Clinical pain research

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Reliability of three linguistically and culturally validated pain assessment tools for sedated ICU patients by ICU nurses in Finland

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Abstract

Background and aims: Pain assessment in intensive care is challenging, especially when the patients are sedated. Sedated patients who cannot communicate verbally are at risk of suffering from pain that remains unnoticed without careful pain assessment. Some tools have been developed for use with sedated patients. The Behavioral Pain Scale (BPS), the Critical-Care Pain Observation Tool (CPOT) and the Nonverbal Adult Pain Assessment Scale (NVPS) have shown promising psychometric qualities. We translated and culturally adapted these three tools for the Finnish intensive care environment. The objective of this feasibility study was to test the reliability of the three pain assessment tools translated into Finnish for use with sedated intensive care patients.

Methods: Six sedated intensive care patients were video-recorded while they underwent two procedures: an endotracheal suctioning was the nociceptive procedure, and the non-nociceptive treatment was creaming of the feet. Eight experts assessed the patients' pain by observing video recordings. They assessed the pain using four instruments: the BPS, the CPOT and the NVPS, and the Numeric Rating Scale (NRS) served as a control instrument. Each expert assessed the patients' pain at five measurement points: (1) right before the procedure, (2) during the endotracheal suctioning, (3) during rest (4) during the creaming of the feet, and (5) after 20 min of rest. Internal consistency and inter-rater reliability of the tools were evaluated. After 6 months, the video recordings were evaluated for testing the test-retest reliability.

Results: Using the BPS, the CPOT, the NVPS and the NRS, 960 assessments were obtained. Internal consistency with Cronbach's alpha coefficient varied greatly with all the instruments. The lowest values were seen at those measurement points where the pain scores were 0. The highest scores were achieved after the endotracheal suctioning at rest: for the BPS, the score was 0.86; for the CPOT, 0.96; and for the NVPS, 0.90. The inter-rater reliability using the Shrout-Fleiss intraclass correlation coefficient (ICC) tests showed the best results after the painful procedure and during the creaming. The scores were slightly lower for the BPS compared to the CPOT and the NVPS. The test-retest results using the Bland-Altman plots show that all instruments gave similar results.

Conclusions: To our knowledge, this is the first time all three behavioral pain assessment tools have been evaluated in the same study in a language other than English or French. All three tools had good internal consistency, but it was better for the CPOT and the NVPS compared to the BPS. The inter-rater reliability was best for the NVPS. The test-retest reliability was strongest for the CPOT. The three tools proved to be reliable for further testing in clinical use.

Implications: There is a need for feasible, valid and reliable pain assessment tools for pain assessment of sedated ICU patients in Finland. This was the first time the psychometric properties of these tools were tested in Finnish use. Based on the results, all three instruments could be tested further in clinical use for sedated ICU patients in Finland.

Keywords: pain assessment; intensive care; sedated; pain tool; nursing.

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1 Introduction

Patient pain assessment and management are required for quality care in intensive care units (ICUs). Studies have shown that pain assessment and management in ICU

patients are insufficient [1, 2]. For example, in Gélinas' [3] study, up to 74% of ICU patients suffered moderate or severe pain, and up to 77% recalled experiencing pain [3]. In addition to illness, a patient's pain can be caused by events such as endotracheal suctioning, chest tube removal, wound drain removal and arterial line insertion, which are some of the most painful procedures in intensive care [4]. Previous research has shown that systematic pain assessment decreases pain, the duration of mechanical ventilation and nosocomial infections [5, 6]. However, pain assessment in the ICU remains a challenge, especially when patients are sedated and not able to communicate.

