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Research article

To assess patients pain in intensive care: developing and testing the Swedish version of the Behavioural Pain Scale

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ABSTRACT

Objectives: The Behavioural Pain Scale has previously been translated into Swedish and psychometrically tested. One of the domains- 'compliance with ventilation'- did not show equally as good psychometric proprieties as the other domains, which led to the question whether a development of that domain would be beneficial. This study aimed to develop the domain of 'breathing pattern' in the Swedish version of the Behavioural Pain Scale and then test the instrument for discriminant validity, inter-rater reliability and criterion validity.
Method: The domain 'breathing pattern' was developed and included when the Swedish version of the Behavioural Pain Scale was psychometrically tested in 360 paired assessments.
Results: The instrument showed discriminant validity through a significant positive change on the scale before and during turning and inter-rater reliability with an absence of significant disagreement on the scale between the paired assessments. The developed domain had a better result in discriminant validity than the original domain. The instrument also showed higher sensitivity in discriminating pain compared to assessment without an instrument.
Conclusion: The Swedish version of the Behavioural Pain Scale, with a developed domain for 'breathing pattern' showed to be a reliable instrument for pain assessment in the adult intensive-care patient.

Implications for clinical practice

- The developed version of the Swedish Behavioral Pain Scale showed discriminant validity and inter-rater reliability in a sample with high sedation level.
- When compared to the original domain of 'compliance with ventilation', the developed domain of 'breathing pattern' showed better results on domain level for discriminant validity.
- Accessing pain with an instrument showed higher sensitivity compared to that of observer-perceived pain among nurses of patients' pain level on a NRS scale.

Introduction

Pain is described as a subjective experience (IASP, 2012), which is why patient assessment is considered the gold standard despite being hard to conduct in intensive care due to impaired communication (i.e. when intubated). At times, pain is difficult to distinguish from other distressing symptoms and correlations have been made which link pain with fear and anxiety, thus highlighting the importance of using sensitive and specific pain-assessment methods (Gélinas et al., 2014). To facilitate communication and improve the clinical outcome, a target light sedation level is recommended (Barr et al., 2013).

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Using a systematic manner of assessing and treating pain in intensive care decreases the observed incidence and intensity of pain and agitation (Chanques et al., 2006; Olsen et al., 2015). Nevertheless, patients continue to report pain during their ICU stay, despite recent advances (Puntillo et al., 2016). The guidelines from the Society of Critical Care Medicine recommend that pain should be assessed routinely in all adult intensive-care patients (Barr et al., 2013). If patients cannot report their pain level (gold standard), validated instruments built on behavioural parameters are to be used (Gélinas, 2016).

One such recommended instrument is the Behavioural Pain Scale (BPS), developed by Payen et al. (2001) for intubated patients and adapted for non-intubated patients (BPS-NI) (Barr et al., 2013; Chanques et al., 2009). The BPS together with the BPS-NI was translated into Swedish by Hylén et al. (2016) and shows promising results concerning validation and inter-rater reliability. However, in the analysis, significance for discriminant validation could not be shown for one of the domains of the BPS, 'compliance with ventilation', which has also previously shown the lowest variance when comparing the different domains though factor analysis (0.63–0.64) (Aïssaoui et al., 2005; Payen et al., 2001). This raised concerns about how advancements in mechanical ventilators may affect the assessment. As the modern ventilator is more sensitive to the patient's breathing pattern, the two descriptors in the domain which generate the highest score (indicating the most pain), – 'fighting ventilator' and 'unable to control ventilation' are hard to achieve. This, and new and lighter sedation routines which generate more spontaneous breathing patterns, could possibly require the need for developing that specific domain (Hylén et al. 2016). How a patient breathes has been shown to correlate with pain intensity in previous studies. This is well known and used in pain scales used for children (Nishino, 2011; Lundqvist et al., 2014; Von Leupoldt et al., 2009).

