British Journal of Anaesthesia **107** (4): 619–26 (2011)
Advance Access publication 30 June 2011 · doi:10.1093/bja/aer195

BJA

Determination of moderate-to-severe postoperative pain on the numeric rating scale: a cut-off point analysis applying four different methods

H. J. Gerbershagen[1]*, J. Rothaug[2], C. J. Kalkman[1] and W. Meissner[2]

[1] Department of Anaesthesiology and Intensive Care, University Medical Centre Utrecht, Heidelberglaan 100, 3584 GA Utrecht, The Netherlands
[2] Department of Anaesthesiology and Intensive Care, University Hospital Jena, Erlanger Allee 101, 07747 Jena, Germany

* Corresponding author. E-mail: h.j.gerbershagen@umcutrecht.nl

Editor's key points

- A numeric rating scale (NRS) of 1–10 is widely used for the assessment of postoperative pain.
- In this study, a number of different methods were used to identify a cut-off value between mild and moderate pain.
- Three of the four methods used identified an NRS of 4 or more as identifying patients with moderate or severe pain.
- Postoperative pain treatment should be tailored to individual patient needs and not based on the NRS alone.

Background. Cut-off points (CPs) of the numeric rating scale (NRS 0–10) are regularly used in postoperative pain treatment. However, there is insufficient evidence to identify the optimal CP between mild and moderate pain.

Methods. A total of 435 patients undergoing general, trauma, or oral and maxillofacial surgery were studied. To determine the optimal CP for pain treatment, four approaches were used: first, patients estimated their tolerable postoperative pain intensity before operation; secondly, 24 h after surgery, they indicated if they would have preferred to receive more analgesics; thirdly, satisfaction with pain treatment was analysed, and fourthly, multivariate analysis was used to calculate the optimal CP for pain intensities in relation to pain-related interference with movement, breathing, sleep, and mood.

Results. The estimated tolerable postoperative pain before operation was median (range) NRS 4.0 (0–10). Patients who would have liked more analgesics reported significantly higher average pain since surgery [median NRS 5.0 (0–9)] compared with those without this request [NRS 3.0 (0–8)]. Patients satisfied with pain treatment reported an average pain intensity of median NRS 3.0 (0–8) compared with less satisfied patients with NRS 5.0 (2–9). Analysis of average postoperative pain in relation to pain-related interference with mood and activity indicated pain categories of NRS 0–2, mild; 3–4, moderate; and 5–10, severe pain.

Conclusions. Three of the four methods identified a treatment threshold of average pain of NRS≥4. This was considered to identify patients with pain of moderate-to-severe intensity. This cut-off was indentified as the tolerable pain threshold.

Keywords: pain categories; pain cut-off; pain threshold; postoperative pain

Accepted for publication: 29 May 2011

The numeric rating scale (NRS 0–10; 0, no pain; 10, worst pain imaginable) has been validated for measuring post-operative pain intensity.[1] This scale is often used to divide patients into groups who are in need of pain treatment (moderate and severe pain) and those who are not (mild pain). The presently used treatment threshold or cut-off point (CP) for moderate pain treatment is arbitrarily set at NRS≥3,[2 3] ≥4,[3 4] or ≥5,[5–7] and even as high as NRS≥6 in different studies.[8]

Different CPs in protocols for acute postoperative pain management lead to variations in treatment. In addition, such CPs are increasingly regarded as a quality indicator of postoperative pain control. The wide range of CPs used in different research studies makes the comparison of results difficult. It is possible that in some study protocols, the threshold for pain treatment was selected to achieve the desired study result.

Initial attempts to define CPs were based on the assumption that the terms mild and moderate pain could distinguish patients requiring additional pain treatment. Pain descriptors on a verbal rating scale (VRS) (mild, moderate, and severe) were matched with the corresponding pain scores of the visual analogue scale (VAS) scores (0–100 mm).[9 10] However, a large prospective study found a discrepancy between reports of severe pain and acceptability; 31% of patients who rated their pain as severe reported this pain as acceptable.[11] Thus, a simple match of the term 'moderate' on the VRS with the scores of the NRS or VAS does not seem appropriate for identifying the optimal CP, indicating a need for analgesic administration.

A different approach was introduced by Serlin and colleagues to calculate the optimal CPs for mild, moderate, and severe pain. These authors analysed the association of pain intensity with pain-related interference in activities such as movement and sleep in cancer patients. Pain interference was measured with the Brief Pain Inventory (BPI).[12] In acute postoperative pain studies, this method of calculation has only been applied twice, in a study of postoperative pain after hip- and knee-replacement surgery and after sternotomy. It is not clear if this method of calculating cut-offs between pain intensity and pain interference actually reflects the need for therapeutic intervention.

