the range of minimum 3 up to maximum 7 points (Med = 3), during nonpainful procedures from 3 to 9 (Med = 4), and during painful procedures from 3 to 12 (Med = 7). On the NVPS scale (range 0-10), patients at rest experienced pain within the range of minimum 0 to maximum 5 points (Med = 1), during nonpainful procedures from 0 to 6 (Med = 2), and during painful procedures from 0 to 9 (Med = 4). The analysis revealed a strong correlation between pain scores assessed using the NVPS and BPS during patient rest and nonpainful and painful procedures (Table 2).

Internal Consistency

Cronbach α for the BPS was .6883. To improve the internal consistency of the scale, an attempt was made to reduce the individual domains to find the components that statistically make up the most consistent set of domains. A reduction in the number of component domains decreased the internal consistency of the scale. The evaluation of internal consistency of assessments in individual phases was in the range of .165 to .560 (Table 3). An attempt to improve the internal consistency by reducing one domain was only made for the rest phase, where the removal of the

TABLE 3.
Internal Consistency of the BPS in Individual Phases of an Observation and after Reducing a Particular Domain

Phase	Cronbach α	Item Total Correlation and Cronbach α after Reduction of One Component	BPS-1 Facial Expression	BPS-2 Upper Limb	BPS-3 Compliance with Ventilation
Rest	.165	Item total	0.13	0.01	0.15
		Cronbach α when removed	.00	.28	.05
Nonpainful	.560	Item total	0.40	0.41	0.38
		Cronbach α when removed	.43	.41	.51
Painful	.451	Item total	0.27	0.32	0.28
		Cronbach α when removed	.36	.29	.38

BPS = Behavioral Pain Scale (Payen et al., 2001).

Table 4.
Internal Consistency of the NVPS in Individual Phases of an Observation and after Reducing a Particular Domain

Phase	Cronbach α	Item Total Correlation and Cronbach α after Reducing of One Component	NVPS-1 Face	NVPS-2 Activity (Movement)	NVPS-3 Guarding	NVPS-4 Physiologic I (Vital Signs)	NVPS-5 Physiologic II (Skin)
Rest	.26	Item total	0.24	0.17	0.24	−0.08	0.20
		Cronbach α when removed	.06	.22	.15	.44	.16
Nonpainful	.51	Item total	0.35	0.48	0.48	−0.01	0.19
		Cronbach α when removed	.41	.33	.32	.63	.50
Painful	.54	Item total	0.21	0.49	0.42	0.08	0.38
		Cronbach α when removed	.54	.35	.41	.62	.45

NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003).

BPS-2 increased the Cronbach α value to .28. For other phases, the reduction decreased the internal consistency.

Cronbach α for the NVPS was .6697. Removal of components 4, 5, and 1 and the inclusion of components 2 and 3 in the analysis increased Cronbach α to.8003. Cronbach α in individual phases of observation ranged from .26 in the rest phase to .54 in the painful phase, and it was improved to .51 and .70, respectively, by removing three components. The highest Cronbach α values were reached by the NVPS scale when it comprised NVPS-2 and NVPS-3. Other parameters of internal consistency for the NVPS are presented in Table 4.

Principal component analysis was carried out for the BPS and NVPS. BPS-1 (facial expression), BPS-2 (upper limb), and BPS-3 (compliance with ventilation) formed separate factors and accounted for 63.9% variance of pain expression. For the NVPS tool, four components, NVPS-1 (face), NVPS-2 (activity [movement]), NVPS-3 (guarding), and NVPS-5 (physiologic II [skin]), accounted for 47.1% variance of pain, whereas NVPS-4 physiologic I (vital signs) was a separate factor explaining 20.2% of variance.

Inter-Rater Reliability

The first step to evaluate the inter-rater reliability was to test the significance of differences between the scores obtained by rater A and B using the Mann-Whitney *U* test (Table 5). The test identified no significant differences between the scores obtained by raters in each of the observation phases, and the differences in scores were random. Median, minimum, and maximum scores for individual rater are presented for a more detailed analysis of inter-rater reliability (Table 6). Additionally, Figure 1 presents a semantic differential.