Thus, the Swedish version of the BPS needs to be further developed. Further studies are needed to psychometrically test the version in a larger sample, thereby ensuring it can detect pain in today's intensive-care context.

Aim

The aims of the study were to develop the domain of 'breathing pattern' in the Swedish version of the Behavioural Pain Scale and then to test the instrument for discriminant validity, inter-rater reliability and criterion validity.

Method

In this quantitative study, the repeated measures design was chosen to evaluate the instrument. The study was conducted in a 10-bed general ICU at a university hospital in Sweden.

Instruments

Behavioural Pain Scale (BPS)

The Swedish version of the BPS consists of both the BPS and BPS-NI (Table 1), and it has a total of three domains. Each domain is scored on a scale from 1 to 4, with increasing pain generating a higher value. The three domains are summed to form a total score of 3–12 for the BPS (Payen et al., 2001; Chanques et al., 2009). Previous tests for inter-rater reliability and validity were performed (Ahlers et al., 2010; Chanques et al., 2009; Hylén et al., 2016; Payen et al., 2001) showing inter-rater reliability with weighted kappa between 0.74 and 0.89 and a significant difference between scores for painful and non-painful procedures. A cut-off score of >5 for the BPS has been established as indicating pain (Payen et al., 2007).

Table 1
The Behavioural Pain Scale, including both the original and developed domains, and the Behavioural Pain Scale – Non-Intubated (BPS and BPS-NI). The original instrument was reproduced with kind permission from the developers (Payen and Chanques).

Domain	Descriptor	Points
Facial expression	Relaxed	1
	Partially tightened (e.g., brow lowering)	2
	Fully tightened (e.g., eyelid closing)	3
	Grimacing	4
Upper limbs	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Intubated (original): Compliance with ventilation	Tolerating movement	1
	Coughing, but tolerating ventilation for most of the time	2
	Fighting ventilator	3
	Unable to control ventilation	4
Intubated (developed): Breathing pattern	For the patient, calm/normal breathing	1
	Laboured* breathing that returns to its original state	2
	Persistent laboured* breathing	3
	Very laboured* breathing that affects the ventilation of the patient in the respirator	4
Non-intubated: Vocalisation	No pain vocalisation	1
	Moaning not frequent (≤3/min) and not prolonged (≤3 s)	2
	Moaning frequent (>3/min) or prolonged (>3 s)	3
	Howling or verbal complaint including "Ow! Ouch! Or breath-holding	4

* *Laboured breathing* is defined as the onset or progression of a high respiratory rate, varying breathing patterns with alternating high and low respiratory rates, episodes of respiratory pauses, and superficial breathing.

The domain, 'breathing pattern' was developed to assess the patients' breathing (Table 1), that is to shift the focus of the domain from the ventilator to the patient. The process of developing the domain started with a review of previous studies. A first draft was then presented to a group of 60 critical care nurses (CCN), assistant nurses and ICU physicians at team meetings, where their perceptions were documented. Minor revisions were then made. The domain was initially tested along with the original instrument in a pilot study of 10 intubated patients. The pilot was later included in the results.

Numeric Rating Scale (NRS)

When the patient is able to self-report, the horizontal NRS is recommended for intensive-care patients (Chanques et al., 2010). The patients were asked to make a subjective assessment of their pain intensity between 0 (no pain) and 10 (worst pain) on a horizontal NRS, or nod/shake their head if pain was present if the patient was unable to use the NRS as intended. The observers were also asked to rate their experience of the patients' pain level on a NRS scale. The cut-off score for the NRS was set at assessments >3 (Gerbershagen et al., 2011).

Richmond Agitation and Sedation Scale (RASS)

The sedation levels were measured using RASS, a 10-point scale ranging from +4 (combative) to −5 (unarousable) with 0 as the calm and alert state (Sessler et al., 2002). The targeted sedation level is usually recommended between −1 and 0, which represents an awake or lightly sedated patient (Barr et al., 2013).