Few potential pain assessment tools are available for sedated intensive care patients [7]. The Behavioral Pain Scale (BPS) [8], the Critical-Care Pain Observation Tool (CPOT) [9] and the Nonverbal Adult Pain Assessment Scale (NVPS) [10] have shown promising psychometric qualities in systematic reviews [11–14]. Fair to good agreement (0.74 and 0.75) has been found when evaluating the reliability of the BPS and the CPOT. Both instruments were able to discriminate between a painful and a non-painful procedure [15]. The reliability varied when the BPS and the NVPS were compared in situations with medical patients (the BPS = 0.60, and the NVPS = 0.65) and surgical patients (the BPS = 0.77, and the NVPS = 0.80). The validity of both tools was adequate [16]. In validation of the Swedish version of the CPOT also demonstrated good inter-rater reliability (on average 0.84) as well as adequate discriminant validity [17]. Validation of the Dutch version of the CPOT showed fair to moderate inter-rater reliability. In that study, the internal consistency was 0.56 (Cronbach α) during rest and when turning [18], and validity of the Swedish version of the CPOT showed that internal consistency was from 0.31 to 0.81 (Cronbach α) [17].

Deep sedation affected the pain assessment, so those scores are lower than without sedation [8]. Systematic pain assessment offers possibilities to ensure patients receive the right amount of sedatives and pain medication [5, 19]. With a systematic pain assessment, we also can diminish the amount of sedation; hence, the procedural pain can be cured adequately [7].

However, in 2017, no valid pain assessment tools were in systematic use in the Finnish ICUs. It is important to use well-established, properly translated and culturally adapted tools for pain care. There is a need for feasible, valid and reliable pain assessment tools for sedated ICU patients in Finland; therefore, we translated and culturally adapted the three above-mentioned tools [20].

The objective of this feasibility study was to test the reliability of the three Finnish translations of the pain assessment tools for sedated intensive care patients.

2 Materials and methods

2.1 Sample and setting

Six sedated intensive care patients were videorecorded while they underwent endotracheal suctioning and creaming of the feet in second-level (see Valentin et al. [21]) ICU care with 12 beds. The patients' pain was assessed from the video recordings by eight experts, who were chosen based on their years of experience in intensive care, pain care and teaching, and their expertise in pain research.

2.2 Inclusion and exclusion criteria

The patients were sedated, intubated and mechanically ventilated. The inclusion criteria for patients dictated that they must be older than 18 years of age, mechanically ventilated, needing sedation and pain medication, and in a hemodynamically reasonably stable state (a physician evaluated that the vital functions were stable enough). The following criteria was used to exclude patients from the study: quadriplegia, need for muscle relaxants, a head wound (brain damage) or other illness causing brain dysfunction, leg ulcer, or liver dysfunction or uraemia that can affect the level of consciousness.

2.3 Assessment tools

The three tools – the BPS, the CPOT and the NVPS, as well as the Numeric Rating Scale (NRS) – were translated into Finnish. The BPS, the CPOT and the NVPS were chosen based on a systematic review which showed that these pain assessment tools were the most effective for assessing the pain of patients in the ICU [13]. The NRS was chosen because it has been the tool most often used by nurses to assess pain in the ICUs in Finland.

The BPS was developed by Payen et al. [8] and includes three assessment categories: facial expression, upper limb movement and compliance with ventilation. Each is scored from 1 to 4, and the total score ranges from 3 to 12 [8]. Patients are considered to experience significant pain if the BPS score is greater than 5 [7]. The CPOT was developed by Gélinas et al. [9] and includes four assessment categories: facial expressions, body movements, and muscle tension, and compliance with the ventilator for intubated patients or vocalization for nonintubated patients. Each behavior is rated on a scale from 0 to 2 with the total score ranging from 0 to 8. [9]. Patients are considered to be in significant pain if the BPS score is 3 or greater [7]. The BPS and the CPOT scales