Inter-rater reliability was evaluated in the next step. For the analysis, two measures of reliability of agreement were used, Fleiss κ and Krippendorff α (Table 7). The value of Fleiss κ indicated that the greatest consistency between raters A and B was in the rest phase (0.52 for BPS and 0.44 for NVPS), and the lowest

Table 5.
Significance of Differences of Scores Assessed by Two Raters in the BPS and NVPS—Mann-Whitney *U* Test

Variable	Rank Sum A	Rank Sum B	U	Z	*p*	Z Corrected	*p*
Rest							
NVPS	5,810.500	6,435.500	2,729.500	−1.10586	.268787	−1.17362	.240547
BPS	6,095.500	6,150.500	3,014.500	−0.09570	.923759	−0.10938	.912899
Nonpainful							
NVPS	6,006.500	6,239.500	2,925.500	−0.411154	.680960	−0.419621	.674763
BPS	6,397.000	5,849.000	2,768.000	0.969401	.332346	0.997299	.318620
Painful							
NVPS	6,427.000	5,819.000	2,738.000	1.075734	.282047	1.092678	.274536
BPS	6,478.500	5,767.500	2,686.500	1.258272	.208294	1.277832	.201309

BPS = Behavioral Pain Scale (Payen et al., 2001); NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003).

TABLE 6.
Comparison of Scores Assessed by Two Raters in the BPS and NVPS

Scale	Rater	Median	Minimum	Maximum
Painful				
NVPS	A	4	0	9
NVPS	B	4	0	9
BPS	A	7	3	11
BPS	B	7	3	12
Nonpainful				
NVPS	A	2	0	6
NVPS	B	2	0	6
BPS	A	5	3	9
BPS	B	4	3	9
Rest				
NVPS	A	1	0	5
NVPS	B	1	0	5
BPS	A	3	3	6
BPS	B	3	3	7

BPS = Behavioral Pain Scale (Payen et al., 2001), total score 3-12; NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003), total score 0-10.

in the painful phase (0.22 and 0.16, respectively). Krippendorff α coefficient indicated the greatest consistency in the nonpainful phase (.76 and .74) and the lowest in the painful phase for the BPS (.58).

Discriminant Validity

Friedman ANOVA for ranks revealed a significant correlation between pain scores assessed using the NVPS and BPS ($p < .01$). There was a strong, significant difference between the pain scores obtained using the NVPS ($\chi^2 = 228.95$, $p < .001$) and BPS ($\chi^2 = 236.46$, $p < .001$) during three different observation phases. The highest mean ranks were obtained for the painful phase, significantly lower for the nonpainful phase and the lowest when patients were at rest. Therefore the zero hypotheses on the homogeneity of scores for different phases were rejected (Table 8). The value obtained in the Kruskal-Wallis ANOVA rank test for multiple comparisons of NVPS scores was H (2, n = 468) = 217.1267, $p < .001$, and indicated a significant difference between scores for all assessment phases. Similarly, Kruskal-Wallis ANOVA rank test for multiple comparisons of BPS scores was H (2, n = 468) = 256.0519, $p < .001$.

An analysis of possible causes of the statistically significant difference between the pain evaluation at rest and in the nonpainful phase was conducted only for the BPS. It was assumed that a significant difference between the phases was caused by various levels of pain intensity in patients at rest. Patients were divided into three subgroups depending on the pain assessment level at rest: QMed, Q1, and Q3, which included