Participants

Both intubated and non-intubated patients were included in the study. Inclusion criteria were adult patients (>18 years), who were in the ICU for more than 24 hours and who needed help with turning in bed. Exclusion criteria were quadriplegic patients and patients receiving neuromuscular blockade or had unclear neurological conditions, which generated uncertainty about whether the patients were able to move their limbs. 'Needing help turning in bed' refers to patients unable to turn over in bed by themselves, thus requiring help from the staff.

Procedure

The BPS and the developed domain along with information about the study, were implemented through one-hour training sessions to all CCNs, assistant nurses, physiotherapists and physicians working at the ICU. The sessions were followed up by two seminar lectures during the data collection.

Data collection

As described in Fig. 1, data was collected through a convenience sample from a total of 59 patients on 92 different occasions from November 2014 to March 2017. Each patient was included a maximum of two times on different days of data collection, generating a total of 360 paired assessments (at rest and during both procedures). At each inclusion, the patient was regarded as a new patient, because of the rapid change in the condition of the ICU patient. During all assessments, one of the researchers was present to register the RASS and NRS of the patient. The observers were from the team caring for the patient (CCNs, assistant nurses, and physicians). Other demographic data – such as age, gender, diagnosis, length of ventilator treatment, sedation and analgesic treatment, and Simplified Acute Physiology Score (SAPS 3) (Metnitz et al., 2005; Moreno et al., 2005) – were collected after written consent was obtained.

Ethical approval

Ethical approval was obtained from the Regional Ethical Board (EPN 2014-105), and written consent was obtained from the patients after the ICU care. If the patients were unable to give consent, the next of kin were asked as a replacement. If neither the patient nor the next of kin were able to give consent, then the patient was excluded from the study. This was the case with two patients who were uncontactable after their ICU care, and therefore, were excluded from the study. All study information was given both orally and in writing, which included the information that the patient can withdraw at any time. As washing and turning the patient in bed are both considered basic types of ICU care, the patients were not exposed to any additional interventions relating to the study's purpose.

Data analysis

Demographic data were summarized using descriptive statistics, with the mean (SD or min-max) calculated for continuous variables and the percentage (%) for categorical variables.

A statistical method developed especially for paired ordered data was used (Svensson, 1998, 2012) to calculate both inter-rater reliability and discriminant validity. This method makes it possible to measure and separate the systematic disagreement in assessments at group level from the changes in the assessments on individual level, by calculating the percentage agreement (PA), relative position (RP) and relative rank variance (RV) between the two assessments included in a pair. When calculating inter-rater reliability, the paired assessments have the two observers

