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Facial expression and pain in the critically ill non-communicative patient: State of science review

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Summary

The aim of this review is to analyse the evidence related to the relationship between facial expression and pain assessment tools in the critically ill non-communicative patients. Pain assessment is a significant challenge in critically ill adults, especially those who are unable to communicate their pain level. During critical illness, many factors alter verbal communication with patients including tracheal intubation, reduced level of consciousness and administration of sedation and analgesia. The first step in providing adequate pain relief is using a systematic, consistent assessment and documentation of pain. However, no single tool is universally accepted for use in these patients. A common component of behavioural pain tools is evaluation of facial behaviours. Although use of facial expression is an important behavioural measure of pain intensity, there are inconsistencies in defining descriptors of facial behaviour. Therefore, it is important to understand facial expression in non-communicative critically ill patients experiencing pain to assist in the development of concise descriptors to enhance pain evaluation and management. This paper will provide a comprehensive review of the current state of science in the study of facial expression and its application in pain assessment tools.

Keywords

Pain assessment; Facial expression; Pain; Critically ill; Non-communicative; Facial Action Coding System

Introduction

Pain assessment is a significant challenge in critically ill adults, especially those who are unable to communicate their pain level. In 1968, Margo McCaffery defined pain as, "whatever the experiencing person says it is, existing whenever the experiencing person say it does" (McCaffery and Pasero, 1999). Unfortunately in critical care, many factors alter verbal communication with patients including endotracheal intubation, reduced level of consciousness, sedation, and administration of paralysing drugs. There is no question that critically ill patients experience acute pain manifested by the patient's underlying disease, invasive procedures, catheters and drains, endotracheal tubes, suctioning, wound care and turning or other preexisting disease processes (Arroyo-Novoa et al., 2008; Erstad et al.,

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

2009; Gelinas et al., 2004, 2006; Granja et al., 2005; Mularski, 2004; Puntillo et al., 2009, 1997, 2001, 2004; Stanik-Hutt, 2003). The International Pain Guidelines require that pain be assessed in "all patients" and that tools to evaluate pain should be specific to the age and disease state of the patient and to the site of pain (ANZCA, 2007; British Pain Society, 2007; Charlton, 2005; Chou, 2009; JCAHO, 2003, 2006). The first step in providing adequate pain relief for patients is systematic and consistent assessment and documentation of pain. Identification of the optimal pain scales for non-communicative patients have been the focus of several studies. To date, however, no one tool is universally accepted for use in these patients.

When patients cannot express themselves, observable indicators, both physiological and behavioural, have been labelled as 'pain behaviours' (Christoph, 1991; Hadjistavropoulos et al., 2002; Harrison and Cotanch, 1987; Herr et al., 2006a; Prkachin et al., 2002; Puntillo et al., 1997). Since the term 'pain behaviour' was first described by Fordyce (Fordyce, 1976) as a one-dimensional construct of chronic pain, there have been several attempts to develop systems for assessing pain behaviour (Gelinas et al., 2004; Keefe et al., 1984, 1990; Prkachin et al., 1977, 2002; Puntillo et al., 1997, 2004). One of the most frequently used pain behaviour incorporated in a variety of pain scales for the non-communicative patients is facial expression (Ambuel et al., 1992; De Jonghe et al., 2003; Gelinas et al., 2006; Merkel et al., 1997; Odhner et al., 2003; Payen et al., 2001; Puntillo et al., 2002; Salmore, 2002; Warden et al., 2003). Although use of facial expression is an important behavioural measure of pain intensity, precise and accurate methods for interpreting the facial expression of pain in critically ill adults has not been identified. Therefore, this review will provide an analysis of the use of facial expressions in non-communicative critically ill patients and the variation of facial expression descriptors used in pain assessment tools.

