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SPECIAL ISSUE INSIGHT

Monitoring pain in the intensive care unit (ICU)

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Most patients report pain during their stay in the intensive care unit (ICU). Pain is multifactorial and can be caused by critical illness, invasive treatment, and standard care procedures [1, 2]. Moreover, pain can induce stress responses that may play an important role in critical illness (e.g., tachycardia, polypnea, increased oxygen consumption), as well as long term psychological stress [1]. Therefore, it is paramount that nurses and physicians be able to monitor and detect pain using valid tools, to titrate analgesic doses, minimise their overuse and serious side-effects, as well as to detect medical complications during ICU stay. Monitoring pain is associated with improved patients' outcomes in ICU (e.g., decrease in sedative use, reduction of mechanical ventilation duration and length of stay) [3, 4] and should be adjusted to the patient's condition (Fig. 1) [1]. The same tool should be used in a given patient with a given condition to monitor change.

Patients able to self-report: self-assessment tools

Pain is a personal experience and the patient's self-report (gold standard) should be obtained whenever possible. Common self-report pain scales include the verbal description scale (VDS), the visual analogical scale (VAS), and the 0–10 numeric rating scale (NRS). The VDS includes 5 descriptors "no pain", "mild pain", "moderate pain", severe pain", and "extreme pain". Clinicians can show their 5 fingers to figure the 5 pain descriptors, helping patients indicating their level of pain directly on the clinician's hand. VAS that has a 10-cm length can be more challenging to use in ICU patients because it may be difficult for them to move the scale's cursor in case of weakness. The 0–10 NRS, when administered visually using a printed scale (A4-paper size with large numbers), is the most feasible scale (91% of patients following simple commands are able to use it, whether they are intubated or not) (Fig. E1) [5]. Having a tracheal tube should not be considered as a systematic failure to self-report, and patients able to follow simple commands should be encouraged to express their pain intensity using a pain scale (Fig. E1) [5]. In the case a patient cannot use pain intensity scales, a simple YES/NO question "do you have any pain?" can be used. However, some patients may answer NO and still experience some pain [5]. This apparent discrepancy can be explained by the specific context of critical illness and the patient's past history (Table E1). NRS showed the highest sensitivity to detect pain in comparison to the simple YES/NO question, VDS and VAS [5]. It is fundamental to improve pain detection using the most appropriate tools because pain is an alarm acting as a life-saving system. It is also encouraged to minimise sedative and opioid use, to promote multimodal and regional analgesia, in order to optimize the patient's capacity to communicate and to self-report their pain [1]. Note that in case of language barrier, the scales should be ideally explained in the presence of a translator (hospital translator, bilingual relative or staff), but even in the absence of a translator, visual NRS and VAS are easy to explain using simple mimics. Finally, further research is needed to explore the emotional component of pain (e.g., pain distress) in ICU patients who are awake and able to self-report in a reliable manner [6].

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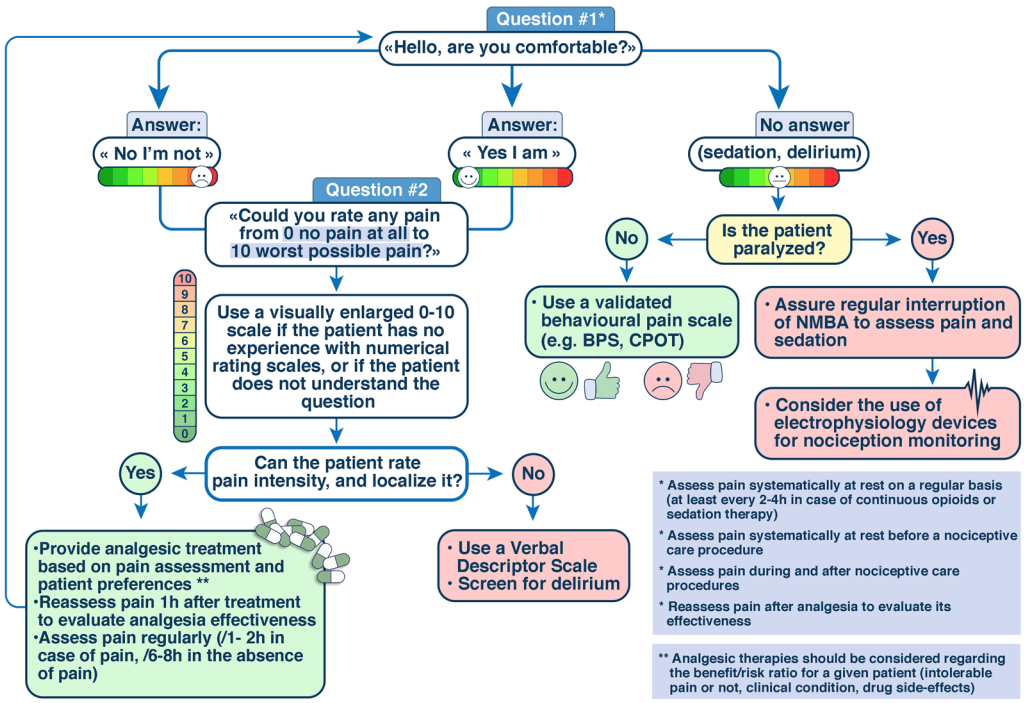

