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Acute Pain Management

Gerald Chanques
Professor of Anaesthesiology and Critical Care
Department of Anaesthesia & Critical Care Medicine
Saint Eloi Montpellier University Hospital
PhyMedExp
University of Montpellier
INSERM, CNRS
Montpellier, France
gerald.chanques@umontpellier.fr

Pain Assessment in Critical Illness

This narrative paper reports the practical assessment of pain in critically ill (ICU) patients, based on current evidence and guidelines.

Introduction

Pain is one of the top stressful symptoms experienced by critically ill patients hospitalised in intensive care units (ICU) (Chanques et al. 2015). This is because critical pathologies are often severely painful (i.e. trauma, surgery, acute pancreatitis…), and because intensive care is basically invasive (multiple catheters and tubes, mechanical ventilation, forced immobilisation on bed…). Thus, most critically ill patients will experience pain during their ICU stay, at rest, or during procedures or mobilisation (Chanques et al. 2006; Puntillo et al. 2014). Also, other causes of pain are related to medical complications that may occur during the ICU stay, such as surgical complications, pneumothorax, phlebitis, myocardial infarction, etc. It is consequently paramount that nurses and physicians are able to detect pain using accurate and sensible tools, even in the most critically ill patients who may not be able to communicate their pain. Moreover, because analgesics can be associated with serious side effects, it is of top priority to measure pain intensity with validated tools, in order to titrate the dose of analgesics, and to minimise the risk of their overuse. Pain assessment, protocolised analgesia, and sedation based on analgesia first are all strategies proved to be associated with patients' outcome in ICU (Chanques et al. 2006), leading to the elaboration of practice guidelines for years (Vincent et al. 2016; Devlin et al. 2018; Chanques et al. 2018a). Pain assessment is the key component of pain management in ICU patients as in other patient populations, even if ICU patients are often unable to communicate, sedated, paralysed, or delirious. The aim of this article is to discuss how to assess pain in the different clinical situations met in the ICU setting.

Patients Able to Communicate (Either Intubated or Nonintubated): Self-Assessment

The priority for pain assessment is to have patients themselves evaluating their pain. Yet, many barriers exist, such as mechanical-ventilation precluding verbal assessment, and physical restraints, which are still often used in European ICUs with high patient-to-nurse ratios. These barriers are more barriers built by health caregivers than by patients themselves. Indeed, intubation is not associated with patient failure to self-report pain intensity using common pain scales, if patients are able to follow simple commands (Chanques et al. 2010). Not trying to ask such patients to self-report their pain could be related to a mental barrier based on prejudgment or anticipated difficulty. Common self-report scales include the Verbal-Descriptor-Scale (VDS), the Visual-Analogical-Scale (VAS), and the 0-10 Numeric-Rating-Scale (NRS).

The VDS has five intensity descriptors: no pain, mild pain, moderate pain, severe pain, and extreme pain. Its use may be difficult in non-verbal patients (i.e. intubated patients) but clinicians can show their five fingers to figure the five levels of the scale, helping patients indicate their level of pain directly on the clinician's hand. VAS that has a 10-cm length can be a little more difficult to use in ICU patients because it may be impossible for them to use the scale's cursor precisely in case of weakness. The 0-10 NRS, when administered visually (and not orally) using a printed scale (A4 paper size with large numbers), is the most feasible scale (91% of patients able to follow simple commands are able to use it, whether they are intubated or not) and has the best negative predictive value (90%) compared to other scales (VDS and VAS) (Chanques et al. 2010). Non-verbal (intubated) patients can choose to show the number directly on the scale, or to communicate it with their 10 fingers, especially in case of severe ICU acquired weakness (**Figure 1**). Clinicians may help the patients by supporting their arm to point out the number directly on the scale.

