Scales for the assessment of pain in the intensive care unit. Systematic review

Escalas para a avaliação da dor na unidade de terapia intensiva. Revisão sistemática

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DOI 10.5935/2595-0118.20200043

ABSTRACT

BACKGROUND AND OBJECTIVES: Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage. Thus, pain is difficult to evaluate, especially in patients undergoing mechanical ventilation in an intensive care unit. However, there are several instruments to assess these patients' pain. Thus, the aims of the present study were described and characterize the psychometric characteristics of the intensive care unit pain assessment scales.

CONTENTS: A systematic review in the electronic databases of Pubmed, LILACS, Cochrane Library and Scielo was performed, without time restrictions. The focus of this evidence synthesis is to examine the validity, reproducibility, and responsiveness of intensive care unit pain scales. 58 studies were included. Cronbach alpha ranged from 0.31 to 0.96 and the intraclass correlation coefficient from 0.25 to 1.00. A cross-cultural adaptation was performed in 28 studies for use in language Portuguese (Brazil), Chinese, Italian, Swedish, Portuguese (Portugal), English, Dutch, Turkish, Persian, Danish, Polish, Spanish and Greek.

CONCLUSION: Among the available scales to measure pain in non-responsive patients, the data is not enough to indicate the superiority between them. In Brazil, most studies demonstrated that the pain scales had satisfactory validity, reliability, and reproducibility rates. Thus, when deciding which scale to use, the convenience of application and familiarity of the team should be considered.

Keywords: Critical care, Intensive care units, Pain measurement, Reproducibility of results.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A dor é considerada como uma experiência sensorial e emocional desagradável, associada a uma lesão efetiva ou potencial dos tecidos. Avaliar a dor é muito complexo, principalmente quando se trata de pacientes ventilados mecanicamente na unidade de terapia intensiva. No entanto, existem diversas escalas para avaliam a dor desses pacientes. Dessa forma, este estudo teve como objetivo sumarizar dados acerca das características psicométricas das escalas de avaliação de dor na unidade de terapia intensiva.

CONTEÚDO: Foi realizada uma revisão sistemática através da pesquisa nas bases de dados Pubmed, LILACS, *Cochrane Library* e SciELO, foram incluídos os estudos que verificaram a confiabilidade, a validade, reprodutibilidade e a capacidade de resposta das escalas de avaliação de dor na unidade de terapia intensiva. Dos 58 estudos incluídos, o alfa de Cronbach variou de 0,31 a 0,96 e o coeficiente de correlação intraclasse variou de 0,25 a 1,00. Houve adaptação transcultural de 28 estudos nas versões brasileira, chinesa, italiana, sueca, portuguesa, inglesa, holandesa, turca, persa, dinamarquesa, polonesa, espanhola e grega.

CONCLUSÃO: Os estudos publicados até o momento demonstraram uma lacuna para indicar a superioridade entre as escalas que avaliam dor em pacientes em ventilação mecânica. No Brasil, a maior parte dos estudos ressaltou que as escalas de avaliação da dor apresentam índices de validade, confiabilidade e reprodutibilidade satisfatórios. Assim, a decisão entre a escala a ser utilizada deve considerar facilidade de aplicação e a familiaridade da equipe.

Descritores: Cuidados críticos, Medição da dor, Reprodutibilidade dos testes, Unidade de terapia intensiva.

INTRODUCTION

Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage[1]. However, assessing pain is something complex, since the perception of pain involves biological, emotional, sociocultural, and environmental aspects[2,3]. Moreover, the interpretation and evaluation of pain are subjective and personal[2,4,5]. Intensive care units are prepared to look out for patients in critical state or that need constant monitoring, but it's common that these patients are submitted to various routine procedures that can promote discomfort and pain. Beyond that, most of the times patients are under mechanic ventilation (MV), using sedatives or with a lowered consciousness level, and therefore incapable of reporting their experience of pain[6].

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Submitted on April 03, 2020
Accepted for publication on May 24, 2020.
Conflict of interests: none – Sponsoring sources: none

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Nowadays there are various scales for measuring pain in intensive care units (ICU), such as the Behavioral Indicators of Infant Pain (BIIP), Behavior Pain Assessment Tool (BPAT), Behavioral Pain Scale (BPS), Critical-Care Pain Observation Tool (CPOT), COMFORT Behaviour Scale, Faces – Legs – Activity – Cry and Consolability Scale (FLACC), Nonverbal Pain Scale (NVPS), COVERS Scale, Pain Assessment Tool (PAT), Behavioural Indicators of Pain Scale (ESCID), Multidimensional Objective Pain Assessment Tool (MOPAT), Visual Analog Scale horizontal (VAS-H) and vertical (VAS-V), Verbal Descriptor Scale (VDS), Numeric Rating Scale Oral (NRS-O), NRS visually enlarged laminated (NRS-V), Neonatal Pain Assessment Scale, Neonatal Infant Pain Scale (NIPS), Premature Infant Pain Profile (PIPP), Nepean Neonatal Intensive Care Unit Pain Assessment Tool (NNICUPAT), Nonverbal Pain Assessment Tool (NPAT), FACES, Numeric Rating Scale (NRP) e Crying – Requires Oxygen – Increased Vital Signs – Expression and Sleepless (CRIES). However, despite the variety of instruments published in the scientific literature, many professionals are unaware of their availability and the methodological aspects for their use in clinical practice.

More recent studies, including guidelines, reinforce the necessity of the evaluation of pain as a routine for patients in the ICU with the objective of improving clinical outcomes[7-9]. To this end, scales are necessary and it's essential that professionals that are going to use these instruments on their daily care of patients have a good knowledge of the scales available, as well as the aspects related to their validity, reliability and reproducibility.

The present study aims at synthesizing data about the psychometric characteristics of the available pain scales for the ICU.

CONTENTS

A systematic review meeting the criteria of the Reporting Guide for JBI Systematic Reviews (JBISRIR) was performed[10].

All original studies that assessed validity, reproducibility and/or reliability of the pain scales for ICU usage in adults and children were considered. The search was not restricted by language or year of publication and was executed during the period of July 2019 to April 2020 in the following databases Pubmed, LILACS, Cochrane Library e Scielo. The mnemonic PICO was used to define the inclusion criteria for this review.