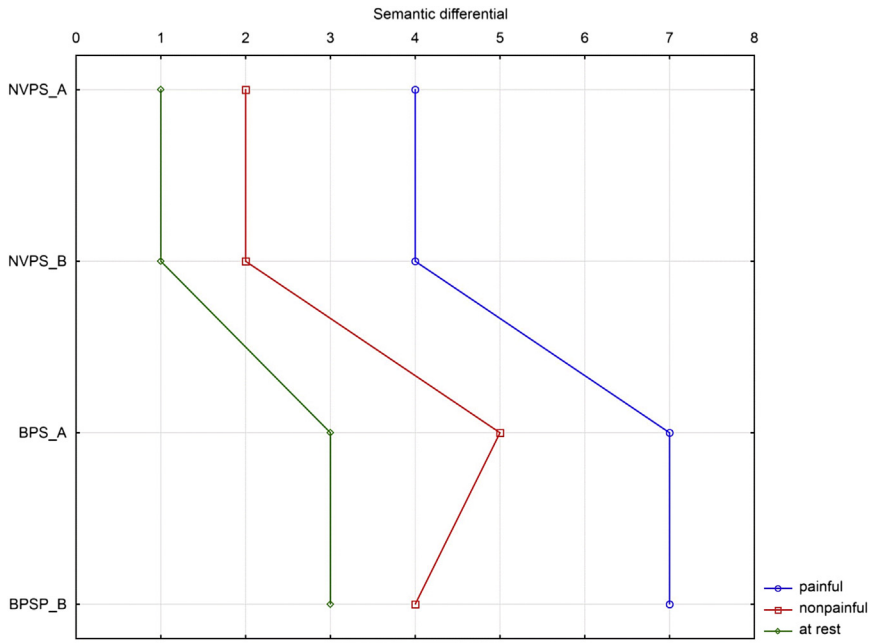

FIGURE 1. ■ Comparison of pain scores assessed by two raters in the BPS and NVPS in particular phases of observation: a semantic differential. NVPS = the original Adult Nonverbal Pain Scale; total score ranges from 0 to 10 (Odhner et al., 2003). BPS = Behavioral Pain Scale; total score ranges from 3 to 12 (Payen et al., 2001). NVPS A = pain assessment by rater A using the NVPS; NVPS B = pain assessment by rater B using the NVPS; BPS A = pain assessment by rater A using the BPS; BPS B = pain assessment by rater B using the BPS.

Table 7.
Reliability of Agreement between Two Raters Using the NVPS and BPS

		NVPS		BPS	
Phase of Observation	N Paired Observations	Fleiss κ	Krippendorff α	Fleiss κ	Krippendorff α
Rest	78	0.44	.63	0.52	.67
Nonpainful	78	0.35	.76	0.48	.74
Painful	78	0.16	.60	0.22	.58

NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003); BPS = Behavioral Pain Scale (Payen et al., 2001).

10, 9, and 8 patients, respectively. The pain in patients from the subgroup QMed (n = 10) at rest amounted to 4 points in the BPS (median value), in the subgroup Q1 less than 4 points in the BPS, and in the subgroup Q3 more than 4 points in the BPS. The results of the pain assessment in particular subgroups are presented in Table 9 and Figure 2.

Significance analysis was conducted for the differences in pain scores in the BPS between the rest phase and the nonpainful phase in particular subgroups. Wilcoxon pair sequence test was used. At the significance level $\alpha = .05$ the difference analysis was statistically significant; however, when the level was $\alpha = .01$ in Q1 and Q3 the differences became statistically nonsignificant (Table 10).

Physiologic Parameters

Differences between the scores for physiologic parameters in individual phases of observation were analyzed by the analysis of variance ANOVA (Table 11). The analysis of variance indicated a statistically significant difference in the values of SBP, DBP, and MAP among observation phases. For parameters that differed significantly, the least statistical difference was estimated at $\alpha = .05$ (Table 12). An increase in SBP by 10.71 mm Hg, DBP by 5.21 mm Hg, and MAP by 6.15 mm Hg indicated the least significant difference in pain intensity. Physiologic parameters such as SBP, DBP, MAP, HR, central venous pressure, respiratory rate, pulse oximetry, and end-tidal expiratory carbon dioxide concentration were considered separately as a scale of changes in physiologic parameters dependent on pain and analyzed for consistency using Cronbach α. Consistency of the scale of physiologic parameters is presented in Table 13.

The highest values of Cronbach α were found after reducing scale components to only two parameters, DBP and MAP. The relations among the SBP, DBP, and MAP values and the BPS pain assessment results were ranked with Spearman rank correlation. The value of the correlation coefficient was very weak in terms of the correlation between BPS scores at particular phases of observations (at rest, nonpainful, and painful) and SBP, respectively: 0.16, 0.34, and 0.26. Similarly, for correlation between BPS scores and DBP, the coefficient was, respectively, 0.34, 0.16, and 0.20, and for MAP, 0.26, 0.14, and 0.22.