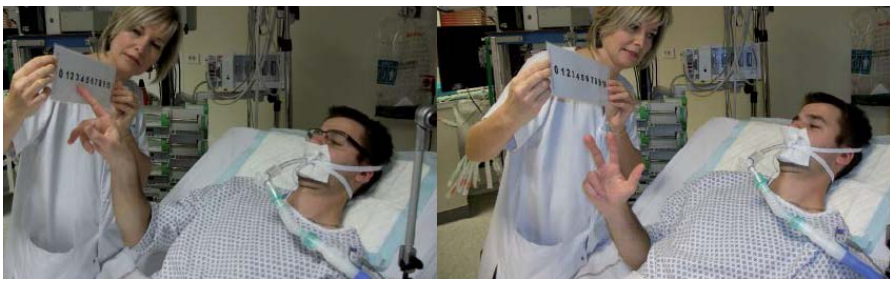

Figure 1. 0-10 Visually enlarged Numerical Rating Scale. Source: Chanques et al. 2010

In case a patient cannot use the NRS, other scales can help, especially the VDS. If this is not possible either, a simple yes/no question - "do you have any pain?" can be asked. However, this simple yes/no question is not recommended to be used solely. Indeed, if used at first, a patient will frequently answer no but could eventually rate her or his pain from 1 to 10 on the NRS, being able to localise pain on body, and even asking for pain relief.

This apparent discrepancy, suggested

by a negative answer to the simple yes/no question, can be explained by the specific context of critical illness and intensive care. For example, an ICU patient who has just undergone surgery may consider that it could be normal to have some pain, or that pain is less severe than expected. Also, patients can figure that the question refers to the surgical site rather than other parts of the body. Specific types of pain (headache, back pain…) may be considered usual and chronic, or even benign because they are not directly related to the surgery or to the admission in ICU. However, some localisations that could be considered insignificant are paramount for the clinicians, such as shoulder pain after abdominal surgery that can be related to subphrenic abscesses, or pain on a leg, that can be the very first symptom of phlebitis. Moreover, patients can be reluctant to receive opioids, or not complaining about catheters or drains considered as fundamental to their recovery. In mind, several examples of the detection of the "syndrome of no pain but 5/10 rating if I am asking for" can save lives (**Table 1**).

Compared to the yes/no question and even to the VDS, the NRS is much more sensible to detect any pain (Chanques et al. 2010). It is like if the verbal questions (yes/no question or VDS) address a highly complex cerebral task leading to a conclusion that may falsely occult the reporting of all sorts of pain. On the opposite, numerical scales are used by patients more like a basic self-scan of their body, with less interpretation, leading to detect all sorts of pain (chronic pain, localisations that would seem insignificant in the global context…). For the clinician, numerical scales allow for recognition of pain as an alarm, what nociception is made for: a life-saving system.

In all, numerical scales should be preferred as first line self-report pain scales, while VDS or especially the simple yes/no question should probably be reserved as back-up methods, in patients unable to use the numerical scales.

Finally, there is a recent tendency to prefer positive communication and to use positive (non-negative) words. Coming from conversational hypnosis, it could be a real innovation in nursing and medical behaviour. Pain, a negative experience, could rather be replaced by comfort, a more positive word. Rather than asking patients if they have any pain, it could be asked if they are comfortable. However, as said before, seeking after a painful alarm point was a real progress in global management of ICU patients, from a diagnosis perspective. Thus, these two approaches should be complementary. Beginning with the positive and relaxing approach ("are you comfortable today?") could be preferred, followed by the research of any pain alarms.

Example	Action	Impact
I rate 10, and I really have no pain	Re-explain the use of the scale, some patients may rate analgesia rather than pain.	Moderate
I rate 2, and I consider this is no pain (no need of treatment)	Ask where pain is located, even if 2/10, make a diagnosis (can be a phlebitis, or a skin ulcer that will make the diagnosis of rickettsiosis)	Potentially critical
I rate 5, but this is usual when I lay on a bed that's not mine, you know, I worked 20 years as a builder. I take acetaminophen only when it is 6.	Mobilise as soon as possible (bed seating, standing up if possible, move to seat), look for the best position in bed (and always consider a disease related to critical illness: osteitis, osteoporosis)	Possibly important
I rate 5, but it is alright, I don't want you to order opioids, they make me vomit (or being constipated).	Ask where pain is located, make a diagnosis, propose non-pharmacological therapies (music therapy, hot-water bottle, cold…); consider non opioids (multimodal analgesia, nefopam, lidocaïne…)	Possibly important
I rate 8, it is related to the nasogastric tube. I answered NO when you asked me if I had pain, because I got chewed out by your colleague when I said the tube was painful yesterday, I was told not to talk about it because the tube was vital. But if you insist with your pain scale…	Check if the gastric tube is still necessary, remove it as soon as possible (in the present case, bag was empty, and tube was removed immediately, decreasing pain from 8 to 0).	Critical
In all situations of apparent discrepancy between the YES/NO question and the numerical rating…	… ask patients why they answered NO at first!	Important for learning and experience
I rate 7 on the stomach area (the patient has a severe mood disorder, and answered NO to everything: pain, anxiety, thirst, switching on TV, opening curtains…).	Perform an electro-cardiogram (ECG) systematically (in the present case, 40-yo woman admitted for acute on chronic liver failure related to C viral chronic hepatitis refractory to interferon, ECG shows a ST+, leading to transfer the patient to the coronarography unit immediately.)	Potentially critical
I rate 7, but I cannot localise pain.	Check cognitive functioning (delirium), consider using a behavioural pain scale.	Critical, lead to delirium management