Pain in critically ill patients

Pain is a complex multidimensional concept that is difficult to define. Individual pain experiences influence cognitive, emotional, and behavioural responses. Pain is a subjective experience that is described as "the unpleasant sensory and emotional experience associated with actual or potential tissue damage" (IASP, 2010). The most reliable and valid indicator of pain is the patient's self-report (Carr and Jacox, 1992; Jacobi et al., 2002; JCAHO, 2000; McCaffery and Pasero, 1999). In numerous studies, it has been reported that seriously ill patients experience pain and some patients can recall their dissatisfaction with pain control (Ahlers et al., 2010; Desbiens et al., 1996; Gelinas et al., 2008; Gelinas and Johnston, 2007; Hamill-Ruth and Marohn, 1999; Puntillo, 1997; Puntillo, 1990; Topolovec-Vranic et al., 2010). The Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments (SUPPORT) (Desbiens et al., 1996) evaluated the pain experience of seriously ill hospitalized patients and their satisfaction with control of pain. Of the 9105 patients admitted to five teaching hospitals in the United States (US), 5176 patients provided interviews of their pain experience. The SUPPORT results indicated that seriously ill, hospitalised patients demonstrated a high prevalence of pain. Specifically, approximately 50% of patients reported pain and 14.9% reported extremely severe pain or moderately severe pain occurring at least half of the time, and nearly 15% of those patients with pain were dissatisfied with its control.

In a more recent study, Topolovec-Vranic et al. (2010) described patients' perspective of pain management in the ICU. The study included 52 patients who had recollection of their ICU stay and agreed to complete the Patient Pain Management Questionnaire. They compared patient satisfaction with pain management before and after implementation of the Non-verbal Pain Scale (NVPS). Although the "worst" level of pain was reduced after use of the NVPS (8.5 vs 7.2 on 10 point scale, $P = 0.04$), the reported level of pain was still very high. Gelinas et al. (2008) found that more than 50% of 99 intubated conscious patients reported pain whilst at rest and 80% during nociceptive exposure such as turning. In critically ill adults, Ahlers et al. (2010) found that nurses tended to report patient's pain higher 16% of the time and lower 12% of the time when compared to patient self-report.

Unconscious or sedated patients cannot communicate their level of pain using numeric pain rating scales (NRS) (0-to-10) and are therefore at risk for being inadequately medicated for pain (Ferguson et al., 1997; Hall-Lord et al., 1998). Furthermore, optimal sedation/analgesia is difficult to achieve in the critically ill and data shows that nurses adjust sedation/analgesia based on a wide range of information, including subjective assessments related to patient amnesia and comfort needs, need for prevention of self-injurious behaviour and efficiency of care (Ahlers et al., 2008; Dasta et al., 1994; Egerod, 2002; Payen et al., 2007; Weinert et al., 2001). Inaccurate pain assessments and resulting inadequate treatment of pain in critically ill adults can lead to significant physiologic consequences such as increased myocardial workload which can lead to myocardial ischaemia or impaired gas exchange which can result in respiratory failure (McArdle, 1999). Therefore, it is imperative that health care providers assess pain accurately in the non-communicative critically ill patients.

Pain assessment in the non-communicative/unconscious patient

The first step in providing adequate pain relief for patients is systematic and consistent assessment and documentation of pain (Chanques et al., 2006; Herr et al., 2006b). Identification of the optimal pain scales for non-communicative (cognitively impaired, sedated, paralysed or mechanically ventilated) patients have been the focus of several studies. To date, however, no one tool is universally accepted for use in the non-communicative patient (Herr et al., 2006b; Jacobi et al., 2002). Pain intensity may be quantified using behavioural-physiological scales in the non-communicative patients but healthcare workers' bias may influence perceptions of the patient's suffering (Christoph, 1991; Harrison and Cotanch, 1987; Kappesser et al., 2006; Puntillo et al., 2003). Puntillo et al. (1997) found that the pain behaviours most frequently reported by nurses in the critically ill abdominal or thoracic surgery patients ($n = 105$) were grimacing, frowning, or wincing (34%); vocalisation (24%); and restlessness (19%); no movement (38%).

The 2004 Thunder Project II, developed by the American Association of Critical-Care Nurses Task Force, identified behaviours displayed during procedures in 5957 critically ill adult patients at 169 sites (Puntillo et al., 2004). In this comprehensive examination of procedural pain-related behaviours, patients ($n = 4278$) who reported pain during a procedure (turning, suctioning, wound care, device removal) displayed five behaviours: grimacing (43%), rigidity (27%), wincing (24%), shutting of eyes (34%) and verbalisation of complaints (24%). In addition, they showed that patient's age and ethnicity or amount of sedation did not contribute to behavioural activity during a procedure. The presumption that sedation would decrease behavioural activity was not supported.