Search strategy

The initial search strategy was composed of four keywords, according to the investigation question (mnemonic PICO) (P: patients, C: construct and O: outcome - measurement properties)[10-12]. The keywords used were described from the Medical Subject Headings (MeSH) and *Descritores em Ciências da Saúde* (DeCS - Health Sciences Descriptors) search terms, in which ICU patients, critical care and their synonyms were included. For construct, the measurement of pain and synonyms was used, for outcome, the reproducibility of results and their synonyms were used.

An experienced reviewer performed the search and initial selection in order to identify the titles and abstracts of potentially relevant studies. Each abstract was independently evaluated by two reviewers. If at least one reviewer considered a reference as eligible, the article was obtained in its entirety. The two authors independently reviewed the articles and selected those that would be included in the review. In case of disagreement, the decision was made by consensus of the authors. A manual citation tracking was also performed on the selected articles.

Selection of studies and extraction of data

A first evaluation was made based on the title and abstract of the articles, excluding those that did not meet the inclusion criteria. After that, the articles, collected through database searches, were read in their entirety.

First, all the selected articles were read. After that, the parts that were really of interest were read selectively and analytically. The information extracted from the articles was recorded to sort and summarize the material, so that relevant information to the research could be obtained.

For the extraction of results, a table was developed by the authors in order to extract the characteristics and results of the studies, registering the following information: author(s); country/language; studied population; mean age; sample; scales used; reliability values; validity; responsiveness and reproducibility/equivalence.

Data synthesis

Since the present study's data are not adequate for a collection in meta-analysis, they were combined through narrative synthesis, and the result consistency and study homogeneity information were presented.

Methodological quality analysis

The checklist proposed by COSMIN risk-bias (Consensus-based Standards for the Selection of Health Measurement Instruments) was used to assess the quality of the studies. The COSMIN risk-bias checklist consists of nine measurement properties.

RESULTS

The search strategy resulted in 241 articles. From these, 58 studies met the eligibility criteria and were included in this study. Figure 1 shows the flowchart regarding the studies selection.

From the 58 included studies, 42 articles aimed at verifying the reliability, validation, reproducibility, and responsiveness of scales individually, while 16 articles verified the psychometric properties of two or more scales in a single study.

The total sample of participants in all studies was 8.122 individuals, 7.787 of whom were adults and 335 children. In 15 studies[14-23.25-28] the number of men and women was not informed (Table 1). From the 58 articles, 36 informed the Cronbach's Alpha, which ranged from 0.31[29] to 0.96[30.31]. The intraclass correlation coefficient (ICC) ranged from 0.25[28] to 1.00[32] and 19 articles did not inform the studies' ICC (Tables 2, 3 and 4).

In Brazil, two scales were validated for the Portuguese language, BPS and CPOT. Thus, four studies evaluated the psychometric properties exclusively of BPS[6,37,42,54] and another of BPS and

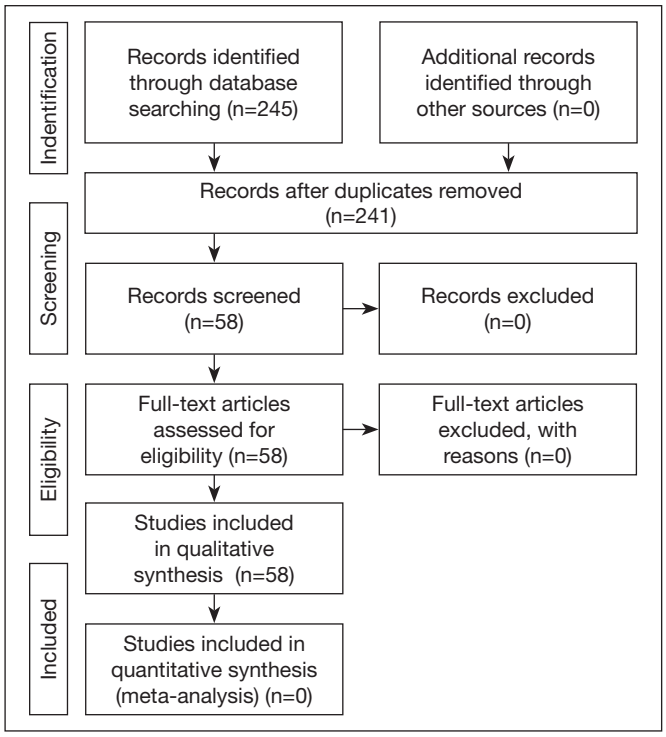

Figure 1. Flowchart of the article selection process

CPOT[34] (Table 3). From the four studies conducted in Brazil that evaluated BPS, two of them[6,54] found Cronbach's alpha coefficient below 0.6, showing low reliability.

In the other two studies[37,42] that evaluated BPS, the Cronbach's Alpha values were 0.8 and the ICC varied from 0.7 to 0.95. It's important to note that all studies done in Brazil reported the execution of a transcultural validity. The rest of the studies that validated BPS outside of Brazil found values between 0.64 to 0.86, which results in a consistency between weak and good. ICC varied from 0.50 to 1.0, obtaining results considered satisfactory to excellent.

Regarding the validity of CPOT in Brazil, only one study performed it and CPOT was evaluated with BPS[34]. No significant differences between the pain measurement properties of the two scales were found[37,42]. Both presented good validity indexes. It should be noted that the authors made a transcultural validity for Brazilian Portuguese. Studies around the world that evaluated CPOT separetly[17-20,29,36,39,45,46,51,52,57,66,67] identified Cronbach coefficient values varying from 0.31 to 0.89 and ICC from 0.53 to 0.99. Comparisons between CPOT and BPS outside Brazil[32,40,43,49,55] also showed no differences between the two scales.

For the other pain assessment scales, no Brazilian study was found. Thus, a brief description of the results is presented below.