Table 1. Examples highlighting the syndrome of "I have no pain (answering the yes/no question "do you have any pain?") but I rate a number ≠ 0 on the numerical scale if it is shown to me".

Warning about the use of self-report pain scales

After having tried to promote a systematic and thorough use of self-report pain scales, in order to sensitise the recognition of pain, it is important to say that no number should lead to a systematic ordering of analgesic drugs, even for a NRS>6 which indicates a severe pain that requires opioids in most patients. Some types of pain are considered sufficiently acceptable for patients, so that it is unnecessary to prescribe analgesics that can expose the patient to undesirable side-effects. It is, however, important to take into consideration all sorts of pain. For example, a patient with back pain history may not complain of it or ask for analgesics. But because we know this kind of pain may severely increase after days of immobilisation, the early recognition of this kind of pain should encourage mobilising the patient immediately if possible.

Patients Unable to Communicate (Either Intubated or Nonintubated): Observational Behavioural Scales

In some patients, clinicians may fail to use a validated self-report pain scale: patients may rate different numbers inconsistently, or rate a number different to zero but would be unable to localise their pain, or even, may absolutely not follow any command or answer any questions, precluding any use of a self-report pain scale. This is the case for some patients with delirium, one of the top risk of self-assessment failure in ICU (Chanques et al. 2010). Moreover, in deeply sedated patients who are unable to follow simple commands, self-reporting is not appropriate as well.

In these situations, the recommended assessment of pain is based on the observation, by clinicians, of the patient's pain behaviour. To standardise the assessment of pain, several behavioural tools have been elaborated for the past twenty years (Gelinas et al. 2019). Two of them are very close, demonstrating similar psychometric properties and performance to recognise pain in adult ICU patients (Chanques et al. 2014; Gelinas et al. 2019): the Behavioral Pain Scale (BPS, originally elaborated and validated by Jean-François Payen's team in France) and the Critical Care Observation Pain Tool (CPOT, originally elaborated and validated by Céline Gélinas' team in Canada). Both scales (Payen et al. 2001; Gélinas and Johnston 2007) have been translated and validated in many different languages across the world.

BPS contains three behavioural domains (**Figure 2**): facial expression, upper limb movements, and adaptation to the mechanical ventilator. BPS has been adapted to non-intubated patients, switching the ventilator domain by a vocalisation and verbal domain (Chanques et al. 2009). Each of the 3 domains of the scale includes 4 descriptors from 1=no pain, to 4=maximal pain behaviour. In all, BPS (or BPS for non-intubated patients) can range from 3x1=3 to 3x4=12. A pain threshold of ≥ 5 or 6 was established by discriminative validation studies, and included in pain management protocols (Chanques et al. 2006; de Jong et al. 2013). A threshold of 5 can be used in intubated patients receiving an analgesia-sedation protocol, to give priority to analgesics while minimising the use of sedatives (Chanques et al. 2017a).

The main difference between BPS and CPOT is that BPS has three behavioural domains, each rated using four descriptors, while CPOT has four domains, each rated using three descriptors (from 0 to 2). The muscular domain is subdivided in two parts for the CPOT: tonus+movement. CPOT ranges then from 4x0=0 to 4x2=8. BPS and CPOT have been validated in non-communicant ICU patients, intubated and non-intubated, sedated or delirious, and even in patients with brain injuries. However, if the use of BPS and CPOT is possible and validated in brain-injured patients, their psychometric properties are modified somewhat by neurological injuries. Specific pain behaviour has been described in patients with brain injuries, such as tearing, face flushing and yawning. The Nociception Coma Scale (NCS, from Liège Coma Science Group, Belgium) was elaborated and validated in non-intubated brain-injured patients (Schnakers et al. 2010), and recently adapted to intubated patients (Bernard et al. 2019). CPOT has recently also been adapted for brain-injured patients (Gelinas et al. 2021). However, because original BPS and CPOT keep accept-