were developed specifically for pain assessment in ICU patients and are based on behavioral indicators. The American College of Critical Care Medicine recommends that the BPS and the CPOT be used for adults who are medical, postoperative or trauma patients in the ICU [7]. The NVPS was developed by Odhner et al. [10]. Wegman [22] revised the assessment tool so that behavioral and psychological indicators could be observed. The revised version was used in this study. The NVPS assesses five responses: face, activity (movement), guarding, physiological (vital signs; blood pressure, heart rate, respiratory rate) and respiration. Each is rated on a scale from 0 to 2 with a total score ranging from 0 to 10 [10]. There is no exact cut-off point for pain based on research using this instrument, but the scale is the same as the NRS. Patients are considered to be in significant pain if the NVPS score is 4 or greater, as is the same with the NRS tool [7]. The NRS was a commonly used pain assessment tool in ICUs around the world before new assessment tools were introduced [23]. It is a sensitive and specific tool used for detecting significant pain and is most often recommended for critically ill patients who can self-report [24]. The psychometric properties of these tools have not been tested in Finnish use.

The depth of sedation was assessed by the Richmond Agitation Scale (RASS), a 10-point score from unresponsive (−5) to combative (+4). The validity and reliability of the RASS have been assessed in several studies [25, 26].

The physiological variables collected from the patients were mean arterial blood pressure (MAP) and heart rate (HR). The analgesia used and the sedation administered were recorded.

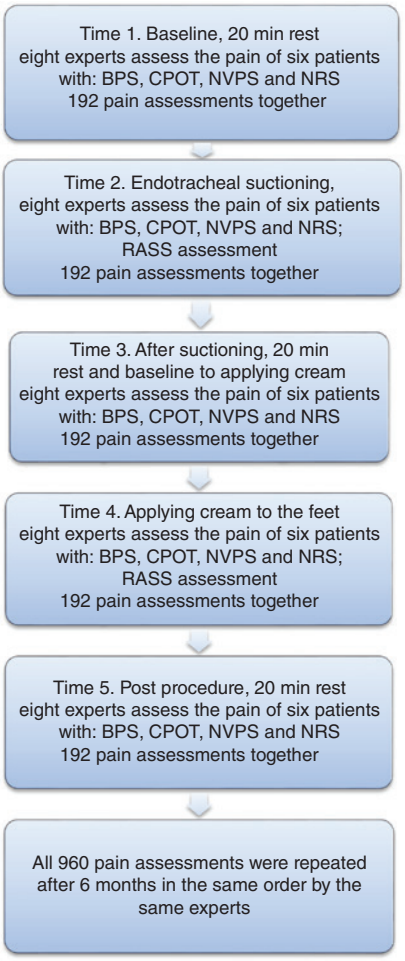

Fig. 1: Study design and data collection. BPS, the Behavioral Pain Scale; CPOT, the Critical-Care Pain Observation Tool; NVPS, the Nonverbal Adult Pain Assessment Scale; NRS, the Numeric Rating Scale; RASS, the Richmond Agitation Scale.

2.4 Procedure for data collection

Each patient was at rest for 20 min before they were touched. Patients received their normal medications throughout the procedure. After the 20-min rest time, the patients were prepared for endotracheal suctioning. The nurse touched the patient, called him or her by name and advised what she was going to do. The nurse also prepared the equipment. Three patients each received an extra bolus of pain medication prior to the procedure. The nurses determined the dosage of the bolus based on their evaluation of each patient's pain. It was not possible to control the amount additional pain medication administered during the study due to ethical reasons.

The nurse performed the suctioning. After the procedure, the patient rested for 20 min. The nurse prepared the patient for creaming of the feet in the same manner as for the suctioning and then performed the creaming. The session ended with the patient being untouched for another 20 min. Each video recording lasted, on average, just over 1 h. The design is seen in Fig. 1.

Eight experts in pain care and ICU nursing care assessed the patients' pain by viewing the video recordings. The pain was assessed using four instruments: the BPS, the CPOT and the NVPS, and the NRS, which was estimated by the nurse as a control instrument. Each expert assessed the patients' pain at five measurement points (Fig. 1). After 6 months, the video recordings were evaluated with the same protocol by the same experts for testing the test-retest reliability.