The aim of this study was to determine the optimal CPs between mild and moderate-to-severe pain intensities on the first postoperative day. There is no generally accepted gold standard to determine the optimal CP on an NRS and presently used CP analysis methods are not known to be appropriate for postoperative pain. We applied and compared four different methods in order to arrive at the most valid approach to analyse CPs.

Methods

Subjects

Data were collected following the guidelines of the QUIPS project (Quality Improvement in Postoperative Pain Management)[13] in the departments of general surgery, traumatology, and oral and maxillofacial surgery at the University of Jena, Germany, between November 2006 and November 2007. A total of 444 patients were included in the study. Inclusion criteria were age more than 18 yr and capability to understand German. Patients were excluded if they were undergoing a repeat surgical procedure and when postoperative mechanical ventilation was planned for more than 24 h, as this was the time-point for pain assessment.[13] There was no restriction with regard to the type of surgery. All consecutive patients fulfilling the inclusion criteria were asked to take part in this study. After approval was obtained from the University Ethics Committee, all patients gave their written informed consent before entering the study.

QUIPS questionnaire

The QUIPS project was set up to analyse postoperative pain management and to anonymously compare outcomes among participating hospitals.[13] The standard QUIPS protocol is divided into sections dealing with (i) average and worst pain intensities during the last 24 h since surgery (NRS 0–10); (ii) pain-related interference with: physical activity (walking, movement); coughing and deep breathing, sleep, and mood during the last 24 h since surgery (NRS 0–10); (iii) pain-related awakening during the previous night; (iv) nausea or vomiting since surgery; (v) wish to have had received additional doses of pain medication during the period since surgery; (vi) patient satisfaction with postoperative analgesia recorded using a 16-box NRS (0–15, 0, very unsatisfied; 15, very satisfied). Information on the type of surgery, anaesthesia, and postoperative pain treatment are also documented. In addition to the standard QUIPS questionnaire items, patients were asked to estimate their tolerable postoperative pain level (NRS 0–10) before operation.

Patient questionnaires were administered by study nurses who were neither associated with the particular departments nor involved in patients' care. Assessment was performed on the first postoperative day between 8 and 11 a.m.

Analysis of CPs

First, we asked patients to indicate postoperative pain thresholds before operation that they would consider 'tolerable'. Secondly, we evaluated the need for therapeutic interventions by asking patients 24 h after surgery if they would have wished to have received additional postoperative analgesia and compared the average and worst NRS scores of patients who indicated a wish to have received more analgesia to patients who did not. Thirdly, average and worst pain intensities in patients 'very satisfied' or 'satisfied' with pain treatment were compared with pain intensities in patients who were less satisfied. Fourthly, we calculated CPs between mild and moderate-to-severe postoperative pain intensities in relation to pain-related interference with movement, taking deep breaths, sleep quality, and mood.

Statistical analysis

All variables measured with the NRS are reported as median (range). This includes individual patients' estimates of their average pain which are summarized as median and range across groups of patients. The Mann–Whitney test was applied to compare postoperative pain intensities between patients with and without a wish to have received more analgesics and between patients with low and high satisfaction with pain treatment. Estimated tolerable pain before operation was compared between patients with mild and moderate-to-severe postoperative pain by means of the Mann–Whitney test.

Satisfaction with pain treatment (NRS 0–15) was graded using German school grade categories: 15–13 (very satisfied), 12–10 (satisfied), 9–7 (neither satisfied, nor dissatisfied), 6–4 (dissatisfied), and 0–3 (very dissatisfied). The scale was dichotomized in NRS$\geq$10 (very satisfied or satisfied) *vs* lower scores. In all comparisons, two-sided tests were used with $P \leq 0.05$ to indicate statistical significance.

The fourth applied method to identify the optimal CP is based on the relation between average and worst postoperative pain intensity since surgery and pain-related interference with mood and activities. The statistical method described by Serlin and colleagues[12] was used. To identify the optimal CP, 28 different combinations of pain CPs from CP 1/2 to CP 7/8 of average and worst pain since surgery were analysed. The upper limits for mild and moderate pain were used to describe the CPs, for example, CPs 1–4, 5–6, 7–10 were termed CP 4/6.

The means of the four variables (interference with mood, deep breathing, sleep, and mood) were pooled to give a