To identify pain behaviours in critically ill intubated patients, Gelinas et al. (2004) conducted a retrospective review of 183 pain episodes that occurred in the first 72 hours after the patients were intubated. Pain behaviours such as facial expressions, agitation, movement, compliance with ventilator, etc, were identified in nurses' notes 73% of the time, whilst physiologic indicators (BP, HR, arrhythmia) were found only 24% of the time. Specifically, facial expressions were identified 6% of the time, whereas, body movement occurred 59% of the time. These studies (Gelinas et al., 2004, 2006; Puntillo et al., 2002, 2004) led to the development of pain assessment tools in the non-communicative critically ill patients.

Adult behavioural pain assessment tools

In a recent critical review, Li et al. (2008) identified psychometric properties of six objective pain measures that were developed to assess pain in non-communicative critically ill patients. A common component of these behavioural pain tools is facial expressions. However the descriptors used to identify facial expression in these tools varies across tools. The most common tools in use today that include facial expression are summarised in Table 1.

The facial expression component of these tools varies in their behavioural descriptors and scoring ranges. Each tool describes wincing, frowning and grimacing differently with a different intensity of pain score. The development of facial expression component in most of these tools were derived from previously described instruments (Mateo and Krenzischek, 1992; McGrath et al., 1985; Payen et al., 2001; Puntillo et al., 1997), chart review (Gelinas et al., 2004), focus groups interviews (Gelinas et al., 2005), or nurses' intuitive knowledge of pain (Mateo and Krenzischek, 1992).

The Pain Assessment and Intervention Notation Algorithm (PAIN) (Puntillo et al., 1997) checklist of behavioural and physiological indicators of pain was derived from research literature and content validity was established by a panel of experts in critical care practice and pain. The Pain Behaviour Assessment Tool (PBAT) (Puntillo et al., 2004) was then adapted from the PAIN tool and Children's Hospital Eastern Ontario Pain Scale (CHEOPS) (McGrath et al., 1985). Even though, the PBAT's was extensively researched for reliability and validity of the facial expressions component of the tool, many of the research used was based on paediatric studies. Both the PAIN and PBAT algorithm were developed not as a scoring instrument but an observation tool to identify specific pain-related behaviours in patients who could respond to questions and were able to use a numeric rating scale of pain intensity.

The Post-Anaesthesia Care Unit Behavioural Pain Rating Scale (PACU BPRS) (Mateo and Krenzischek, 1992) and Non-verbal Pain Scale (NVPS) (Odhner et al., 2003) were adopted from previously established tools (Chambers and Price, 1967; Merkel et al., 1997). These tools were pilot tested in a specialised population of the Post-Anaesthesia Care Unit and Burn Trauma Unit, respectively. The PACU BPRS has four of the original eight categories for assessing three types of pain (acute, chronic and progressive pain) that were developed by Chambers and Price (1967). The four dimensions (restlessness, tense muscles, frowning or grimacing and patient sounds) range from none to severe (0–3) with total pain score ranging 0–12.

The NVPS consists of five dimensions (face, activity, guarding, physiological I and II). Each dimension ranges from 0 to 2 with total pain score ranging 0–10. The face and activity dimension of NVPS was patterned after the face, legs, activity, cry, consolability (FLACC) (Merkel et al., 1997) pain assessment tool. The FLACC was developed by clinicians to provide a simple, consistent method to identify, document, and evaluate pain in the paediatric population. One of the major limitations of the FLACC tool is the applicability of cry and consolability which are not appropriate for the critically ill, intubated adults. Thus, the NVPS used only the face and activity dimensions of FLACC tool.