2.5 Statistical methods

The pain scores are described as means and standard deviations at different time points. Mean arterial pressure

and HR are described as absolute values. Internal consistency is described with Cronbach's alpha coefficient. The inter-rater reliability was calculated using the Shrout-Fleiss ICC test, and the test-retest reliability was described using the Bland-Altman plots. The statistical software SAS 9.3 (SAS Institute, Cary, NC, USA) was used.

2.6 Ethical aspects

The study protocol was approved by the Joint Commission on Ethics of the Satakunta Hospital District on 10 February 2010 and of Satakunta Central Hospital on 22 March 2010. Written informed consent could not be obtained from the patients due to their inability to communicate. Instead, a family member of each patient was informed orally and in writing. After providing the information, those family members were asked to provide consent on behalf of the patient. The nurses participating in the study also were informed orally and in writing, and they also signed informed consents regarding their participation. Only the research team had access to the data. The video recordings and patient data were kept separate and secure.

3 Results

Four participants were male and two were female. Their diagnoses were pneumonia (4), acute respiratory insufficiency (1) and epiglottitis (1). The patients' mean age was 69 (from 40 to 83). Their sedation levels varied from –3 to –5. Propofol 120–180 mg/h was given for sedation, and oxycodone hydrochloride 1–3 mg/h was given for pain. The sedation medication and pain medication were administered, on average, 7 min 30 s (from 0 to 20 min) before the ETS. One patient did not receive additional medication. The propofol bolus averaged 40 mg (two patients were not administered a propofol bolus), and the oxycodone hydrochloride bolus averaged 2.3 mg (three patients did not receive an oxycodone hydrochloride bolus). Systematic pain and agitation guidelines were not in use. The nurses followed the doctor's orders when administering the medications. Prior to the treatment, the nurses determined the dosage of each bolus. Nine hundred and sixty observations were evaluated. Mean pain scores and standard deviations are described in Table 1. The MAP and HR, which remained fairly stable throughout the study, also are illustrated in Table 1.

Table 1: Pain scores at different time points (means and standard deviations).

Mean pain scores (SD) n=6	Time 1		Time 2		Time 3		Time 4		Time 5	
	At rest	Test-retest	During ETS	Test-retest	After ETS, 20 min	Test-retest	During creaming	Test-retest	Post procedure	Test-retest
BPS (scale 3–12)	3.61 (1.03)	3.52 (0.85)	5.10 (1.08)	4.54 (1.15)	3.13 (0.11)	3.17 (0.19)	3.06 (0.1)	3.10 (0.2)	3.13 (0.25)	3.27 (0.46)
CPOT (scale 0–8)	0.90 (1.38)	0.65 (1.13)	2.54 (1.41)	1.60 (1.15)	0.15 (0.12)	0.25 (0.30)	0.04 (0.1)	0.23 (0.27)	0.23 (0.56)	0.29 (0.48)
NVPS (scale 0–12)	0.98 (1.49)	0.73 (1.15)	2.50 (1.73)	1.75 (1.38)	0.30 (0.18)	0.25 (0.31)	0.17 (0.13)	0.19 (0.29)	0.46 (0.62)	0.40 (0.61)
NRS (scale 0–10)	1.38 (0.81)	1.02 (1.10)	4.46 (2.17)	3.13 (1.86)	0.98 (0.33)	0.63 (0.22)	1.00 (0.51)	0.56 (0.35)	1.00 (0.34)	0.58 (0.50)
MAP	82		88		79		78		82	
HR	74		80		91		74		72	

BPS = the Behavioral Pain Scale; CPOT = the Critical-Care Pain Observation Tool; NVPS = the Nonverbal Adult Pain Assessment Scale; MAP = mean arterial pressure; HR = heart rate; ETS = endotracheal suctioning.

Internal consistency with Cronbach's alpha coefficient varied greatly with all instruments. The lowest values were recorded in those measurement points where the pain scores were 0. Highest scores were achieved after the endotracheal suctioning at rest: for the BPS, the score was then 0.86, the CPOT was 0.96, and the NVPS was 0.90. Table 2 shows the results of the internal consistency measures for the study.