Table 1. Description of the characteristics of the included studies

Authors	Country	Patients	Sample	Scales
Hylén et al.[33]	Sweden	Adults	n=57 (63% men and 37% women)	BPS
Kaya and Erden[26]	Turkey	Adults	n=74	NVPS
Sulla et al.[14]	Italy	Children	n=09	BPS
Klein et al.[34]	Brazil	Adults	n=168 (88 men and 80 women)	BPS - CPOT
Pudas-Tähkä and Salanterä[30]	Finland	Adults	n=06 (04 men and 02 women)	BPS - CPOT - NVPS
Fagioli et al.[35]	Italy	Children	n=35 (17 boys and 18 girls)	COMFORT
Shan et al.[36]	China	Adults	n=400 (235 men and 165 women)	CPOT
Dionysakopoulou et al.[31]	Greece	Newborns	n=81 (44 boys and 37 girls)	NIPS - PIPP
Ribeiro et al.[37]	Brazil	Adults	n=27 (25 men and 02 women)	BPS
Wiegand et al.[38]	United States	Adults	n=27 (13 men and 14 women)	MOPAT
Sulla et al.[20]	Italy	Adults	n=50	CPOT
Kotfis et al.[39]	Poland	Adults	n=71 (50 men and 21 women)	CPOT
Chookalayia et al.[18]	Iran	Adults	n=65	CPOT
Rijkenberg et al.[40]	Netherlands	Adults	n=72 (52 men and 20 women)	BPS - CPOT
Cheng et al.[32]	China	Adults	n=113 (73 men and 40 women)	BPS - CPOT
Gélinas et al.[41]	28 countries	Adults	n=3851 (60,8% men and 39,2% women)	BPAT
Azevedo-Santos et al. [42]	Brazil	Adults	n=25 (10 men and 15 women)	BPS
Hylén et al.[15]	Sweden	Adults	n=20	BPS
Severgnini et al.[43]	Italy	Adults	n=101 (64 men and 37 women)	BPS - CPOT
Al Darwish, Hamdi and Fallatah[44]	Saudi Arabia	Adults	n=47 (27 men and 20 women)	BPS - CPOT - NVPS
O'Sullivan et al.[16]	New Zealand	Children	n=80	COVERS - PAT
Aktas and Karabulut[45]	Turkey	Adults	n=66 (48 men and 18 women)	CPOT
Latorre-Marco et al.[23]	Spain	Adults	n=190	ESCID

Continue...

Table 1. Description of the characteristics of the included studies – continuation

Authors	Country	Patient	Sample	Scales
Frandsen et al.[46]	Denmark	Adults	n=70 (44 men and 26 women)	CPOT
Joffe et al.[19]	Canada	Adults	n=79	CPOT
Chen et al.[47]	China	Adults	n=53 (26 men and 27 women)	BPS
Rahu et al.[48]	United States	Adults	n=150 (78 men and 72 women)	NVPS - BPS - FACES - FLACC - COMFORT - NRP
Azevedo-Santos et al. [6]	Brazil	Adults	n=15 (12 men and 03 women)	BPS
Liu, Li and Herr[49]	China	Adults	n=117 (84 men and 33 women)	BPS - CPOT
Boitor, Fiola and Gélinas[17]	Canada	Adults	n=125	CPOT
Latorre-Marco et al.[22]	Spain	Adults	NI	ESCID
Navarro-Colom et al.[50]	Spain	Adults	n=34 (22 men and 12 women)	BPS
Li et al.[51]	China	Adults	n=63 (39 men and 29 women)	CPOT
Echegaray-Benites, Kapoustina and Gélinas[52]	Canada	Adults	n=43 (22 men and 21 women)	CPOT
Chanques et al.[53]	United States	Adults	n=30 (11 men and 19 women)	BPS - CPOT - NVPS
Morete et al.[54]	Brazil	Adults	n=100 (61 men and 39 women)	BPS
Rijkenberg et al.[55]	Netherlands	Adults	n=68 (41 men and 27 women)	BPS - CPOT
Topolovec-Vranic et al.[56]	Canada	Adults	n=66 (36 men and 30 women)	CPOT - NVPS
Linde et al.[57]	NI	Adults	n=30 (23 men and 07 women)	CPOT
Batalha et al.[58]	Portugal	Adults	n=60 (42 men and 18 women)	BPS
Rivas, Rivas and Bustos[59]	Chile	Newborns	n=112 (69 boys and 43 girls)	NIPS
Chen et al.[60]	China	Adults	n=70 (51 men and 19 women)	BPS
Nurnberg Damstrom et al.[29]	Sweden	Adults	n=40 (21 men and 19 women)	CPOT
Marmo and Fowler[21]	United States	Adults	n=24	CPOT - NVPS - FLACC
Chanques et al.[61]	France	NI	n=111 (74 men and 37 women)	VAS-H - VAS-V - VDS - NRS-O –
Voepel-Lewis et al.[62]	United States	Adults and Children	n=29 (17 men and 12 women) n=08 (04 boys and 03 girls)* *Data about gender absent in one of the children	NRS-V FLACC
Klein et al.[24]	Guinea-Bissau	Adults	n=270	NPAT
Chanques et al.[63]	France	Adults	n=30 (20 men and 10 women)	BPS
Johansson and Kokinsky[64]	Sweden	Children	n=40 (22 boys and 18 girls)	COMFORT - FLACC (modified)
Kabes, Graves and Norris[25]	United States	Adults	n=121	NVPS
Holsti et al.[65]	Canada	Preemies	n=69 (36 boys and 33 girls)	BIIP
Gélinas and Johnston[66]	Canada	Adults	n=55 (32 men and 23 women)	CPOT
Gélinas et al.[67]	Canada	Adults	n=105 (83 men and 22 women)	CPOT
Young et al.[68]	Australia	Adults	n=44 (26 men and 18 women)	BPS
Spence et al.[27]	NI	Newborns	n=144	PAT
McNair et al.[28]	Canada	NI	n=51	PIPP - CRIES
Marceau[69]	Australia	Newborns	n=30 (17 boys e 13 girls)	NNICUPAT
Payen et al.[70]	France	Adults	n=30 (17 men e 13 women)	BPS