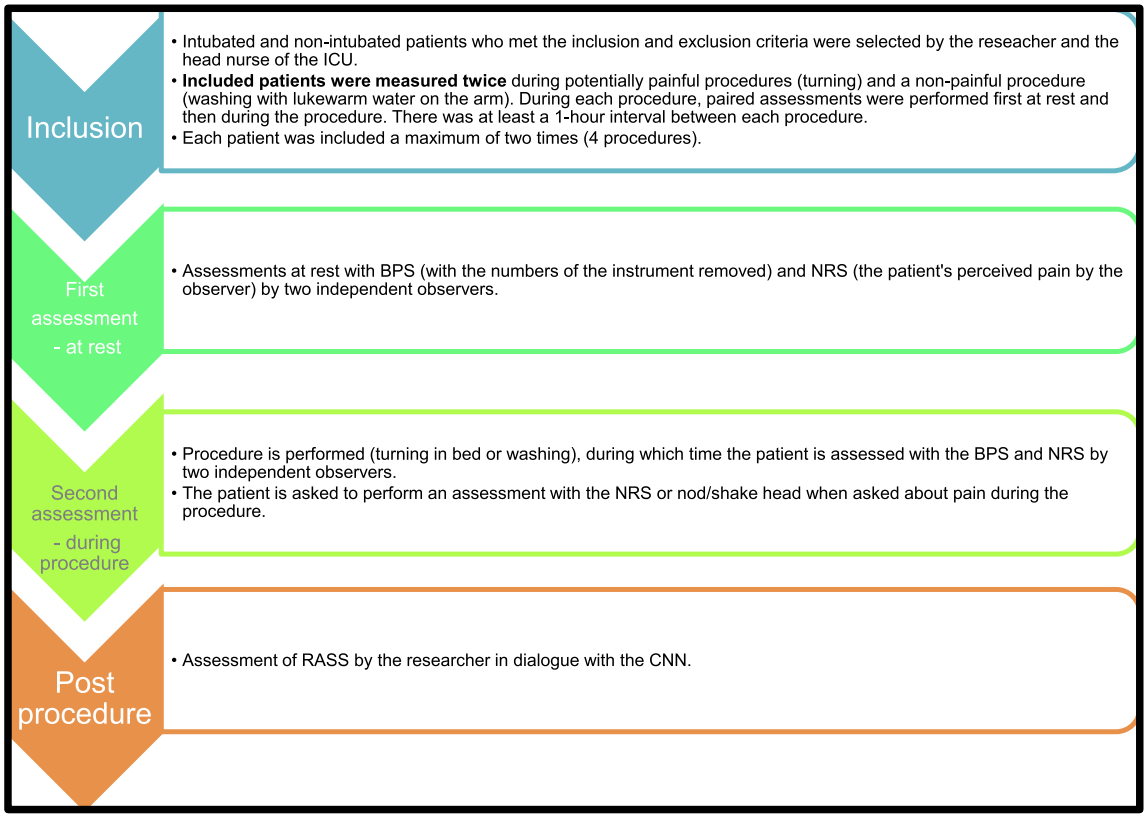

Fig. 1. Flow chart of the data collection.

measuring simultaneously, and for discriminant validity, the paired assessment is represented by the assessments before and during the procedure by the same observer.

The PA indicates the proportion of unchanged positions on the scale between the two assessments (%). The RP signifies the systematic disagreement in position on the scale between the two assessments, with a possible value ranging from −1 to 1 (where the value of zero indicates a lack of systematic disagreement). The RV is a measure of individual variety that cannot be explained by the measures of systematic disagreement. Non-zero values of RV indicate that individual variability is present. Statistically significant disagreement of RP values on at least the 5% level are indicated by 95% confidence intervals (CI) that do not cover the zero value of the measurements. Measures and CI of measures was calculated by means of a free software at http://avdic.se/svenssonsmetod.html.

As many of the patients were only able to nod or shake their head to indicate the presence of pain, the NRS and BPS were dichotomized into 'pain' or 'no pain', using the previously described cut-off value (NRS >3 and BPS >5). In order to test for *sensitivity* (the ability to correctly identify the individuals with a specific condition, i.e., pain), *specificity* (the ability to correctly identify the individuals, without a specific condition), and *accuracy*, the patient assessments in relation to the BPS and the NRS of the observers were calculated using the free software at http://vassarstats.net/.

Result

During two procedures (first at rest and then during turning or washing), a total of 360 paired assessments (240 intubated and 120 non-intubated) were included in the study. The study protocol was initially tested on 10 patients (pilot) with a focus on the developed domain, which was found valid and reliable after a preliminary data analysis by the research group. These assessments were included in the final analysis. The characteristics for the patients including sedation levels are shown in Table 2.

Table 2
Demographic data for all the patients (n = 57) and number of days intubated, including sedation levels, sedatives and analgesics distributed for intubated patients at time of assessments. More than one sedative per patient is possible.