The inter-rater reliability with the Shrout-Fleiss ICC tests showed the best results after the painful procedure and during the creaming. The scores were slightly lower for the BPS compared to the CPOT and the NVPS. At the baseline measurement point, the eight evaluators gave a score of 0 for pain in 80% of the evaluations with any of the instruments. Therefore, the reliability scores are close to 0. See Table 2 for detailed results of the inter-rater reliability scores.

The test-retest results are illustrated in Figs. 2–4. The BPS Bland-Altman plots are illustrated in Fig. 2, the CPOT Bland-Altman plots are in Fig. 3, and the NVPS Bland-Altman plots are in Fig. 4. The Bland-Altman plots show that all instruments gave similar results. The retest values were always within one point of the first measurement and had a 95% confidence interval. The figures show less variability between the test and the retest measurements for the NVPS at time points 2 and 4 compared to those for the CPOT.

Table 2: Intraclass correlations and inter-rater reliability scores for BPS, CPOT and NVPS.

Measure point n=6	BPS	CPOT	NVPS
Time 1: At rest			
ICC[a]	0.30	0.19	0.06
Cronbach α[a]	0.00	0.48	0.00
Time 2: During ETS			
ICC	0.29	0.18	0.06
Cronbach α	0.00	0.57	0.26
Time 3: After ETS, 20 min			
ICC	0.80	0.80	0.80
Cronbach α	0.86	0.96	0.90
Time 4: During creaming			
ICC	0.49	0.67	0.69
Cronbach α	0.69	0.89	0.85
Time 5: Post procedure 20 min			
ICC	0.20	0.36	0.38
Cronbach α	0.47	0.58	0.67

[a]Cronbach α = Cronbach alpha coefficient, ICC = Shrout-Fleiss intraclass correlation coefficient. BPS = the Behavioral Pain Scale, CPOT = the Critical-Care Pain Observation Tool, NVPS = the Nonverbal Adult Pain Assessment Scale, ETS = endotracheal suctioning.