The Behavioural Pain Scale (BPS) (Payen et al., 2001) was developed to assess pain in the mechanically ventilated patients. The BPS consists of three dimensions (facial expressions, upper limbs movement and compliance with ventilation) ranging from 1 to 4 points with total pain score ranging 3–12. The scoring of each facial expression from 1 (no response) to 4 (full response) was based on assumptions that these behaviours reflect increases in pain intensity in the critically ill as well. The facial expressions were derived from Prkachin's

(1992a,b) study of specific facial muscle actions related to pain states. Prkachin used the Facial Action Coding System (Ekman and Friesen, 1978) to measure facial actions during painful and pain-free periods on healthy adult volunteers. He divided facial expressions of pain into four groups by graded pain intensity: brow lowering, tightening and closing of the eye lids and nose wrinkling/upper lip raising. Payen et al. (2001) modified these facial expressions (Table 1) in the BPS to make it easy for the paired evaluators to rate.

A more recently developed tool, the Critical Care Pain Observation Tool (CPOT) (Gelinas et al., 2006) includes components of facial expressions that were derived from previous established tools, such as the PACU BPRS (Mateo and Krenzischek, 1992), PAIN Tool (Puntillo et al., 1997), and Behavioural Pain Scale (BPS) (Payen et al., 2001). The CPOT consist of 4 components with 0–2 rating for each behaviour: facial expression, body movements, muscle tension and compliance with the ventilator for intubated patients or vocalization for extubated patients.

In summary, facial expressions have not been rigorously tested in any of the above tools. If facial expressions are an essential component of pain evaluation tools, then scoring should be based on objective data related to facial expression during pain in the critically ill. Tools in use today include a wide range of facial expression descriptors such as no facial response, relaxed, smile to most extreme wince, frown, and grimacing. Experts (Li et al., 2008) suggest that more research is needed to identify facial indicators that reflect pain-related affective distress, to identify changes in facial pain behaviour that may occur with ageing to determine the effects of sedatives and the presence of an endotracheal tube and/or its securing device have on facial expressions of pain. Systematic identification of facial expression during pain is therefore crucial.

Study of facial expressions

The face reveals a wealth of information about human behaviour and emotions. The most frequently used pain behaviour in pain evaluation scales for patients who cannot orally communicate is facial expression (Ambuel et al., 1992; De Jonghe et al., 2003; Gelinas et al., 2006; Merkel et al., 1997; Odhner et al., 2003; Payen et al., 2001; Puntillo et al., 2002; Salmore, 2002; Warden et al., 2003). Facial expression has been studied for centuries, dating back to Charles Darwin's "The Expression of Emotions in Man and Animals" (Darwin, 1998) reporting observations and detailed explanations of why particular facial expressions occur with particular emotions (Black, 2002; Darwin, 1998). Ekman et al., experts in facial expressions studies, conducted extensive cross-cultural studies in determining if facial expressions are universal or specific to each culture (Ekman et al., 1969, 1987; Ekman, 1972, 1993, 1999; Ekman and Friesen, 1971). They demonstrated that observers' judgments of anger, disgust, fear, sadness, happiness and surprise made by preliterate people as isolated as New Guineans (Ekman and Friesen, 1971) were no different than judgments made by college students in eight literate cultures around the world (Ekman et al., 1987). They concluded that regardless of age, gender, and race/ethnicity, facial expressions are evidence of universal expressions across cultures with variation due to the expression itself, and in what the expression signifies to the person showing the expression and to others (Ekman, 1999). Their studies led to the development of the Facial Action Coding System (FACS) (Ekman and Friesen, 1978), which identifies distinct facial muscle movements during an emotional response. These facial muscle movements are typically identified through the use of slow action video and stop-frame feedback.

The basic elements of FACS are 44 action units (AUs). Each AU represents the movement of a single facial muscle or a group of muscles, which move as a unit. The 44 AUs can be reliably identified by trained FACS coders and can also be reliably graded on a 5-point scale for intensity (degree of muscle excursion). Once the pain expressions are identified, data on number of expressions per minute over the course of each condition can be derived (Ekman and Friesen, 1978). The FACS has been shown to be highly reliable in many studies and shows a distinct pattern of facial actions that are characteristic of pain (Ambuel et al., 1992; Craig et al., 1991, 1994, 2001; Craig and Patrick, 1985; De Jonghe et al., 2003; Prkachin, 1992a,b; Terai et al., 1998). Facial Action Coding is a complex manual process but advances in automated face analysis using computer vision are being developed (Cohn et al., 1999). Cohn et al. (1999) reported high concurrent validity with automated face analysis by feature point tracking and manual FACS in the brow, eye and mouth regions.