NI: not informed

BIIP = Behavioral Indicators of Infant Pain; BPAT = Behavior Pain Assessment Tool BPS = Behavioral Pain Scale; CPOT = Critical-Care Pain Observation Tool; FLACC = Faces - Legs - Activity - Cry and Consolability Scale; COMFORT Behaviour Scale; FACES Scales; NVPS = Nonverbal Pain Scale; COVERS Scale; PAT = Pain Assessment Tool; ESCID = Behavioural Indicators of Pain Scale; MOPAT = Multidimensional Objective Pain Assessment Tool; VAS-H = Visual Analog Scale horizontal and VAS-V = vertical; VDS = Verbal Descriptor Scale; NRS-O = Numeric Rating Scale Oral; NRS-V = Numeric Rating Scale visually enlarged laminated; NPAS = Neonatal Pain Assessment Scale; NIPS = Neonatal Infant Pain Scale; PIPP = Premature Infant Pain Profile; NNICUPAT = Nepean Neonatal Intensive Care Unit Pain Assessment Tool; NPAT = Nonverbal Pain Assessment Tool; NRP = Numeric Rating Scale; CRIES = Crying-Requires Oxygen - Increased Vital Signs - Expression and Sleepless.

Table 2. Measurements properties of validated pain assessment scales in adults

Authors	Internal consistency (Cronbach α)	Reliability (ICC)	Validity	Transcultural Adaptation
Hylén et al.[33]	NI	NI	Discriminatory validity NPP (CI) 0.65 (0.56 - 0.75) PP (CI) 0.28 (0.17 - 0.40)	Swedish Version
Kaya and Erden[26]	0.776	NI	Construct validity Barlett Test $\chi 2$= 105.433 (p<0.001)	Turkish Version
Pudas-Tähkä and Salanterä[30]	BPS: 0.86 CPOT: 0.96 NVPS: 0.90	BPS: 0.80 CPOT: 0.80 NVPS: 0.80	NI	Swedish, Dutch and Chinese Version
Shan et al.[36]	NI	0.86 to 0.93	Discriminatory validity	Chinese Version
Wiegand et al.[38]	0.68 - 0.72	NI	p<0.001	NI
Sulla et al.[20]	Intubated patients: 0.78	NI	Spearman correlations: 0.42 (p<0.05) to 0.99 (p<0.001)	Italian Version
Kotfis et al. [39]	0.89	> 0.97	Spearman correlations: R > 0.85, p<0.0001	Polish Version
Chookalayia et al.[18]	02 examinators Before NPP: 0.79 / 0.79 During NPP: 0.66 / 0.67 After NPP: 0.76 / 0.76 Before PP: 0.59 / 0.64	Before NPP: 0.98 NPP: 0.96 After PP: 0.99 Before PP: 0.97 PP: 0.96 After PP: 0.98	Discriminatory validity Mann-WhitneyTest: p<0.001	Persian Version
Rijkenberg et al.[40]	CPOT Nurse 1: 0.65 Nurse 2: 0.58 BPS Nurse 1: 0.62 Nurse 2: 0.59	0.74 (0.68 – 0.79) P = 0.001	Discriminatory validity by Friedman	NI
Cheng et al.[32]	NI	Kappa coefficient: CPOT Facial expression: 0.64 (0.31 - 0.98) / Body movements: 1.00 (1.00 - 1.00) / Muscle tension: 0.72 (0.43 - 1.00) / Complication with ventilation: 1.00 (1.00 - 1.00) BPS Facial expression: 0.73 (0.46 - 0.99) / Upper limbs: 0.94 (0.86 - 1.00) / Complication with ventilation: 0.80 (0.41 - 1.00)	Construct validity: CPOT Wald X^2= 22.82 (p<0.05) BPS Wald X^2= 19.71 (p<0.05)	Chinese Version
Gélinas et al. [41]	NI	Kappa: Neutral facial expression (0.69) Presence of grimace (0.69) Shivering (0.60) Eyes closed (0.70) Moans (0.69) Verbal complaints (0.78) Muscle rigidity (0.57) Clenched fists (0.62)	Convergent validity Pearson correlation: r = 0.79 (p<0.001)	NI
Hylén et al.[15]	NI	Kappa: > 0.89	Discriminatory validity by Svensson NPP: 0.6406 (0.4861 to 0.7951) PP: 0.1020 (0.0000 to 0.2066)	Swedish Version
Severgnini et al.[43]	NI	Kappa: Before PP: 0.69 PP: 0.64 After PP: 0.66	Discriminatory validity (p<0.0001)	NI
Al Darwish, Hamdi and Fallatah[44]	BPS: 0.95 CPOT: 0.95 NVPS: 0.86	BPS: 0.77 CPOT: 0.47 and 0.69 (during aspiration and rotation, respectively) NVPS: 0.72	NI	NI

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Table 2. Measurements properties of validated pain assessment scales in adults – continuation