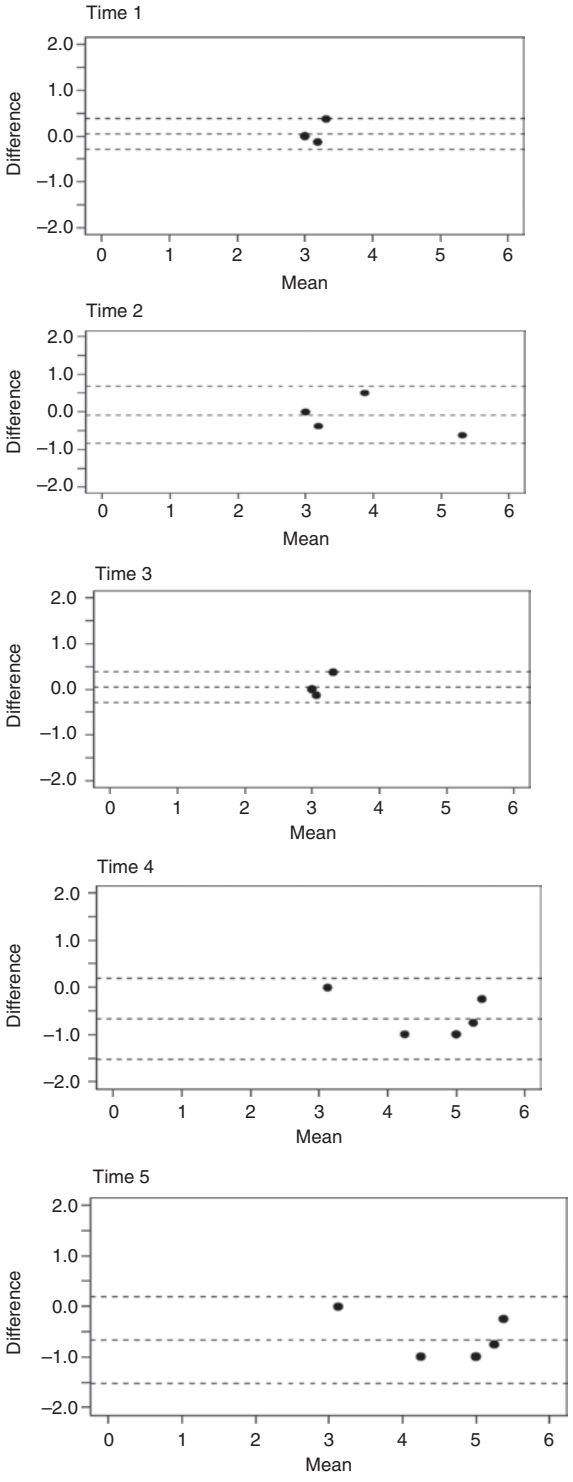

Fig. 2: BPS Bland-Altman plots in time 1–5.

4 Discussion

The participants were fairly deeply sedated, and pain medication was administered continuously in an infusion. Some patients also were given boluses before the

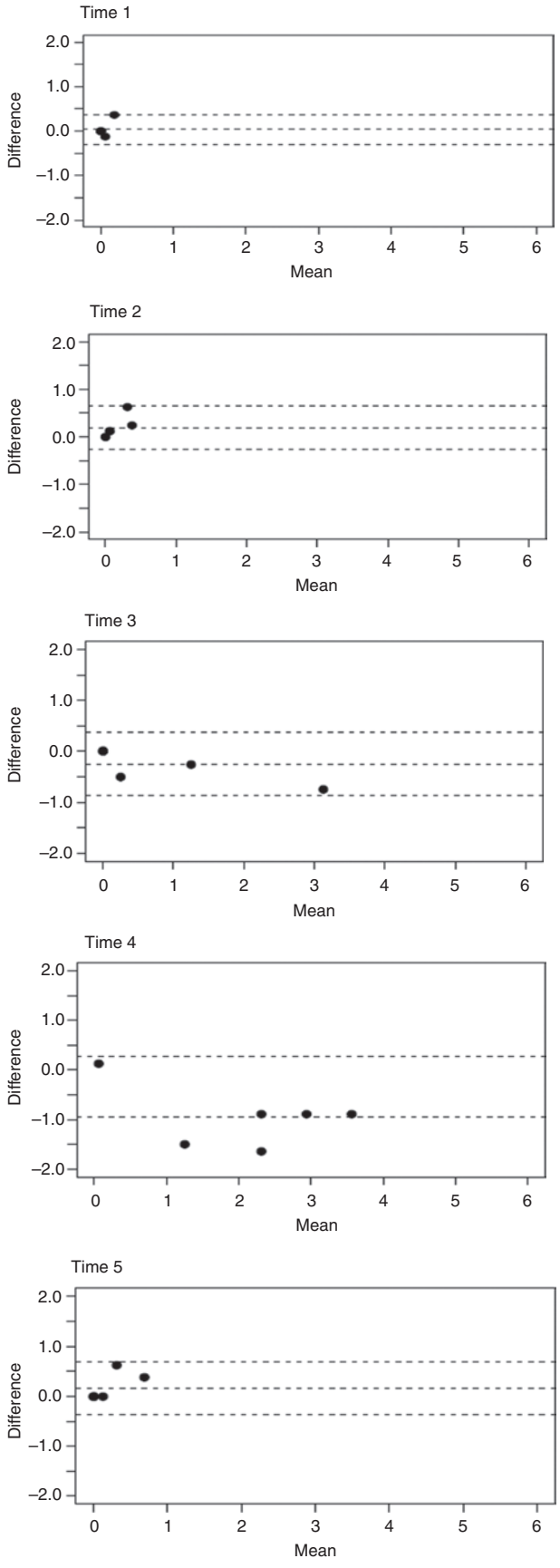

Fig. 3: CPOT Bland-Altman plots in time 1–5.