Table 8.
Significance of Differences of Pain Scores Obtained in the BPS and NVPS during Three Observation Phases—Friedman Test

	NVPS Friedman Test: $\chi^2 = 228.95$, $p < .001$		BPS Friedman Test: $\chi^2 = 236.46$, $p < .001$	
Phase	Rank Sum	Mean Rank	Rank Sum	Mean Rank
Painful	443.50	2.84	447.50	7.28
Nonpainful	295.50	1.89	295.00	4.86
Rest	197.00	1.26	193.50	3.59

BPS = Behavioral Pain Scale (Payen et al., 2001); NVPS = original Adult Nonverbal Pain Scale (Odhner et al., 2003).

DISCUSSION

Although there are international guidelines for the management of pain (Barr et al., 2013; Herr et al., 2011), in many ICUs, pain assessment in adult patients unable to self-report is performed based on indicators of vital signs, observation of behavioral reactions, and the clinical experience of the staff. In Poland, using observation scales for pain assessment is not a routine practice because the relevance indicators and the reliability of the adapted foreign scales remain unknown. This study should result in practical benefits such as recommending one of the pain assessment scales to be used at Polish ICUs. The BPS was chosen for validation because it is one of the scales recommended by the Society of Critical Care Medicine to

TABLE 9.
Comparison of Pain Scores Assessed in the BPS in Each Subgroup

BPS	N Observations	Pain Score Minimum	Pain Score Subgroup Q1	Pain Score Subgroup QMed	Pain Score Subgroup Q3	Pain Score Maximum
Rest	215	3	3	4	5	7
Nonpainful	215	3	4	5	7	9
Painful	215	3	6	8	9	12

BPS = Behavioral Pain Scale; Q1 = subgroup with <4 points on the BPS scale at rest; QMed = subgroup with 4 points on the BPS scale at rest; Q3 = subgroup with >4 points on the BPS scale at rest.

be applied for patients at ICUs. The original NVPS was chosen because it includes vital signs domains that, in many medical units, are traditionally perceived as important indicators in pain assessment in adult sedated, mechanically ventilated patients unable to self-report (Odhner et al., 2003).

Many studies have so far confirmed the applicability of the BPS as a valid tool for assessing pain in sedated, mechanically ventilated ICU patients (Aïssaoui et al., 2005; Azevedo-Santos et al., 2016; Cade, 2008; Chanques et al., 2014; Gélinas et al., 2013; Payen et al., 2001; Rijkenberg et al., 2015; Young et al., 2006). Internal consistency of the Polish version of the BPS measured with Cronbach's α was moderate in total and ranged from .165 at rest to.560 in the nonpainful phase and was lower than in the studies of other authors. However, a reduction in the number of domains did not improve the internal consistency of the BPS. Principal component analysis carried out for the BPS indicated that all three domains formed a separate factor and explained 63.9% of the variance. Item-total correlation, which examined the relation between ratings in each scale domain and total scoring in nonpainful and painful periods, ranged from 0.27 to 0.41 and indicated poor correlation. These results indicate that the Polish version of the BPS is currently homogenous in terms of domains that it contains; however, the dependencies