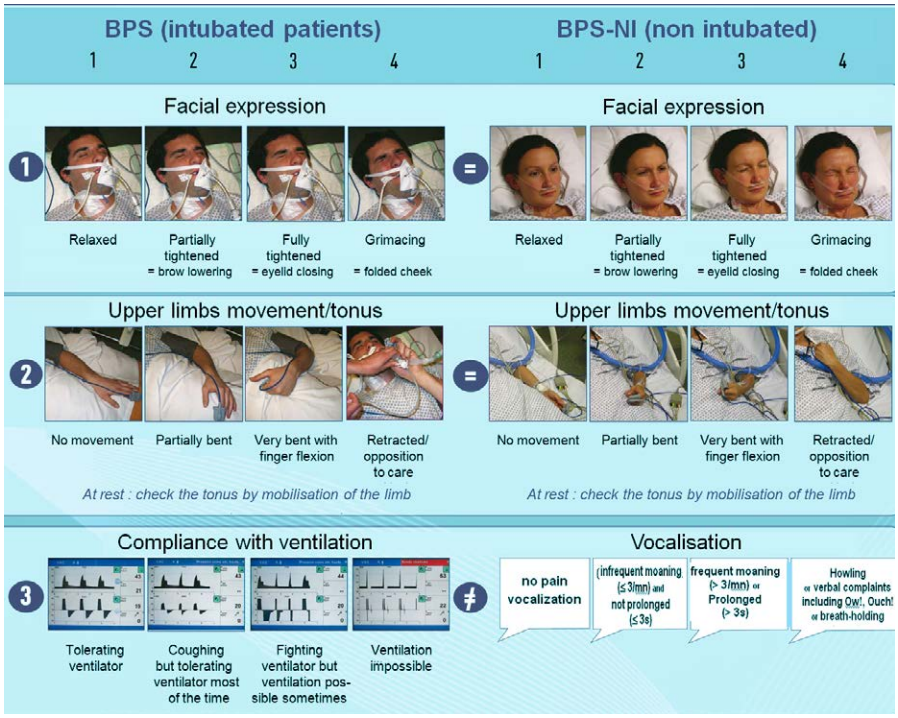

Figure 2. Behavioural Pain Scale (BPS). Source: Payen et al. 2001; Chanques et al. 2009

able psychometric properties in brain-injured patients (Joffe et al. 2016; Bernard et al. 2019), some polyvalent, non-neurological ICUs may prefer using the original version of the scale in all patients, rather than multiply the number of scales in the same ICU.

Warning about the use of behavioural pain scales

Some patients may suffer from the use of behavioural pain scales! Indeed, we often hear clinicians do not believe a patient who communicates a moderate to severe pain intensity (i.e. 4/10 or more), because there is absolutely no pain behaviour observable (BPS=3: CPOT=0). To understand this apparent discrepancy, we should remember that the statistical correlation between self-report pain scales (NRS, VAS, VDS) and behavioural pain scales is very low in patients able to communicate (Chanques et al. 2010). Moreover, implementation of behavioural pain scales may be associated with a decreased use of self-report pain scales, even in patients who are able to communicate (based on our experience, and regular quality control surveys at our institution). One possible reason is that it could be easier and quicker to just give a look at the patients and rate their behavioural score, than to wake them up if they may be sleeping (good reason), or even than to talk to them (bad reason). It is thus paramount to remember that:

- Human beings always underrate others' pain intensity: nurses, physicians and even relatives underrate patients' pain intensity compared to patients' self-assessment of their own pain (Ahlers et al. 2008).
- For this reason, self-assessment of pain by patients themselves is strongly recommended by all medical societies (Devlin et al. 2018).
- Behavioural pain scales should be used only if patients are not able to self-report their pain intensity.
- Behavioural pain scales were basically designed to assess pain in patients unable to communicate.
- Behavioural pain scales were validated in such populations of patients (patients under sedation, or patients with delirium).
- Social behaviour is modified by vigilance and psychological status.

If any doubt persists regarding the reality of a patient's suffering related to a given self-reported pain intensity, clinicians should:

- Make sure that the patient understood correctly the use of the pain scale (often, patients inverse the numbers, 10 meaning very good analgesia for example).
- Ask the patient to localise their pain in order to assess the consistency of the pain assessment.
- Ask the patient if they would like to receive or not a treatment for this pain.