Authors	Internal consistency (Cronbach α)	Reliability (ICC)	Validity	Transcultural Adaptation
Aktas and Karabulut[45]	During PP: 0.72 After PP: 0.71	Kappa Coefficient 0.89	Discriminatory validity: (p=0.001) Pearson: 0.63 (p<0.001)	Turkish Version
Latorre-Marco et al.[23]	0.85	NI	Convergent validity r = 0.94 – 0.99 (p<0.001)	Spanish Version
Frandsen et al. [46]	> 0.70	> 0.90	Discriminatory validity Spearman Correlations	Danish Version
Joffe et al.[19]	NI	0.727 (95% IC 0.570 - 0,833)	Discriminatory validity by Friedman: (Chi-square = 150.656, p<0.001)	NI
Chen et al.[47]	Intubated patients: 0.724 – 0.743 Not intubated patients: 0.701 – 0.762	0.962 – 1.000	Pearson Correlation Intubated patients: 0.815 – 0.937 Not intubated patients: 0.755 – 0.899	Chinese Version
Rahu et al.[48]	NVPS: 0.78 BPS: 0.94 COMFORT: 0.90	NI	Spearman Correlations NVPS NPP: -0.1485 / p=0.35 PP: 0.5594 / p<0.001 BPS NPP: 0.2050 / p=0.19 PP: 0.5557/ p<0.001 FACES NPP: 0.2197 / p=0.18 PP: 0.7613 / p<0.001 FLACC NPP: 0.1072 / p=0.50 PP: 0.6320 / p<0.001 COMFORT NPP: 0.3385 / p=0.03 PP: 0.6527 / p<0.001	NI
Liu et al.[49]	CPOT: 0.795 BPS: 0.791	NI	CPOT Z = - 14.352 p<0.001 BPS Z = -14.440 (p<0.001)	Chinese Version
Boitor, Fiola and Gélinas[17]	NI	Rest: 0,863 NPP: 0,956 Rest:: 0,535 PP: 0,828	Discriminatory validity Mauchly test: (p<0.001) Convergent validity: r = 0.313 (p<0.01)	NI
Latorre-Marco et al.[22]	0.70 a 0.80	NI	Pearson correlations Before the evaluation: 0.97 During the evaluation: 0.94 After the evaluation: 0.95	Spanish Version
Navarro-Colom et al.[50]	NPP: 0.66 (CI 95% 0.33-0.83) PP: 0.73 (CI 95%: 0.50-0.87)	NPP: 0.50 (CI 95%: 0.19 – 0.71) PP: 0.58 (CI 95%: 0.31 – 0.77)	NI	NI
Li et al.[51]	0.59 to 0.86	0.80 to 0.91	Discriminatory validity Spearman correlations: 0.81 to 0.93	Chinese Version
Echegaray-Benites, Kapoustina and Gélinas[52]	NI	> 0.75	Wilcoxon Test with Bonferroni correction: (Z = 5.14, p<0.001) AUC: 0.864, P < 0.001 (CI 95% = 0.757 – 0.971)	NI
Chanques et al.[53]	BPS: 0.80 CPOT: 0.81 NVPS: 0.76	Kappa: BPS: 0.81 CPOT: 0.81 NVPS: 0.71	BPS: 0.90 CPOT: 0.86 NVPS: 0.92	NI

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Table 2. Measurements properties of validated pain assessment scales in adults – continuation

Authors	Internal consistency (Cronbach α)	Reliability (ICC)	Validity	Transcultural Adaptation
Rijkenberg et al.[55]	CPOT: 0.71 BPS: 0.70	CPOT 0.75 (0.69 – 0.79) p=0.001 BPS 0.74 (0.68 – 0.79) p=0.001	Discriminatory validity by Friedman and Wilcoxon	English Version
Topolovec-Vranic et al.[56]	0.36 to 0.75	0.62 to 0.68	Discriminatory validity by ANOVA CPOT: F = 5.81 p=0.019 NVPS-R: F = 5.32 (p=0.25 validity of criteria: 0.59 to 0.71 (p<0.05)	NI
Linde et al.[57]	NI	Kappa Coefficient: 0.87 (CI 95%, 0.79 -0.94)	Competing validity	NI
Batalha et al.[58]	0.65 – 0.73	0.79 (0.67 – 0.87)	Construct validity 02 examinators Facial expression: 0.75 - 0,83 SL movement: 0.90 – 0.92 Ventilator adaptation: 0.83 – 0.71	Portuguese Version
Chen et al.[60]	NI	NI	Pearson correlation: r = 0.50 - 1.00 (p < 0.001) Discriminatory validity by ANOVA (F = 377.7 p<0.001)	Chinese Version
Nurberg-Damstrom et al.[29]	0.31 – 0.81	0.84 (0.72 – 0.92)	Spearman correlations: 0.32 – 0.45	Swedish Version
Marmo and Fowler[21]	0.89	NI	Pearson Correlations	NI
Chanques et al.[61]	NI	NI	Pearson Correlations	NI
Klein et al.[24]	0.82	NI	Construct validity (p<0.001)	NI
Voepel-Lewis et al.[62]	0.882	0.67 - 0.95	Construct validity PP: 5.27 SD 2.3 NPP: 0.52 SD 1.1 (p<0.001)	NI
Chanques et al.[63]	0.79	0.57 – 0.59 Kappa Coefficient: 0.89 / 0.82	Discriminatory validity	NI
Gélinas and Johnston[66]	NI	Before PP: 0.80 PP: 0.88 After PP: 0.92 Before PP: 0.84 PP: 0.84 After PP: 0.93	Discriminatory validity by RM-MANOVA Pearson coefficient: (p≤0.05)	English Version
Gélinas et al.[67]	NI	NI	Discriminatory validity by ANOVA Spearman Correlations 0.49, 0.59 and 0.40 (p≤0.001)	NI
Young et al.[68]	0.64	NI	NI	NI
McNair et al.[28]	NI	Before surgery: 0.60 72 hours after surgery: 0.25	Convergent validity	NI
Kabes, Graves and Norris[25]	Before PP: 0.36 PP: 0.62 After PP: 0.62	NI	Spearman Correlations 135.86 p<0.001	NI
Payen et al.[70]	NI	Kappa Coefficient: 0.74 (p<0.01)	NI	NI

NI = not informed; PP = painful procedure; NPP = non painful procedure; BPS = Behavioral Pain Scale; CPOT = Critical-Care Pain Observation Tool; COMFORT Behaviour Scale; NVPS = Nonverbal Pain Scale; UL = upper limb, ICC = Intraclass correlation coefficient.

Table 3. Measurement properties of validated pain assessment scales in adults in Brazil

Authors	Internal consistency (Cronbach)	Reliability (ICC)	Validity	Transcultural Adaptation
Klein et al.[34]	NI	Kappa coefficient: Pressure algometry CPOT / BPS 0.96 (0.95 - 0.97) and 0.96 (0.94 - 0.97), (p<0.001), respectively. Standard care CPOT / BPS 0.96 (0.94 - 0.97) and 0.94 (0.92 - 0.95), (p<0.001), respectively.	Predictive validity: CPOT 0.44 (0.35 – 0.65) BPS 0.44 (0.52 – 0.87)	Brazilian Version
Ribeiro et al.[37]	NI	0.95 (0.90 – 0.98) Kappa:0.70	Discriminatory validity by Friedman and Wilcoxon p<0.0001	Brazilian Version
Santos et al.[42]	NPP (0,8) PP (0,8)	NPP (0,8) PP (0,9)	Criteria validity: SBP: 0,35 (p=0,86) DBP: -0,83 (P = 0,69) MBP: -0,17 (P = 0,93) HR: -0,30 (P = 0,89) SpO2: 0,11 (P = 0,61) Ramsay: -0,34 (P = 0,10) RASS: 0,32 (P = 0,12) Apache II: -0,03 (P=0,8) Construct validity – hypothesis test (p ≤ 0.0001)	Brazilian Version
Azevedo-Santos et al.[36]	Rest (0,42) NPP (0,53) PP (0,57)	Rest and PP (0,65) NPP (0,53)	Friedman Test and Tukey Test	Brazilian Version
Morete et al.[54]	0.501	Kappa: 0.740 ICC of 0.807 (CI 95%: 0.727 - 0.866)	NI	Portuguese Version (Brazil)