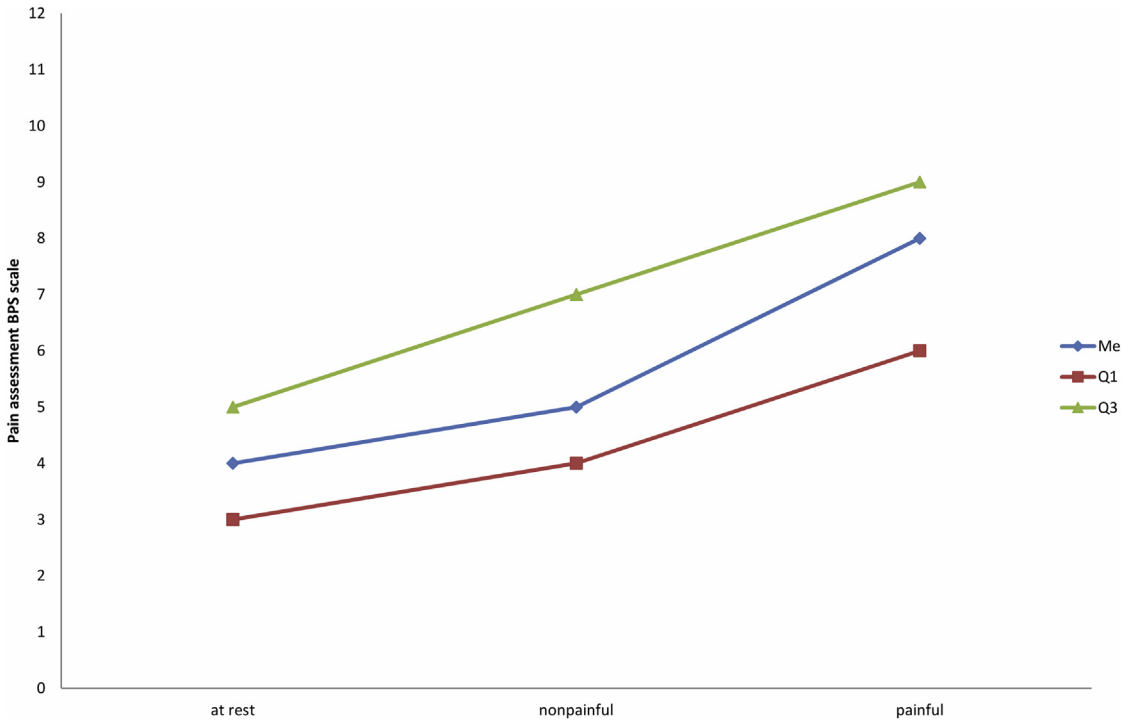

FIGURE 2. ■ Comparison of pain scores assessed in the BPS in each subgroup. BPS = Behavioral Pain Scale; Me = the subgroup with 4 point in the BPS scale at rest; Q1 = the subgroup with less than 4 point in the BPS scale at rest; Q3 = the subgroup with more than 4 point in the BPS scale at rest.

Table 10.
Significance of Differences between the Pain Score Obtained on the BPS at Rest and in Nonpainful Phases at the Level of $\alpha = .01$

Phases of Observation	Subgroups	N Patients	T	z	p
At rest and nonpainful	QMed	10	0.00	2.67	.0077
At rest and nonpainful	Q1	9	0.00	2.20	.0277
At rest and nonpainful	Q3	8	0.00	2.37	.0180

BPS = Behavioral Pain Scale; QMed = subgroup with 4 points on the BPS scale at rest; Q1 = subgroup with <4 points on the BPS scale at rest; Q3 = subgroup with >4 points on the BPS scale at rest.

between the results of particular domains and the general result should be investigated further. The Polish version of the BPS is internally consistent below the expected level. The results of the study indicate that this low internal consistency might have been caused by ineffective training of the staff as well as by imprecise definition of the descriptors used in the adapted versions of the scales.

The lowest item-total correlation values were noted in the compliance with the ventilation domain. This domain does not have a precise operational definition. Diagnosing particular descriptors requires the observers to possess skills to interpret respiratory curves and loops depending on the ventilation mode. The use of an open suction system, which causes temporary respiratory system separation, makes it more difficult to interpret the observations in this domain. ICU nurses conducting direct observation of the patient's reaction were given 2 hours of theoretical and practical training in the field of behavioral pain alerts. However, the results of the study indicate that before implementing the behavioral scale into clinical practice it is essential to provide the staff with intensive training on using a particular scale.