Facial expression in pain

Facial expression specific to pain has been studied (Craig et al., 1991, 2001; Craig and Patrick, 1985; Patrick et al., 1986; Poole and Craig, 1992; Prkachin, 1992a,b; Prkachin and Craig, 1985; Prkachin and Mercer, 1989) using the Facial Action Coding System (FACS) developed by Ekman and Friesen (1978). Several facial actions that correlated with pain that have been identified include lowered brows, raised cheeks, tightened eyelids, a raised upper lip or opened mouth, and closed eyes (Fig. 1) (Craig et al., 1991, 2001; Prkachin, 1992a,b). In the general population, Craig and Patrick identified facial expressions of acute pain-related facial activity (brow lowering, narrowing of the eye aperture from below, raising the upper lip, and blinking) (Craig and Patrick, 1985; Patrick et al., 1986). They used the FACS to identify facial activity associated with exposure to one noxious stimulus in healthy adults and identified six action units (AU) categories that occurred more frequently during exposure to the noxious stimulus than during a baseline experience.

Prkachin (1992b) focused on pain behaviour of healthy adults ($n = 41$), specifically facial expression during three different types of pain stimulus (electric shock, cold, pressure, and muscle ischemia). He identified four actions during pain, increasing in intensity or duration across all modalities using the FACS: brow lowering (AU4), tightening and closing of the eye lids (AU6/AU7), and nose wrinkling/upper lip raising (AU9/AU10). Hadjistavropoulos et al. (2000) examined the validity of non-verbal measures in detecting pain amongst seniors who were experiencing movement-related exacerbations of musculoskeletal pain and documented the utility of behavioural coding of pain-related body/limb movements (e.g., bracing and guarding). The results demonstrate that FACS not only discriminates between pain and absence of pain but can also provide information about the variability of the pain experience (Hadjistavropoulos et al., 2000, 2002).

In another study to evaluate gender differences in facial expressiveness to pain, Kunz et al. (2006) used FACS, focusing on 4 AUs: brow lowering (AU 4), tightening of the orbital muscles surrounding the eye (AUs 6/7), nose wrinkling/upper lip raising (AUs 9/10) and eye closure (AU 43). They found that in young and pain-free individuals (male $n = 20$, female $n = 20$) that men and women were equally facially expressive during tonic heat stimulation at non-painful and at painful intensities. These observations are similar to previous findings of lack of gender differences in the facial expressiveness of pain (Craig et al., 1991; Prkachin, 1992a,b).

FACS provides an objective assessment of facial reactions that are most reflexive and automatic non-verbal indices of pain. Even though, facial expressions have been identified in infants, children, adults and the elderly using FACS, there is little empiric evidence of its utility in the critically ill patients. More research is needed to identify facial expressions during pain in the critically ill patients.

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Conclusion

Pain assessment is a significant challenge in critically ill adults, especially those who are unable to communicate their pain level. Unfortunately in critical care, many factors alter verbal communication with patients including tracheal intubation, reduced level of consciousness, sedation and administration of paralysing drugs. Therefore, accurate assessment of non-verbal pain behaviours such as facial expression, especially in the critically ill, is important. Facial expressions provide a critical behavioural measure for the study of emotion, cognitive processes and social interaction (Ekman, 1999). Understanding facial expressions may assist in the development of strategies to enhance pain assessment tools. Tools currently available to assess pain in the non-communicative critically ill patient are not universally accepted and provide a wide range of descriptors of facial expressions. Interestingly, most of the facial descriptors identified in the pain assessment tools are of the upper face (eyes and brow) and using the Facial Action Coding System to study facial expressions in this region may be feasible since other facial areas (mouth, nose) are often distorted by the presence of an endotracheal or nasogastric tubes. Specifically, Facial Action Coding data may provide empirical evidence to use facial expressions accurately in assessment tools that are appropriate, practical, reliable and valid across patient populations.