NI: not informed; PP: painful procedure; NPP: non painful procedure; BPS = Behavioral Pain Scale; CPOT = Critical-Care Pain Observation Tool; SBP = systolic blood pressure; DBP = diastolic blood pressure; MBP = mean blood pressure; HR = heart rate; SpO2 = peripheral oxygen saturation; RASS = Richmond Agitation-Sedation Scale; APACHE = Acute Physiology Health Chronic Evaluation; ICC = intraclass correlation coefficient.

Table 4. Measurement properties of validated pain assessment scales in children

Authors	Internal consistency (Cronbach's α)	Reliability (ICC)	Validity	Transcultural Adaptation
Sulla et al.[14]	0.865	NI	Discriminatory validity (ROC): 0.995 (p<0.001; s.e. = 0.007; C.I. 95%) [0.982; 1.009])	Italian Version
Fagioli et al.[35]	NPP: 0.81 PP: 0.91	Kappa: 0.558	NI	Italian Version
Dionysakopoulou et al.[31]	NIPS: 0.87 - 0.95 PIPP: 0.93 - 0.96	> 0.98	Validity of criteria	Greek Version
O'Sullivan et al.[16]	COVERS NPP: 0.74 PP: 0.79 PAT NPP: 0.79 PP: 0.85	COVERS NPP: 0.82 PP: 0.80 PAT NPP: 0.83 PP: 0.86	Spearman: r = 0.81 (p=0.001)	NI
Rivas et al.[59]	0,78	NI	Varimax rotation technique and standardisation with Kaiser	NI
Johansson and Kokinsky[64]	NI	Kappa coefficient: COMFORT-B 0.71 (0.75 - 0.77) FLACC 0.63 (0.53 – 0.72)	Competing validity 0.76 (p<0.05)	NI
Holsti et al.[65]	NI	NI	Discriminatory validity by ANOVA	NI
Spence et al.[27]	NI	0.84	Pearson Correlations 0.76 (p<0.001)	NI
Marceau[69]	NI	NI	Discriminatory validity by ANOVA	NI

NI: not informed; PP: painful procedure; NPP: non painful procedure; NIPS = Neonatal Pain Assessment Scale; PIPP = Premature Infant Pain Profile; COVERS Scale; PAT = Pain Assessment Tool; FLACC = Faces - Legs – Activity – Cry and Consolability Scale; COMFORT Behaviour Scale; ICC = intraclass correlation coefficient.

Nonverbal Pain Scale (NVPS), Critical-Care Pain Observation Tool (CPOT) and Behavioral Pain Scale (BPS)

Two studies[25,26] aimed to review the NVPS. Cronbach coefficient of 0.82 and a construct validity of p<0.001 were found[25], favorable results for good reliability.

Three studies[30,44,53] compared the reliability of BPS, CPOT and NVPS. There were disagreements in the studies to define the best scale. The BPS and CPOT presented better reliability (0.80 and 0.81)[53] and better internal consistency (0.81) than the NVPS (Cronbach coefficient: 0.76 and ICC: 0.71). One study showed that NVPS, BPS and CPOT[44] are reliable and valid tools, with a Cronbach coefficient of 0.95 for BPS and CPOT, and of 0.86 for NVPS. However, as for pain assessment sensitivity, BPS was considered the best scale, followed by CPOT. The NVPS presented consistency p=0.16 to p=0.21. In this sense, good results were identified in the internal consistency of the three scales, but CPOT and NVPS were better when compared to BPS (0.96, 0.90 and 0.86, respectively)[30]. Nevertheless, the three tools were considered reliable. A study evaluated the validity and clinical utility of two pain assessment tools, CPOT and NVPS[56]. The discriminating validity by ANOVA suggests that CPOT is more acceptable than NVPS, however, the two tools present good viability for use.

Faces – Legs – Activity – Cry and Consolability Scale (FLACC), COMFORT, Critical-Care Pain Observation Tool (CPOT) and Nonverbal Pain Scale (NVPS)

The reliability and validity of FLACC was evaluated[62] and the ICC of 0.67 to 0.95 showed high reliability among evaluators. The Cronbach coefficient found was 0.88. In this sense, authors[35] validated the Italian version of the COMFORT Behaviour Scale in pediatric ICU. Internal consistency ranged from 0.81 to 0.91 and the Cohen Kappa coefficient was 0.558, a moderate index.

In another study, the pain measurement capability of CPOT, NVPS and FLACC was tested[21]. CPOT and NVPS had a Cronbach coefficient of 0.89, which means high reliability. The FLACC tool was considered the most widely used tool in practice. The comparison between COMFORT and modified FLACC was performed[64] and the ICC found was 0.71 for COMFORT and 0.63 for FLACC. The concurrent validity (p<0.05) suggests that both scales are reliable for pain assessment.

Behavior Pain Assessment Tool (BPAT) and Behavioral Indicators of Infant Pain Scale (BIIPS)

The BPAT scale was considered a reliable and valid instrument to measure pain in critically ill patients (Kappa coefficient varied from 0.57 to 0.78)[41]. BIIPS was compared to BPAT in a single study[65] by the ANOVA method, and BIIPS was considered accurate and valid to measure acute pain in premature infants (Pearson's coefficient of 0.79).