Patients Unable to Communicate and Without Any Behaviour (Deep Sedation, Paralysis): Electrophysiology

For deeply sedated patients, it is recommended to use a validated behavioural pain scale (e.g. BPS, CPOT), as for moderately sedated patients who are not able to communicate (Devlin et al. 2018). Whether electrophysiology may improve the detection of subclinical pain in order to help managing analgesics and sedatives in deeply sedated patients requires further research. For deeply sedated patients who receive neuromuscular blocking agents (NMBA), the complete paralysis of body muscles preclude any use of behavioural pain scales (which remain usable in case of incomplete paralysis, such as acquired ICU weakness: at least the facial domain of the behavioural pain scales can still be used, facial muscles being generally preserved).

No recommendation can be made today regarding the use or not of an electrophysiological measurement of pain and stress during paralysis (Murray et al. 2016). It is recommended to ensure deep sedation and analgesia before using NMBA, and to interrupt NMBA on a regular basis to check the clinical level of sedation and the absence of pain (Murray et al. 2016; Chanques et al. 2020).

During paralysis, the observation of a change in continuously monitored vital signs (i.e. heart rate, arterial blood pressure) during a nociceptive care procedure should help determine the need for strengthening analgesia. However, change of vital signs is much less sensible than behavioural pain scales in non-paralysed patients (Gelinas et al. 2019). It is why behavioural pain scales are recommended to be used systematically to assess pain in non-paralysed, non-communicant patients, rather than the only observation of vital signs.

To enhance the electrophysiological measurement of stress response, related to pain or other stressful factors (e.g. anxiety, fear…), new devices have been developed recently. All these devices are based on the measurement of surrogate markers of the adrenergic response: increase of the pupillary diameter (measured by videopupillometry), decrease of physiological Heart Rate Variability (HRV) related to a decrease of parasympathetic tone (meaning an increase of sympathetic tone), or other parameters, for example the increase of electric skin conductance due to increased sudation.

Literature is contrasted regarding the validity of videopupillometry to detect pain in critically ill patients. A study reported at first that videopupillometry was more sensible for pain detection than the behavioural observation in deeply sedated patients (Li et al. 2009). However, subsequent studies using validated behavioural tools, reported that videopupillometry could not recognise pain during nociceptive care procedures (Bernard et al. 2019). Then, a new strategy was developed, not to measure pain during a care procedure, which is basically highly challenging using a videopupillometer at the same time of doing the procedure, but to measure the pupil dilation, induced by electrical stimulation of the skin. This strategy was able to define subclinical thresholds of pain that are predicting of clinical pain during a real nociceptive care procedure (Vinclair et al. 2019). Following this strategy, it might be possible to avoid any pain response

related to care procedures. This could be very relevant in some patients at high risk of increased stress response (e.g. patients with severe intracranial hypertension). The limit of this strategy is that it can be used only in deeply sedated patients because electrical stimulation is painful in non-sedated patients, and also because pupillary diameter is highly reactive in non-deeply sedated patients.

The analysis of HRV has been increasingly developed in commercialised devices. The Analgesia Nociception Index (ANI) is much more sensible than behavioural pain scales to detect nociception in sedated patients or non-sedated patients (Chanques et al. 2017b; Chanques et al. 2018b). In the absence of studies evaluating the use of HRV devices to help managing analgesics, the routine use of HRV cannot be recommended because of a risk of an overuse of analgesics (especially opioids), due to a high sensibility of the device. In patients who were paralysed, ANI demonstrated a better performance to detect tracheal aspiration than the bispectral index (BIS) monitoring, that was not modified by the recovery from paralysis, contrary to the BIS (**Figure 3**).

Finally, the use of electroencephalogram derived parameters (e.g. BIS), is not recommended in routine in the ICU setting, either in paralysed and non-paralysed patients, because of the high proportion of false positive and false negative measurements of sedation (Murray et al. 2016; Chanques et al. 2020).