Age, mean (min-max, SD)	67 (26–86, +−14.9)
Gender, %	
Women	37
Diagnosis, %	
Medicine	49
Surgical	40
Trauma	11
SAPS 3, mean (min-max, SD)	64 (22–101, +−17)
Number of days intubated, mean (min-max, SD)	5 (1–17, +−3,7)
Analgesics distributed, %	
Oxycodone	85
Fentanyl patch	2
No analgesic treatment	13
Sedatives distributed, %	
Propofol®	42
Midazolam®	5
Dexmedetomedine®	13
Clonidine®	40
Sedation levels; RASS, %	
0	11.7
−1	10.0
−2	31.7
−3	36.6
−4	10.0

Discriminant validity

Discriminant validity for the paired assessment in intubated patients before and during turning by the same observer was similar for the total score of the BPS in both the original and developed versions (Table 3). Both indicated pain during the turning procedure, with a PA showing low agreement between the two assessments. The RP indicated a significant positive systematic change on the scale with a CI not covering zero. This can be compared to the assessments before and during washing (non-painful procedure), where no significant systematic change on the scale was shown (PA 90%, RP 0.0274 [CI −0.0161 to +0.0708], RV 0.0003 [CI 0–0.0010]).

In non-intubated patients, discriminant validity was also shown before and during turning by the same observer (Table 3) by PA, indicating a lower agreement between assessments and RP not covering zero. This can be compared to before and during washing with PA 90%, RP −0.06 (CI −0.15 to +0.03) and RV 0, indicating that the instrument is discriminating when pain is present.

Discriminant validity was also calculated for the different domains separately in intubated and non-intubated patients (Table 4). In all the domains, the RP showed a significant systematic change in position for the assessments on the scale, with a confidence interval not covering zero.

Inter-rater reliability

Table 5 shows the results with the total scores of all the paired assessments of the different observers of the BPS for intubated patients (original and developed version) and non-intubated patients both before and during the procedures.

When separated into domains, the inter-rater reliability for intubated and non-intubated patients is consistent with the CI for RP covering zero, indicating no significance for systematic change on the scale (Table 6).

Criterion validity

In 50 of 120 assessments (intubated, both observers), the patients could only indicate experiencing pain or not by nodding or shaking their head. Only one of the patients could use the enlarged NRS scale. Of these 50 assessments, 24 reported experiencing pain.

Dichotomizing the NRS and BPS into pain/no pain by cut-off scores, as described, made it possible to estimate the sensitivity and specificity of the instrument opposite the NRS of the observers in regard to the patient's assessment (Table 7).

Table 3
Discriminant validity for the paired assessment of the same observer (total score of BPS) comparing developed and original version before and during turning procedure in intubated patients (120 paired assessments) and non-intubated patients (60 paired assessments). Percentage agreement (PA), relative position (RP) and relative rank variance (RV) are shown with 95% confidence intervals.

	PA	RP (CI)	RV (CI)
Discriminant validity – intubated original version BPS	22%	0.67 (0.59–0.76)	0.20 (0.10–0.29)
Discriminant validity – intubated developed version BPS	22%	0.65 (0.56–0.75)	0.28 (0.17–0.40)
Discriminant validity – non–intubated BPS	29%	0.66 (0.32–0.99)	0.31 (0.00–1.50)

Table 4
Discriminant validity for the paired assessments of the same observer in each separate domain on BPS, intubated patients (120 paired assessments) and non-intubated patients (60 paired assessments), before and during turning procedure. Percentage agreement (PA), relative position (RP) and relative rank variance (RV) are shown with 95% confidence intervals.

	Domain	PA	RP (CI)	RV (CI)
Intubated patients	Facial expression	33%	0.57 (0.48–0.66)	0.09 (0.02–0.15)
	Upper limbs	48%	0.47 (0.37–0.57)	0.05 (0.002–0.09)
	Compliance with ventilation (original domain)	71%	0.28 (0.19–0.36)	0.004 (0.00–0.01)
	Breathing pattern (developed domain)	47%	0.49 (0.39–0.58)	0.03 (0.00–0.07)
Non-intubated patients	Facial expression	30%	0.62 (0.38–0.86)	0.17 (0.00–0.43)
	Upper limbs	30%	0.41 (0.11–0.71)	0.21 (0.00–0.51)
	Vocalisation	70%	0.30 (0.10–0.50)	0

Table 5
Inter-rater reliability for the paired assessment of the different observers (total score of BPS) comparing the developed and original version in intubated patients (240 paired assessments) and non-intubated patients (120 paired assessments). Percentage agreement (PA), relative position (RP) and relative rank variance (RV) are shown with 95% confidence intervals.