Pain Assessment Tool (PAT) and COVERS scale

Through a prospective study[27], validity of the newborn pain assessment tool, PAT, was performed. The interexaminators reliability was 0.84 and Pearson's correlations were 0.76, p<0.001. It's possible to conclude that the PAT is considered a valid and reliable scale for pain assessment outside of Brazil. The comparison between the COVERS Scale and the PAT[16] in neonatal ICU showed that both scales have satisfactory internal consistency, 0.74 to 0.79 and 0.79 to 0.85, respectively. The ICC showed good reliability, COVERS – 0.80 to 0.82 and PAT – 0.83 to 0.86. No significant differences were found between the scales, the two were considered reliable and valid.

Behavioural Indicators of Pain Scale (ESCID) and Multidimensional Objective Pain Assessment Tool (MOPAT)

Two studies[22,23] presented the Cronbach coefficient values from 0.70 to 0.85 for the Spanish version of ESCID. The validity measured by Pearson's correlation was of 0.94 to 0.97 and the convergent validity (p<0.001), respectively. In the study that measured the psychometric properties of MOPAT, the values of Cronbach coefficient and validity were considered satisfactory[38].

Neonatal Infant Pain Scale (NIPS), Neonatal Pain Assessment Scale (NPAS) and Premature Infant Pain Profile (PIPP)

The NPAS[59] presented a Cronbach coefficient of 0.78. NIPS and PIPP in the Greek version are used to measure pain in newborns admitted to ICUs. A Cronbach coefficient of 0.87 to 0.95 was found for NIPS and of 0.93 to 0.96 for PIPP. The ICC was higher than 0.98 for both, which suggests excellent consistency between the scales[31].

Premature Infant Pain Profile (PIPP), Crying – Requires Oxygen – Increased Vital Signs – Expression and Sleepless (CRIES) and Nonverbal Pain Assessment Tool (NPAT)

The comparison of the convergent validity of two scales, PIPP and CRIES, showed more evident correlation in the first 24 hours after surgery and more divergent correlations from 40 to 72 hours after[28]. Both scales were considered valid for pain assessment in neonates in the ICU. The validity of NPAT was evaluated in the study[24] and the authors concluded that this tool has good validity and reliability among evaluators, with a Cronbach coefficient of 0.82. Moreover, it's an easy-to-use tool that allows a standardized approach for assessing pain in adult patients who cannot verbalize pain.

Nepean Neonatal Intensive Care Unit Pain Assessment Tool (NNICUPAT)

validity of NNICUPAT for measuring pain in neonatal ICU was performed and interexaminator reliability showed significant correlation, being r = 0.88 and p<0.02.

Nonverbal Pain Scale (NVPS) versus Behavioral Pain Scale (BPS) versus FACES versus Legs – Activity – Cry and Consolability Scale (FLACC) versus COMFORT Behaviour Scale versus Numeric Rating Scale (NRS)

In a study included in this review[48], validity and sensibility of six scales, NVPS, BPS, FACES, FLACC, COMFORT Behaviour Scale and NRS were measured with the objective of comparing their psychometric properties on assessing pain in non-communicative patients. The authors concluded that the six tools had moderate to high correlations, confirming their validity for pain

assessment and sensibility for pain response. However, FACES require attention due to its subjectivity, which can result in interpretation of exaggerated answers.

The quality classification of the studies included was performed by COSMIN (Table 5). Of the 58 studies, 21 did not report internal consistency, 20 did not report reliability, 4 presented criteria validity and 46 presented construct validity.

Table 5. Methodological quality of included studies

Authors	1	2	3	4	5	6	7	8	9
Hylén et al.[33]	NI	NI	NI	+	NI	NI	NI	+	NI
Kaya and Erden[26]	NI	NI	+	+	NI	NI	NI	+	NI
Sulla et al.[14]	NI	NI	+	+	NI	NI	NI	+	NI
Klein et al.[34]	NI	NI	NI	+	+	NI	+	NI	NI
Pudas-Tähkä and Salanterä[30]	NI	NI	+	+	+	NI	NI	NI	NI
Fagioli et al.[35]	NI	NI	+	+	+	NI	NI	NI	NI
Shan et al.[36]	NI	NI	NI	+	+	NI	NI	+	NI
Ribeiro et al.[37]	NI	NI	NI	+	+	NI	NI	+	NI
Dionysakopoulou et al.[31]	NI	NI	+	+	+	NI	+	NI	NI
Wiegand et al.[38]	NI	NI	+	NI	NI	NI	NI	+	NI
Sulla et al.[20]	NI	NI	+	+	NI	NI	NI	+	NI
Kotfis et al.[39]	NI	NI	+	+	+	NI	NI	+	NI
Chookalayia et al.[18]	NI	NI	+	+	+	NI	NI	+	NI
Rijkenberg et al.[40]	NI	NI	+	NI	+	NI	NI	+	NI
Cheng et al.[32]	NI	NI	NI	+	+	NI	NI	+	NI
Gélinas et al.[41]	NI	NI	NI	NI	+	NI	NI	+	NI
Azevedo-Santos et al.[42]	NI	NI	+	+	+	NI	NI	+	NI
Hylén et al.[15]	NI	NI	NI	+	+	NI	NI	+	NI
Severgnini et al.[43]	NI	NI	NI	NI	+	NI	NI	+	NI
Al Darwish, Hamdi and Fallatah[44]	NI	NI	+	NI	+	NI	NI	NI	+
O'Sullivan et al.[16]	NI	NI	+	NI	+	NI	NI	+	NI
Aktas and Karabulut[45]	NI	NI	+	+	+	NI	NI	+	NI
Latorre-Marco et al.[23]	NI	NI	+	+	NI	NI	NI	+	NI
Frandsen et al.[46]	NI	NI	+	+	+	NI	NI	+	NI
Joffe et al.[19]	NI	NI	NI	NI	+	NI	NI	+	NI
Chen et al.[47]	NI	NI	+	+	+	NI	NI	+	NI
Rahu et al.[48]	NI	NI	+	NI	NI	NI	NI	+	NI
Azevedo-Santos et al.[6]	NI	NI	+	+	+	NI	NI	+	+
Liu et al.[49]	NI	NI	+	+	NI	NI	NI	+	NI
Boitor, Fiola and Gélinas[17]	NI	NI	NI	NI	+	NI	NI	+	NI
Latorre-Latorre-Marco et al.[22]	NI	NI	+	+	NI	NI	NI	+	NI
Navarro-Colom et al.[50]	NI	NI	+	NI	+	NI	NI	NI	NI
Li et al.[51]	NI	NI	+	+	+	NI	NI	+	NI
Echegaray-Benites, Kapoustina and Gélinas[52]	NI	NI	NI	NI	+	NI	NI	+	NI
Chanques et al.[53]	NI	NI	+	NI	+	NI	NI	+	+

Continue...