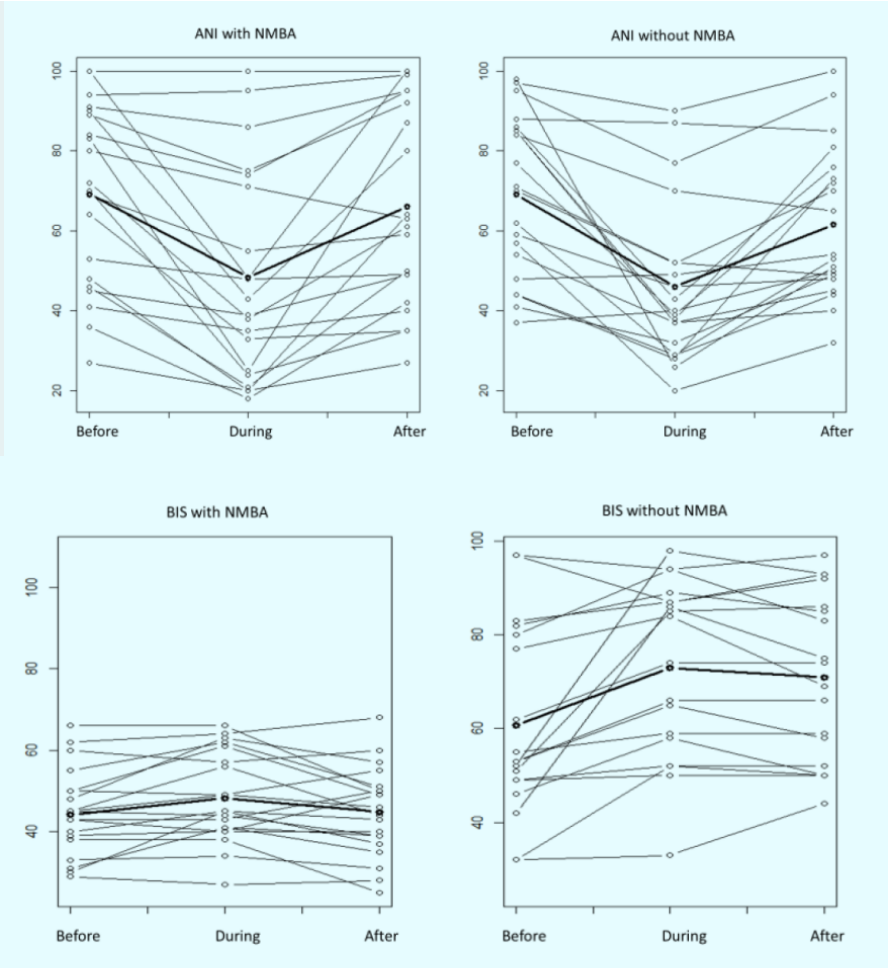

Figure 3. Pain assessment using electrophysiology in paralysed critically ill patients receiving neuromuscular blocking agents, before, during, and after tracheal suctioning.
Analgesia Nociception Index (ANI) is a surrogate marker of the sympathetic/parasympathetic tone balance using Heart Rate Variability analysis. ANI significantly decreased during tracheal suctioning, suggesting that parasympathetic tone decreased, or sympathetic tone increased (stress response related to the nociceptive care procedure) (upper left panel). This decrease was reproduced just after recovery from paralysis (upper right panel). The bispectral analysis of the electro-encephalogram (BIS) increased during tracheal suctioning, suggesting a cortical awakening related to the nociceptive procedure, but in a less discriminative fashion than ANI (lower left panel), including after interruption of paralytic agents, where BIS measurement was modified by electromyogram activity related to the recovery from paralysis, even with a specific electromyogram filter (lower right panel). From Voeltzel J 2020, MD thesis, Montpellier University, France.
ANI: Analgesia Nociception Index; NMBA: Neuromuscular Blocking Agents; BIS: bispectral analysis

Warning about the use of electrophysiology

When an electrophysiological monitoring is used in paralysed patients, it should be used only to detect a possible awakening, or a possible increase of stress response (pain, anxiety…). This observation should make consider strengthening sedation and analgesia until the next NMBA window, which is recommended to assess patients' comfort clinically. Pending further studies, these monitoring tools should not be used to decrease sedatives and analgesics. Indeed, it has been reported that a significant proportion of patients can be clinically awake just after the interruption of NMBA, despite an electrophysiological monitoring (BIS) indicating the inverse (Tasaka et al. 2016).