	PA	RP (CI)	RV (CI)
Inter-rater reliability – intubated original version BPS	77%	0.017 (−0.02 to +0.0553)	0.01 (0.0009–0.02)
Inter-rater reliability – intubated developed version BPS	76%	0.03 (−0.009 to +0.07)	0.01 (0.002–0.02)
Inter-rater reliability – non-intubated BPS	80%	−0.06 (−0.16 to +0.04)	0.02 (0.00–0.05)

Table 6
Inter-rater reliability for the paired assessment of the different observers in each separate domain on BPS, intubated patients (240 paired assessments) and non-intubated patients (120 paired assessments). Percentage agreement (PA), relative position (RP) and relative rank variance (RV) are shown with 95% confidence intervals.

	Domain	PA	RP (CI)	RV (CI)
Intubated patients	Facial expression	86%	−0.004 (−0.04 to +0.03)	0.003 (0.00–0.007)
	Upper limbs	90%	0.05 (−0.01 to +0.09)	0.0006 (0.0–0.002)
	Compliance with ventilation (original domain)	93%	0.004 (−0.03 to +0.04)	0.0005 (0.00–0.001)
	Breathing pattern (developed domain)	88%	0.04 (−0.0002 to +0.08)	0.003 (0.00–0.005)
Non-intubated patients	Facial expression	85%	−0.06 (−0.17 to +0.04)	0.002 (0–0.006)
	Upper limbs	93%	0.008 (−0.06 to +0.08)	0.0002 (0–0.0007)
	Vocalisation	100%	0	0

Table 7
Sensitivity, specificity and accuracy for the BPS and the NRS observer in relation to the NRS of the patients are shown with 95% confidence intervals.

	SENS (CI)	SPEC (CI)	Accuracy
BPS in relation to patient's assessment	0.88 (0.67–0.97)	0.58 (0.37–0.76)	0.72
NRS observer in relation to patient's assessment	0.54 (0.33–0.74)	0.80 (0.60–0.93)	0.68

SENSitivity = A / (A+C),
SPECificity = D / (B+D),
Accuracy = A+D / (A+B+C+D)

	NRS patient	
NRS observer / BPS	**Pain**	**No pain**
Pain	A	B
No pain	C	D

Discussion

The present study aimed to test the Swedish version of the BPS, including a developed domain for 'breathing pattern' instead of 'compliance with ventilation', thereby focusing more on the patient than the on ventilator. The domain of 'breathing pattern' was developed and tested psychometrically with the original version. The results indicate that both the whole instrument and the domains separately discriminate for pain in intensive care patients with inter-rater reliability that indicated no significant disagreement between assessments.

Previous studies found the BPS to have good psychometric proprieties (Ahlers et al., 2010; Chanques et al., 2009; Payen et al., 2001) and it is one of the recommended instruments in international guidelines (Barr et al., 2013). Still, advances are needed to assure that the assessments of pain are as precise as possible, consequently, this study aimed to develop one of the domains which previously showed the lowest variance (Aïssaoui et al., 2005; Payen et al., 2001). When compared, the developed domain had a considerably better result in discriminant validity than the original domain, with a lower percentage of agreement and higher RP (CI not covering 0) indicating higher scores during the painful procedure. In addition, the intention clinically was to shift focus from the ventilator towards the patient to make the instrument more patient focused; this could be regarded as facilitating the assessment.

The measurements from the observers in the present study were generated from the team caring for the patient. These could vary each time data were collected for the purpose of the study. Though this could be a limitation, the inter-rater reliability still showed no significant changes on the scale; in clinical practice, this is of importance. Although the BPS has previously been regarded as easy to use (Chanques et al., 2014), future studies are needed to explore the observers experience of the developed domain.