Table 11.
Significance of Differences in the Values of Physiologic Parameters in Individual Phases of Observation: Analysis of Variance

Question on the Observation Form	Parameter	F	p
3	Systolic blood pressure	4.425	.014
4	Diastolic blood pressure	6.066	.003
5	Mean arterial pressure	6.807	.002
6	Heart rate	2.097	.127
7	Central venous pressure	1.147	.321
8	Respiratory rate	0.961	.385
9	Pulse oximetry	0.527	.592
10	End-tidal expiratory carbon dioxide concentration	0.605	.547

The Polish version of the BPS was found to have significantly higher scores during painful procedures than at rest. This finding confirms good discriminant validity. However, a significant difference was also identified between scores obtained during rest and nonpainful procedures. This finding does not support the scale's ability to differentiate pain from other factors causing discomfort. Payen et al. (2001) explained that this may be caused by inaccurately selected stimuli used in the nonpainful phase. In our study we used only noninvasive blood pressure measurement. Therefore the type of stimuli cannot have been the cause of the resulting indicators. While validating the Brazilian version of the BPS, Azavedo-Santos et al. (2016) also claimed that one of the observers presented statistically significant differences between the results of at rest and nonpainful phases. Similar results were reported by Rijkenberg et al. (2015) and Dehghani et al. (2014), who found that BPS average scores increased significantly during nonpainful stimuli (eye care, oral care).

The evaluation of discriminant validity of the Polish version does not allow one to state clearly that the scale assesses the pain level as opposed to the discomfort level caused by stimuli or the disturbing environmental factors. Nevertheless, physical and psychological discomfort are conditions that should be effectively treated. Gelinas et al. (2006), while validating the CPOT, claimed that behaviors observed during use of the CPOT may indicate more than pain and that further research is needed to determine the sensitivity and specificity of the scale.

The authors performed an analysis of possible causes of the statistically significant difference between the pain score obtained in the Polish version of BPS at rest and in nonpainful phases. It was assumed that a different initial level of pain in patients at rest is the cause of the significant difference between the pain score obtained in both phases. It was found that patients with a higher level of pain at rest (Q3 subgroup) had a greater increase in the BPS scores in response to the potentially nonpainful stimuli than patients with a lower (Q1 subgroup) or average (QMed subgroup) level of pain at rest. At the significance level $\alpha = .05$ the variance between at rest and nonpainful phases remained statistically significant in all the groups. However, at $\alpha = .01$ in groups of patients with the pain level higher and lower than the assumed median value, the

TABLE 12.
Least Statistical Difference (LSD) for Physiologic Parameters

Question on the Observation Form	Parameter	Phase	Mean	Standard Deviation	LSD $\alpha = .05$
3	Systolic blood pressure	Rest	125.90	29.70	10.71
		Nonpainful	129.80	26.08	
		Painful	141.71	25.91	
4	Diastolic blood pressure	Rest	68.76	13.61	5.21
		Nonpainful	70.28	12.76	
		Painful	77.56	13.52	
5	Mean arterial pressure	Rest	87.81	16.41	6.15
		Nonpainful	90.12	15.03	
		Painful	98.94	15.61	

discrepancies in pain assessment scores between rest and nonpainful phases were statistically insignificant. It was determined that in patients whose pain at rest was at the median level or lower, the nonpainful stimulus evoked an increase in pain assessment score in the BPS by 1 point. On the other hand, in the group with the pain level greater than the median it resulted in a 2-point increase. Possibly the interpretation of the pain assessment result should consider not only the point value in the BPS but also an individual characteristic of the patient's behavioral reaction at rest and an increase in the number of points as a response to the given stimuli. Nonetheless, because of the small number of patients qualified in each of the groups—at median level QMed = 10, Q1 = 9 less than the median, and Q3 = 8 more than the median—the results have to be confirmed in further studies. That is why the Polish version of the BPS should be implemented into practice and tested in further research.