Conclusion

The assessment of pain in ICU patients has been more clearly standardised (**Figure 4**) since the beginning of the century, based on the elaboration of different clinical pain assessment tools adapted to the critically ill patients' condition (unable to communicate or not). These tools have been validated at a large scale in different cultures, and included in studies reporting improved outcomes when pain assessment was standardised and systematic. Thus, their use is now recommended by national and

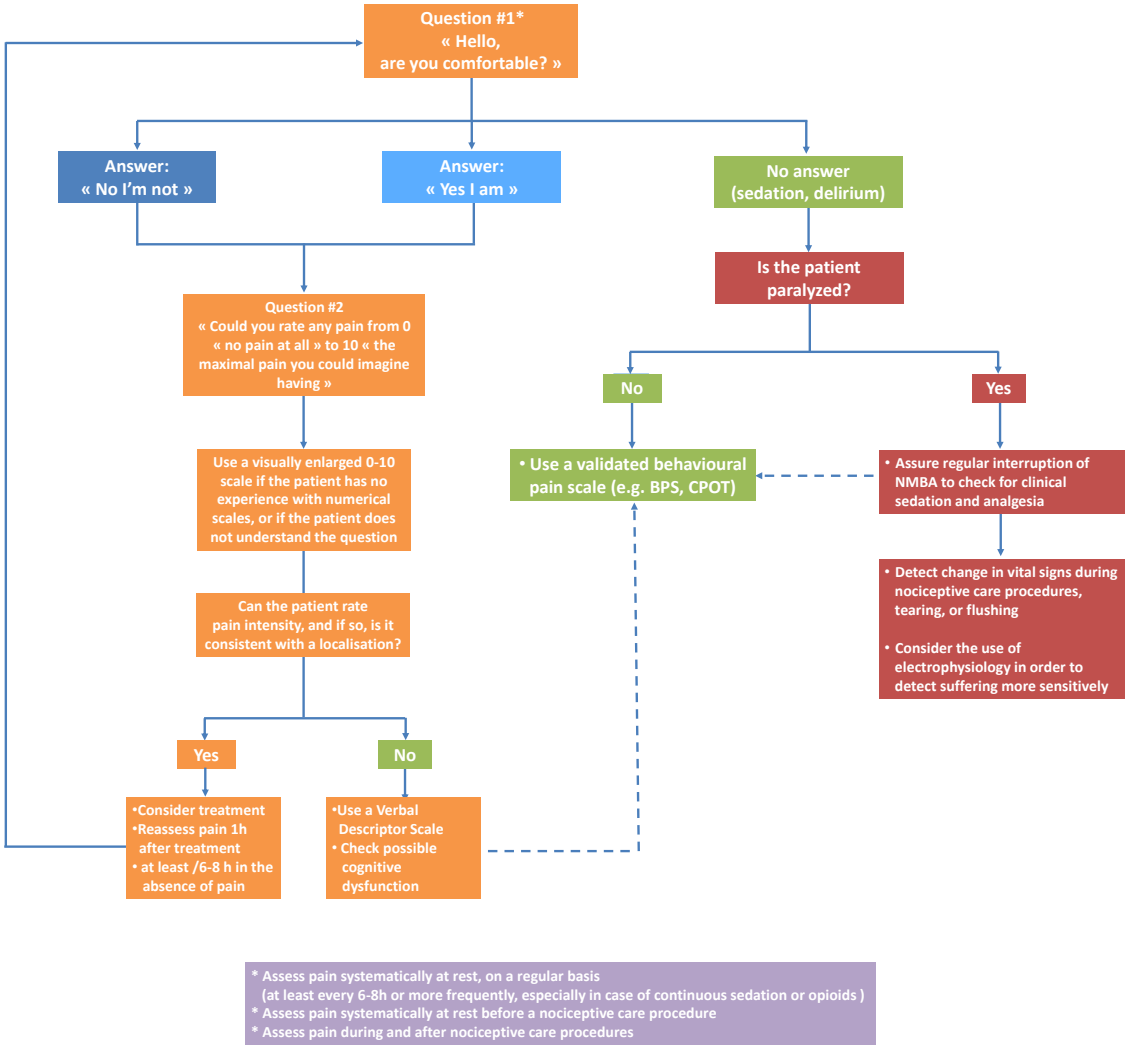

Figure 4. Pain assessment algorithm

international practice guidelines. New technology has been developed also to monitor pain electrophysiologically. These techniques should not be used in place of asking patients what they feel, but in some situations where clinical tools cannot be used, especially during pharmacologically induced paralysis. Further studies are needed to evaluate protocols of use of these new technologies in these situations, with the objective to better manage opioids and sedatives, avoiding their overuse and side effects, while ensuring patient comfort.

Conflict of Interest

None. ■

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