The method used for the analysis (Svensson, 1998, 2012) was chosen because it was developed especially for paired, ordered data and thereby perceived as more specific. A limitation could be that the statistical method differs from more-commonly-used psychometric methods; therefore, only the interpretation of the results is comparable with other studies within the area. This method enables the results to be shown for both the total score and domain levels. It also differentiates between the systematic change in assessments on the group and individual levels, which is considered as strengthening for the results.

Cut-off scores were used when looking for differences between assessments, which could be limiting because dichotomizing potentially removes the plurality of the results. Nevertheless, the cut-off scores for the NRS and the BPS have been established and used in previous studies (Chanques et al., 2006; Gerbershagen et al., 2011; Olsen et al., 2015; Payen et al., 2001). Further, as most of the patients were only able to nod or shake their head when asked if they were in pain, dichotomizing the assessments in regard to the cut-off scores made the comparison of the instrument and the observers possible.

The present study also showed higher sensibility when assessing pain with an instrument, than without. Bouajram et al. (2018) showed poor correlations between self-reported pain (NRS) and behavioural pain scales which made the authors question the relevance of using scales based on behavioural parameters. Although the sample in the present study was smaller, a sensitivity of 0.88 indicate that behavioural instrument is adequate in assessing pain in the ICU. However, the observers were more specific in noticing when pain was not present than with the BPS, which indicates that an instrument only shows one aspect of the complexity of assessing pain in the intensive-care patient. The multidimensional nature of pain and other distressful symptoms, such as anxiety and fear, have previously been described (Gélinas et al., 2014); and the difference between the dimensions of pain intensity and pain distress should be considered (Gélinas, 2016). Therefore, instruments based on behaviour should always be combined with the overall communication and evaluation between the patients and the caregivers. Observing the patients and making them the focus of care has been discussed within the concept of person-centred care (PCC) in the intensive-care setting (Jakimowicz and Perry, 2015). The concept of PCC could therefore also be considered when working to make instruments based on behaviours more patient-focused.

The high levels of sedation in the present study are an issue as they are not in line with recommended guidelines (Barr et al. 2013). Nevertheless, the BPS still indicated pain, as the assessments were higher during the potentially painful procedure (turning in bed). Using a pain assessment instrument has been proven to reduce the incidence of agitation among patients (Chanques et al., 2006). Patients without pain are calmer and in need of less sedation, and are thus, more awake. This could facilitate person-centred care, which is considered beneficial.

Limitations

A possible limitation of this study might be the large variation of different observers at each assessment. Another is the statistical method, which differs from the more widely used psychometric methods; therefore, only the interpretation of the results is comparable with other studies within the area. Cut-off scores were also used when looking for differences between assessments. This could be limiting because dichotomizing potentially removes the plurality of the results. The high level of sedation shown in the study could possibly affect the assessments through concealing the behavioural signs of pain.

Conclusion

The Swedish version of the Behavioural Pain Scale was developed within one of the domains to be more focused on the patients' breathing ('breathing pattern') instead of the ventilator ('compliance with ventilation'). When psychometrically tested, the instrument showed inter-rater reliability and discriminant validity in both intubated and non-intubated patients for both the total sum and for the different domains respectively despite high levels of sedation. When comparing the domains, the developed domain ('breathing pattern') had better results in discriminant validity then the original domain ('compliance with ventilation'). Therefore, could be recommended to replace the original domain in the instrument for intubated adult patients in the ICU.

The BPS showed a higher sensitivity than the NRS estimated by the observer when measuring the patients' self-reported pain, indicating that the instrument is useful when assessing pain in the ICU.

Contribution of the authors

All authors made substantial contributions to the design of the study and interpretation of the data. MH collected the data and drafted the article. EA, C A-R and EI revised the manuscript critically; thereafter, the final version was approved by all authors to be submitted.

Conflict of interest

The authors have no conflicts of interest.

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