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Facial expression correlated with pain using the Facial Action Coding System

Description	Action Unit
Brow lower	AU4
Cheek raised	AU6
Lid tightened	AU7
Nose wrinkle	AU9
Upper lip raiser	AU10
Lip corner puller	AU12
Lip stretcher	AU20
Lip presser	AU24
Lips parted	AU25
Jaw drop	AU26
Mouth stretched	AU27
Eyes closure	AU43
Blink	AU 45

Natural Expression | Pain Expression

Figure 1.

Facial expression correlated with pain using the Facial Action Coding System.

Table 1

Pain assessment tools used in the non-communicative patients.

Scale	Facial Behaviour Descriptors and Scoring	Validity and Reliability Studies for Facial Behaviour Component
The Pain Assessment and Intervention Notation (PAIN) Algorithm	Checklist • Grimacing, frowning, wincing • Drawn around mouth and eyes • Wrinkled forehead • Teary/crying	Puntillo et al. (1997) • Validated by performing five pain assessments for the presence or absence of the pain behaviours post-operative patients using behavioural indicators, the 0–10 numeric rating scale of pain intensity and patient self-report pain rating ($n = 31$) • Facial pain behavioural most frequently reported was grimacing, frowning, or wincing (34%); drawn around mouth and eyes (9%); and wrinkled forehead (16%), and teary/crying (4%) • Content validity established by a panel of experts clinicians • No inter-rater reliability reported
Pain Behaviour Assessment Tool (PBAT)	Checklist • Grimace • Frown • Wince • Eyes closed • Eyes wide open with eyebrows raised	Puntillo et al. (2004) • Validated in 5957 subjects (169 sites) comparing behaviours before and during the procedure (turning, central venous catheter insertion, wound drain removal, wound care, tracheal suctioning and femoral sheath removal). More behaviours exhibited during procedural pain ($p < .001$) • Facial behaviours exhibited during procedural pain: Grimace 42.8%, Eyes closed 33.7% and Wince 23.7%, ($n = 4278$)
PACU Behavioural Pain Rating Scale (BPRS)	• Looking away in opposite direction of the pain • Grin/smile • Mouth wide open to expose teeth and tongue • Clenched teeth exposing slightly open mouth • None • Unable to assess • Other • Does not frown forehead or grimace 0 • Slight frowning and grimacing 1 • Moderate frowning and grimacing 2 • Constant frowning and grimacing 3	• Mateo and Krenzischek (1992) (English version) • Validated by 10 minute periods of observation of pain behaviour within the first hour of arrival at the PACU ($n = 30$ patients) • Content validity established by a panel of experts • Internal consistency of scale (Cronbach $\alpha = .92$) • Inter-rater reliability for each category of the scale ($r = 0.71$–1.0) • Frowning or grimacing correlated to self-reported pain ($r = 0.69$, $p < 0.05$) Persson and Ostman (2004) (Swedish version) • The reliability of the Swedish version was tested by performing test–retest and inter-rater reliability in clinical conditions of post-operative pain after arrival at the PACU ($n = 49$) • Test–retest reliability between two observers showed good agreement in frowning or grimacing ($\kappa = 0.274$, 69.3% concordance) • Inter-rater reliability between two observers showed high concordance for frowning or grimacing (Cronbach $\alpha = .0.615$, 90% concordance observer 1 and 2); (Cronbach $\alpha = 0.621$, 91% for observers 1 and 3) ($n = 11$)
Non-verbal Pain Scale (NVPS)	• No particular expression or smile 0 • Occasional grimace, tearing, frowning, wrinkled forehead 1 • Frequent grimace, tearing, frowning, wrinkled forehead 2	Odhner et al. (2003) • Validated by comparing NVPS and the FLACC ($n = 59$) • Strongest inter-scale correlations were seen between NVPS and FLACC: facial assessment components ($r = 0.78$, $p < 0.0001$) • Internal consistency: NVPS – Cronbach $\alpha = 0.78$; FLACC Cronbach $\alpha = 0.84$ • Inter-rater reliability for both the FLACC and the NVPS reported as good