In the present study there was a strong correlation between pain scores assessed using the Polish version of the NVPS and BPS at rest and during nonpainful and painful procedures. This suggests that both scales measure the same construct. In previous studies the original NVPS presented diversified psychometric indicators: internal consistency as indicated by Cronbach α was.78 as reported by Odhner et al. (2003), and .36 at rest, .62 during a painful procedure, and .62 after the procedure (Kabes, Graves, & Norris, 2009). Interobserver reliability measured by the weighted κ coefficient was 0.71 (Chanques et al., 2014). Kabes et al. (2009) reported quite low Spearman rank correlation for the physiologic II item of the original NVPS to the total score. The original NVPS scale is currently not recommended by scientific societies as a pain assessment tool in the ICUs because of its psychometric properties. The present study has found that the Polish version of the NVPS has a low level of internal consistency. Cronbach α was moderate in the nonpainful and painful phases; however, it was low at rest, and additionally one of the domains (physiologic I [vital signs]) created a separate factor, which accounted for 20.2% of pain expression. It has also been confirmed by item total correlation analysis. Discriminant validity of the Polish version of the NVPS was not confirmed. The values for pain assessment differed significantly between rest and nonpainful phases in terms of statistical analysis. The data collected are compliant with current clinical practice guidelines and indicate that at this moment there are no methodologic grounds for implementing the Polish version of the NVPS into clinical practice.

TABLE 13.
Internal Consistency Assessment of Physiologic Parameters: Value of Cronbach α

Cronbach α	Painful	Nonpainful	Rest
All physiologic parameters included in the study protocol	.624	.590	.593
After reduction to SBP, DBP, MAP, CVP	.801	.794	.772
After reduction to SBP, DBP, MAP	.910	.894	.877
After reduction to DBP, MAP	.967	.957	.952

SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; CVP = central venous pressure.

The inter-rater reliability of both Polish versions of scales is acceptable. There were no significant differences between scores obtained by the raters in each of the observation phases. However, the value of Fleiss κ coefficient was only moderate at rest and low in the painful phase. Krippendorff α coefficient, although it was higher, also indicated the lowest agreement in the

painful phase. Analysis of median values for scores in each scale indicated that a 1-point difference existed between observers when marking the pain with Polish versions of the BPS in the nonpainful phase of observation. Young et al. (2006) claimed that inter-rater reliability depends on different assessment periods and that the compliance is higher at rest. The observers in the present study marked on a checklist the observed pain indicators comprising the descriptors of domains included in both pain assessment scales, yet the rating of each descriptor and calculation of the total score in each scale was done by the investigators based on the completed checklist. Lack of full inter-rater reliability may have been caused either by the observers who, because of little experience in diagnosing particular behavioral pain indicators, did not mark them on the checklist or there was a lack of clear and precise description of the BPS descriptors. The problem especially applies to the facial domain, which is a descriptor in both scales, yet defining it and assigning points to it is different in each scale (Arif-Rahu & Grap, 2010). The BPS facial domain consists of four descriptors rated 1 to 4, in the NVPS facial domain consists of three descriptors rated 0 to 2. The differences in using this domain in various available scales may be the cause for investigator incompatibility. Marmo and Fowler (2010) stated that the most common discrepancies between the investigators occur at the assessment of facial expressions, especially during procedures such as suctioning. In the present study the observers participated in practical training concerning conducting the observation, yet they were not trained in using each of the scales separately. Before the study, none of the wards where the observations were carried out had used observational scales for pain assessment. The need for education and understanding the rules for implementing the scales has been emphasized by many authors (Chen et al., 2011; Marmo & Fowler, 2010).

In the present study a statistically significant difference was found in the values of SBP, DBP, and MAP among observation phases. Spearman correlation coefficient for DBP and MAP values and the pain assessment with the BPS in different observation periods was statistically significant. At rest, it amounted to 0.34 (DBP) and 0.26 (MAP), whereas during painful procedure it was 0.20 (DBP) and 0.22 (MAP), respectively. If DBP and MAP values constituted a separate scale for pain assessment, the value of Cronbach α would amount to .967 during painful procedure, .957 during a nonpainful procedure, and .952 at rest, which indicates excellent internal consistency. A statistically significant dependency among painful procedures and DBP and HR was also reported by other authors (Al Sutari et al., 2014; Chen & Chen, 2015; Payen et al., 2001). The dependency for painful procedures and MAP was reported by Gelinas et al. (2004). However, studies did not confirm statistically significant relationships between the physiologic indicators and patient self-reports of pain intensity (Kapoustina et al., 2014). Current clinical practice guidelines state that the pain intensity assessment at an ICU should not be based only on physiologic parameters, which may be misleading because many factors can influence the values of physiologic parameters. However, in many ICUs pain assessment in patients unable to communicate is still often based on physiologic parameters. The reasons for this could be the fact that monitoring and documenting physiologic parameters is a routine practice at ICUs and it is performed by nurses, who are experienced in the matter and constantly undergo additional training. Hence, monitoring behavioral indicators included in the observation scales is a new professional task that requires extra theoretical and practical background.