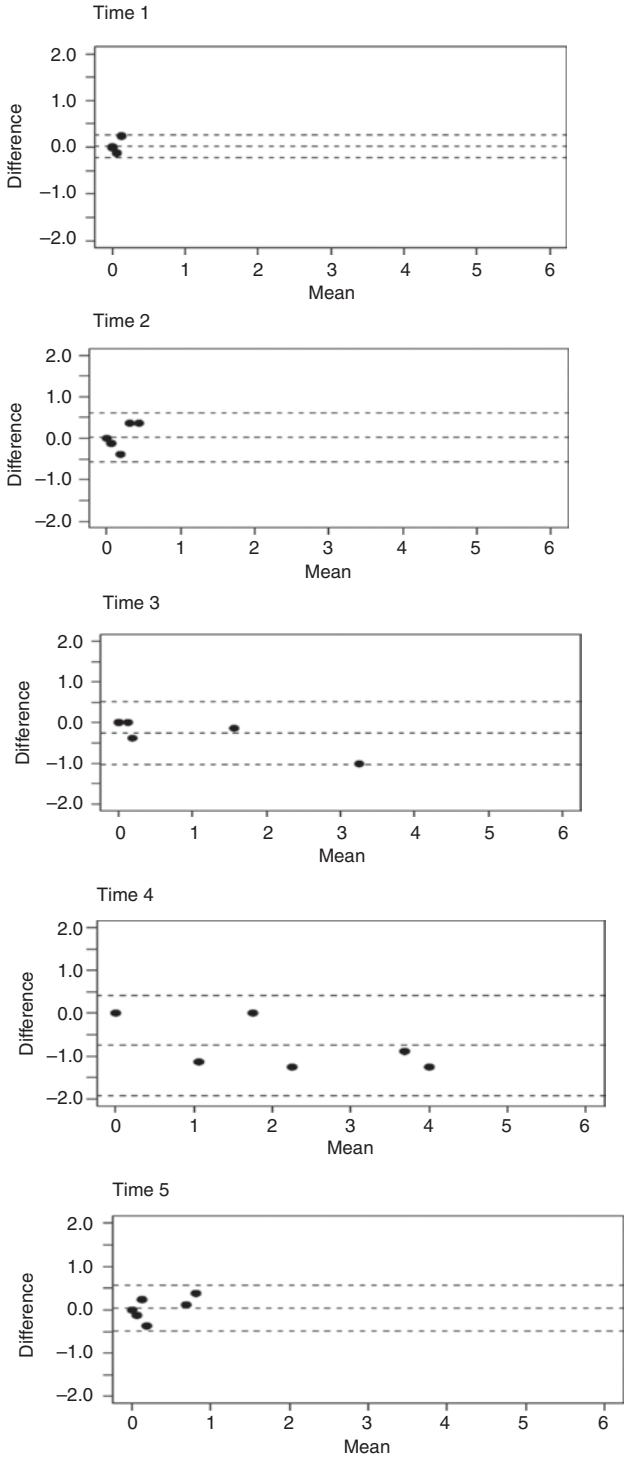

Fig. 4: NVPS Bland-Altman plots in time 1–5.

procedure. This seems to have affected the study results – during the painful procedure, the participants were not expressing pain, but when the effects of the bolus were diminishing, the patients showed expressions of pain even 20 min after the procedure. This could be seen in all results. The pain medication oxycodone hydrochloride was given

in a varied scheme ranging from 0 to 20 min before the procedure. The effect of this medication was seen a few minutes after administration [27]. In some cases, the medication did not have an effect on the patient's pain. Nurses did not necessarily evaluate the connection between the extra pain medication bolus and the procedure. This indicates a serious lack in systematic pain assessment and pain care. A more systematic approach to pain care would help intensive care nurses to recognize pain symptoms and signs. A systematic approach will secure correct doses of pain medication and sedation [5, 7, 19, 28]. In our study, the patients' MAPs and HRs did not react greatly to pain.