Fig. 1 Pain monitoring algorithm. This pain monitoring algorithm starts with a question about comfort rather than pain (Question#1). There is a recent tendency to prefer positive communication and to use positive (non-negative) words. Coming from conversational hypnosis, it could be a real innovation in care. Pain, a negative experience, could rather be replaced by comfort, a more positive word. However, monitoring specifically pain and seeking after a painful alarm point are mandatory, being associated with improved patients' outcomes (Table E1). Thus, these two approaches should be complementary. Beginning with the positive and relaxing approach ("are you comfortable today?", Question#1) might be preferred (allowing the patients to report other causes of discomfort than pain (e.g., thirst, anxiety, sleep disruption, itching…)), followed by the research of any pain alarms (Question#2)

Patients unable to self-report: observational behavioural scales

The self-report of pain becomes impossible to obtain in heavily sedated patients or may lead to unreliable information from delirious patients [5]. In these situations, the alternative measure of pain is based on the observation of patient's pain behaviours. Several behavioural scales exist but two of them showed robust psychometric performance and are available in many different languages [7]: the critical care observation pain tool (CPOT) and the behavioural pain scale (BPS). These scales help standardizing the observation of behaviours indicative of pain (facial expressions, body movements/tonus, vocalization/or ventilator compliance) (Fig. E2). CPOT and BPS have been validated in ICU patients with various conditions, intubated and non-intubated, sedated or delirious, and in patients with a brain injury [7]. Recent research has highlighted that brain-injured patients with altered consciousness express atypical behaviours (e.g., tearing, face flushing, yawning). The nociception coma scale (NCS) was validated in non-intubated brain-injured ICU patients [8], and adapted to intubated patients [9]. The CPOT has recently been adapted to better represent behaviours relevant to brain-injured ICU patients [10]. The CPOT and CPOT-Neuro have similar scoring systems with content specific to the patient's condition. However, the original BPS and CPOT have shown acceptable psychometric properties in brain-injured patients [9, 11], and could be used in mixed ICUs where the use of a single scale may be more feasible. External validation of newly developed scales is required in brain-injured ICU patients.

Patients unable to self-report nor express behaviours (deep sedation, chemical paralysis): physiologic parameters

Neuromuscular blocking agents (NMBA) are used along with deep analgesia-sedation in severe neurological or respiratory conditions. Behavioural scales are not usable in chemically paralyzed patients. It is recommended to interrupt NMBA on a regular basis to assess pain and sedation [12, 13]. Therefore, in such situations, other alternative pain measures must be explored [1]. During chemical paralysis, changes in continuously monitored

vital signs (i.e., heart rate, blood pressure) are used to guide decisions for the titration of analgesia sedation. However, vital signs are not valid indicators of pain in ICU patients [1]. New electrophysiological devices have been developed for the monitoring of nociception and related pain that might be used in situations where self-report or behavioural pain tools cannot be used (e.g., chemical paralysis) [14]. Those devices are based on the measurement of physiologic markers related to the sympathetic-parasympathetic responses (e.g., pupillary dilation, heart rate variability (HRV), sudation). Inconsistent validity of video pupillometry to detect pain in critically-ill patients was reported [9]. Its use during standard care procedures is challenging. Some authors defined pupil dilation threshold induced by a gradual, standardized, electrical noxious stimulation of the skin. These electrical stimulations, that can predict pain behaviour during standard care procedures [15], should be performed only in moderately to deeply sedated patients (potentially painful in lightly sedated patients). Other technologies based of HRV analysis have been increasingly developed, such as the analgesia nociception index (ANI). ANI changes more likely than BPS during care procedures suggesting a high sensibility to stimulations [16, 17]. A new multi-parameter, the nociception level (NOL) index, was developed based on the assumption that the combination of multiple physiologic parameters is superior to their individual use. The NOL simultaneously integrates HRV, photoplethysmographic waveform amplitude, skin conductance and temperature. Pilot studies showed that the NOL could discriminate between non-nociceptive and nociceptive care procedures and was associated with NRS and CPOT scores [18, 19]. Limitations of HRV-derivate devices are the lack of heart and respiration coupling (cardiac arrythmia, pacemaker, bradypnea, medications and critical illness factors). Furthermore, due to the absence of research studies, HRV-related devices cannot be recommended for analgesia titration in the ICU because of a risk of opioid overuse, due to a high sensibility of these devices to nociceptive stimuli. In all, the clinical benefits on patients' outcome, of all available monitoring devices (primarily developed for anesthetized patients) remain to be further examined in the ICU setting. Their use in a given patient unable to self-report nor expressed any behaviour (e.g., paralysis, deep sedation, catatonia) could be trialled case by case with regular assessment especially for analgesia titration.

Supplementary Information
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Declarations

Conflicts of interest
GC and CG declare no conflict of interest for the past 3 years.

Ethics statement
This position paper was performed in accordance with the ethical standards.

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