Scale	Facial Behaviour Descriptors and Scoring	Validity and Reliability Studies for Facial Behaviour Component
Face, Legs, Activity, Cry, Consolability Observational Tool (FLACC)	• No particular expression or smile 0 • Occasional grimace or frown, withdrawn or disinterested 1 • Frequent to constant quivering chin, clenched jaw 2	Merkel et al. (1997) • Test the reliability of FLACC tool by measuring changes in scores in response to administration of analgesics in post-operatively after the child was awake and arousable ($n = 89$) • Validity showed higher preanalgesia scores than post-analgesia scores ($p < 0.001$) • Positive correlation between Objective Pain Scale (OPS) and FLACC scores ($r = 0.80$; $p < 0.001$) Positive correlation ($r = 0.41$, $p < 0.005$) between FLACC scores and PACU nurses' global rating of pain • Inter-rater reliability: two observers ($r = 0.94$; $p < 0.001$) and 69% agreement between observers, ($\kappa = 0.52$) for facial expression
Behavioural Pain Scale (BPS)	• Relaxed 1 • Partially tightened (e.g., brow lowering) 2 • Fully tightened (e.g., eyelid closing) 3 • Grimacing 4	Payen et al. (2001) • Validated during three assessments at rest and during a procedure [non-nociceptive (central venous catheter dressing change or compression stocking) and nociceptive (suctioning or turning)] in 30 mechanically ventilated patients (301 observations). BPS scores increased during painful procedure ($p < .01$) • Principal component first factor analysis accounted for 55% of the variance in pain expressions, with coefficients of $r = .789$ for facial expression • Inter-rater reliability between a pair of evaluators (nurse and nurse's aide) [weighted κ coefficient = 0.74 ($p < .01$)] • Validated during rest and painful procedures (tracheal suction and peripheral venous cannulation) ($n = 30$) • BPS scores increased during painful procedures, ($p < 0.001$) • Principal component first factor analysis accounted for 65% of the variance in pain expressions, with coefficients of $r = 0.90$ for facial expression • Intraclass correlation coefficient for facial expression was 0.91 (95% CI, 0.88–0.93) • Intraclass correlation coefficient (ICC) to evaluate inter-rater reliability was high (0.95) Young et al. (2006)[a] • Validated during painful (repositioning) and non-painful (eye care) procedures ($n = 44$) • Internal consistency: Cronbach $\alpha = 0.64$ • Inter-rater reliability between two raters tested in 11 patients: good agreement (82–91%) for pre-procedure assessments; lower agreement post-procedure, with agreement after eye care assessments ranging between 64 and 73% and agreement after repositioning ranging between 36 and 46%
Critical Care Pain Observation Tool (CPOT)	• Relaxed, neutral: no muscular tension observed 0 • Tense: presence of frowning, brow lowering, orbit tightening, and levator contraction 1 • Grimacing: all of the above facial movements plus eyelid tightly closed 2	Gelinas et al. (2006) (French version)[a] • Validated during three assessments (rest, noxious procedure (turning) and recovery) in 105 cardiac surgery patients. Significant increase in CPOT scores during turning ($p < .001$) • Inter-rater reliability between two raters was moderate to high at all assessments (weighted κ coefficients ranged from 0.52 to 0.88) • Criterion validity for mean CPOT scores according to patients' self-reports of the presence or absence of pain during the second testing period was significant ($p \le 0.005$)

Scale	Facial Behaviour Descriptors and Scoring	Validity and Reliability Studies for Facial Behaviour Component
		• Discriminant validity for the differences in scores on the Critical-Care Pain Observation Tool measured at rest before the procedure (T1, T4, and T7) and during the procedure (T2, T5, and T8) was significant ($p < 0.001$) • Content validity of the CPOT was established with 4 physicians and 13 critical care nurses Gelinas and Johnston (2007) (English Version)[a] • Validated during nociceptive procedure (turning) and non-nociceptive procedure (non-invasive blood pressure) before, during and 20 minutes after the procedures CPOT scores increased during turning ($n = 55$, $p \leq 0.001$) • Intraclass correlation coefficients (0.80–0.93) high in all six assessments

[a]Facial expression component not separately evaluated or reported.