Internal consistency varied with all instruments. However, they were slightly lower than in previous studies that used instruments in the original language, English or French [e.g. 9, 10, 29]. In our study, several patients had a pain score of 0 at several measurement points. This affected the results and lowered the ICCs. Similar results were previously reported when the Dutch version of the CPOT was tested [18]. Perhaps this is due to the small sample size and the type of patients participating in the study. In addition, we utilized eight evaluators instead of two, which is usually the case in similar studies [e.g. 30–32]. In real life, there are often more than two pain assessors for the same patient; hence, our study resembled actual practice. Also, the ICC was lower in the Dutch study, which used more than two evaluators [18]. Furthermore, deep sedation diminishes a patient's pain expressions. Payen et al. [8] had low scores with the BPS with deeply sedated patients. In Wøien et al.'s [28] study, nurses estimated the pain of deeply sedated patients using the NRS, and the results were in line with Payen's [8] study and with ours.

Even though the inter-rater reliability calculations gave low interclass correlations at measurement points with low pain scores, it does not mean that the reliability is low. This is due to how the calculations were performed. The differences between raters were measured in relation to the total variation, and if the differences in pain scores between the participants are smaller, then the variation between the raters is greater compared to the variation when differences in pain scores are bigger. Based on the inter-rater reliability scores, the CPOT differentiates mild pain less accurately than the NVPS.

All the instruments reacted to painful situations, an effect that has been seen in other studies [e.g. 29]. Payen et al. [8] made similar findings in deeply sedated patients while Topolevic-Vranic et al. [33] showed that the CPOT and the NVPS scores increased during a painful situation.

The test-retest reliability proved to be similar and good for all tools. All tool scores were within one point difference between the two measurement times with a 95% confidence interval. Similar results have been reported in two Chinese studies where the test-retest reliability of the Chinese version of the CPOT ranged from 0.81 to 0.93 [31], and test-retest reliability of the Chinese version of the BPS ranged from 0.50 to 0.84 [32].

Pain scores measured with the NRS were higher at all measurement points than with other tools. Similar results were reported previously [34].

Our results support the previous studies, and the Finnish translations of the BPS and the CPOT can be utilized as pain assessment tools in Finnish ICUs [29]. Accurate pain assessment supports ICU pain care and leads to an increase in care outcomes [6, 7].

This study had some limitations. Our sample size was small. However, the inclusion and exclusion criteria for the participants were strict, and the sample was homogeneous. In addition, we were able to use the same eight experts for both measurement time points, which increased the trustworthiness of the results. The deep sedation of the patients was challenging and made the assessment slightly difficult, especially when the participant was at rest. Some low pain scores may be due to the fairly deep sedation of the participants. The participants also were given intravenous pain medication. It would have been preferable to evaluate the pain of the participants in real-life situations. For example, in some cases it was difficult to evaluate the muscle tension since the evaluator was not able to touch the patient and assess the tension. However, our design made it possible to use the test-retest design. This was rarely used in previous studies.

5 Conclusions

To our knowledge, this was the first time all three behavioral pain assessment tools were evaluated in the same study in a language other than English or French. Although the study had its limitations, we concluded that the three tools had good internal consistency, but the results were better for the CPOT and the NVPS tools compared to the BPS. The inter-rater reliability was best for the NVPS, but it was good for the other two as well. The test-retest reliability was strongest for the CPOT, but the other instruments were not far behind. All three tools proved to be reliable for further testing in clinical use.

6 Implications

There is a need for reliable pain assessment tools for clinical use in Finnish ICUs. Our study design made it possible

to test and retest three pain assessment tools for sedated patients in ICUs. All three instruments (the CPOT, the NVPS and the BPS) proved to be reliable with sedated ICU patients. Further clinical testing with larger samples is recommended.

Authors' statements

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Conflict of interest: The authors declare that they have no conflict of interest.

Informed consent: Informed consent was obtained from a family member of patients and nurses according to local regulations.

Ethical approval: The study protocol was approved by the Joint Commission on Ethics of the Satakunta Hospital District on 10 February 2010 and of Satakunta Central Hospital on 22 March 2010.

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