Table 5. Methodological quality of included studies – continuation

Authors	1	2	3	4	5	6	7	8	9
Morete et al.[54]	NI	NI	+	+	+	NI	NI	NI	NI
Rijkenberg et al.[55]	NI	NI	+	+	+	NI	NI	+	NI
Topolovec-Vranic et al.[56]	NI	NI	+	NI	+	NI	NI	+	NI
Linde et al.[57]	NI	NI	NI	NI	+	NI	+	NI	NI
Batalha et al.[58]	NI	NI	+	+	+	NI	NI	+	NI
Rivas, Rivas and Bustos[59]	NI	NI	+	NI	NI	NI	NI	+	NI
Chen et al.[60]	NI	NI	NI	+	NI	NI	NI	+	NI
Numberg-Damstrom et al.[29]	NI	NI	+	+	+	NI	NI	+	NI
Marmo and Fowler[21]	NI	NI	+	NI	NI	NI	NI	+	NI
Chanques et al.[61]	NI	NI	NI	NI	NI	NI	NI	+	+
Voepel-Lewis et al.[62]	NI	NI	+	NI	+	NI	NI	+	NI
Klein et al.[24]	NI	NI	+	NI	NI	NI	NI	+	NI
Chanques et al.[63]	NI	NI	+	NI	+	NI	NI	+	+
Johansson and Kokinsky[64]	NI	NI	NI	NI	+	NI	+	NI	NI
Kabes, Graves and Norris[25]	NI	NI	+	NI	NI	NI	NI	+	NI
Holsti et al.[65]	NI	NI	NI	NI	NI	NI	NI	+	NI
Gélinas and Johnston[66]	NI	NI	NI	+	+	NI	NI	+	NI
Gélinas et al.[67]	NI	NI	NI	NI	NI	NI	NI	+	NI
Young et al.[68]	NI	NI	+	NI	NI	NI	NI	NI	+
McNair et al.[28]	NI	NI	NI	NI	+	NI	NI	+	NI
Marceau[69]	NI	NI	NI	NI	NI	NI	NI	+	NI
Payen et al.[70]	NI	NI	NI	NI	+	NI	NI	NI	NI

1.Content validity; 2. Structural validity; 3. Internal Consistency; 4. Transcultural validity; 5. Reliability; 6. Measurement and reproducibility error; 7. Criteria validity; 8. Hypothesis test for construct validity; 9. Responsiveness; NI: not informed.

DISCUSSION

Although the assessment and measurement of pain is difficult in critically ill patients, it should be performed in a valid and reliable way to provide pain control, if necessary. Therefore, to use pain assessment scales in clinical practice, professionals need to know the tools' potential for measurement errors, as well as the potential they have to provide the necessary information with accuracy and reproducibility.

Previously released reviews and guidelines for the management of pain in the ICU[71-74] report the importance of using behavioral scales to assess the patient's pain. These studies reinforce the importance of pain assessment tools and their use by physiotherapists and other health professionals in ICUs. In addition to these studies, the newest written clinical practice guideline[7] highlights that pain assessment and management strategies for critically ill patients should be adopted, emphasizing clinical applicability and awareness of professionals on the importance of measuring pain.

Standard tools for pain assessment and new trends for measuring pain in patients under MV, such as pupilometry, skin conductivity and bispectral index (BIS), are already described in the literature for pain assessment in those patients[72,75-78]. However, there is more scientific information about the behavioral scales for measuring pain in the ICU compared to these new methods[71,74-77]. Additionally, the use of scales is still a more practical and inexpensive method and can be incorporated more easily and comprehensively by the health system. Therefore, by the most recently published clinical guideline on ICU pain management, the systematic assessment of ICU pain has been indicated, since such conduct promotes favorable change in the clinical outcome.

It's worth noting the importance of developing studies on pain assessment of patients under MV in Brazil, improving the scientific evidence over this subject. Additionally, its essential to encourage the evidence-based practice in the ICUs, promoting pain assessment as the fifth vital sign by the means of good quality instruments and, consequently, improving the routine of analgesia and sedation. In the present study, it was possible to observe that the pain assessment scales were tested in their psychometric properties and in different ways by the authors. The results varied for each of them although, in general, the scales presented good psychometric indexes, without great differences when compared between each other. In Brazil, the scarcity of validated scales for the measurement of pain in ICU patients who do not verbalize reinforces the need for more studies in this area in order to expand the availability of measurement instruments and the comparison of these instruments in regard to accuracy. However, despite the reduced number of scientific papers on the subject, most studies that measured validity, reliability and/or reproducibility of scales in Brazil showed good psychometric indexes for both BPS and CPOT.

CONCLUSION

Pain cannot be treated unless it's assessed. The most important principle is that the professionals should evaluate the levels of pain and be aware of the methodological aspects of the chosen tools. Special scales developed and validated for patients with difficulties in communication should be made available and a plan for assessing pain in different scenarios must exist.

Most of the evidence published so far was not capable of presenting superiority between the scales that assess pain in patients under MV. The included studies emphasize that most pain assessment scales have satisfactory rates of validity, reliability, and reproducibility. In Brazil, five studies for the validity of ICU pain measurement scales were identified and two tools were validated, BPS and CPOT. From these articles, most demonstrated adequate psychometric quality for BPS, making it reliable and valid for use in Brazil. As for CPOT, only one validity study that confirmed the reliability of this tool for practical clinic was found. Thus, when deciding which scale to use, the convenience of application and familiarity of the team should be considered.

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