The direct aim of this study was not to assess pain in sedated, mechanically ventilated ICU patients. However, it was found that patients at rest experienced pain that was marked 3-7 on the BPS (scale range 3-12), despite undergoing assigned analgesic treatment and sedation. This indicates an urgent need to implement effective methods of pain management in ICU patients.

Limitations

The present study did not analyze the feasibility of the scales because both the scales constituted part of a joint observation sheet. In further studies it is recommended to evaluate this essential characteristic of the implemented tool. Because of a lack of data it was impossible to analyze the dependency between the sedation level in studied patients and the pain level assessed with the Polish versions of the scales. Unfortunately, none of the ICUs taking part in the study performed sedation assessment as a routine practice. Further analysis should concern determining the relation between the applied analgesic treatment and sedation level and the pain assessment with the Polish version of the BPS. This could contribute significantly to pain management care. The study distinguished three groups of patients: the first group received only intravenous analgesia; the second, intravenous sedation; and the third, a constant sedatives and analgesics infusion. Because of the determined psychometric factors of the Polish version of the BPS and a small number of particular patients in groups, the analysis was not performed. Nonetheless, this should be a subject of future research with the modified Polish version of the BPS.

A potential limitation of the study is the fact that the study group included patients differing in cognitive impairment according to neurologic diagnosis. However, all the patients met the criteria for inclusion in the study, such as being hemodynamically stable and having no upper or lower limb paresis or paralysis. Interpretation of the results of the study may also be limited because of the apparently insufficient staff training program implemented before the beginning of the study.

Implications for Nursing Practice

Evidence suggests that introducing an effective educational strategy concerning observational scales of pain assessment in clinical practice is not only a necessary factor but it is also a prerequisite for obtaining reliable and accurate results of pain assessment. It is particularly important to conduct practical training in observing patient behavioral responses during painful procedures because there are differences in the assessment of pain by nurses in this element of observation. The intensive care unit and all nursing staff within the hospital may have challenges as they implement the behavioral pain assessment scale for use in nonverbal patients. Hospitals should approve the standardized scales used to assess pain in different groups of patients hospitalized in their units on the basis of scientific evidence and monitor the process of their implementation. This will allow the staff to gain hands-on experience and effectively apply the scale of choice. Knowledge of the psychometric properties of the applied pain assessment scale makes it possible to properly interpret the obtained results, to diagnose pain, and to implement proper treatment. In the case of the Polish version of the BPS, it should be implemented in practice and tested in the course of further research to introduce modifications needed to improve its psychometric properties.

CONCLUSIONS

The evaluation of psychometric values of the Polish version of the BPS and original NVPS in adult patients does not confirm their reliability and validity. The results of the present study indicate that the Polish version of the BPS has better psychometric properties than the NVPS and that the BPS should be recommended for wide use in practice. However, the Polish version of the BPS is currently internally consistent at less than the expected level. The BPS is homogenous in terms of the domains it contains. Discriminant validity of both scales has not been reported, although significantly higher scores were obtained during painful procedures than at rest. However, the value of pain assessment also increased significantly in the case of nonpainful procedures. This was most likely a result of differing preliminary pain levels at rest, stress, fear, or other undefined factors. At present, the results of pain assessment conducted with the use of the Polish version of the Behavioral Pain Scale must be interpreted very carefully. The results should not constitute the only basis for clinical decision making. Pain assessment in patients unable to self-report should include data from other available sources.

Psychometric parameters of the Polish version of the BPS should be further monitored. Conducting further research is essential to define the descriptors precisely and point out patterns in each domain in the Polish version of the Behavioral Pain Scale. The study determined that there is a statistically significant difference in the values of SBP, DBP, and MAP between various phases of patient observation. The results of the study suggest that implementation of an effective staff training program is crucial to introduce the scale into clinical practice successfully.

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