Measuring acute postoperative pain using the visual analog scale: the minimal clinically important difference and patient acceptable symptom state

P. S. Myles¹,²,*, D. B. Myles², W. Galagher¹, D. Boyd¹, C. Chew¹, N. MacDonald³ and A. Dennis³

¹Department of Anaesthesia and Perioperative Medicine, Alfred Hospital and Monash University, Melbourne, Victoria, Australia, ²Department of Epidemiology and Preventive Medicine, Monash University, Melbourne, Victoria, Australia and ³Department of Anaesthesia, Royal Women’s Hospital, Parkville, Victoria, Australia

*Corresponding author. E-mail: p.myles@alfred.org.au

Abstract

Background. The 100 mm visual analog scale (VAS) score is widely used to measure pain intensity after surgery. Despite this widespread use, it is unclear what constitutes the minimal clinically important difference (MCID); that is, what minimal change in score would indicate a meaningful change in a patient’s pain status.

Methods. We enrolled a sequential, unselected cohort of patients recovering from surgery and used a VAS to quantify pain intensity. We compared changes in the VAS with a global rating-of-change questionnaire using an anchor-based method and three distribution-based methods (0.3SD, standard error of the measurement, and 5% range). We then averaged the change estimates to determine the MCID for the pain VAS. The patient acceptable symptom state (PASS) was defined as the 25th centile of the VAS corresponding to a positive patient response to having made a good recovery from surgery.

Results. We enrolled 224 patients at the first postoperative visit, and 219 of these were available for a second interview. The VAS scores improved significantly between the first two interviews. Triangulation of distribution and anchor-based methods resulted in an MCID of 9.9 for the pain VAS, and a PASS of 33.

Conclusions. Analgesic interventions that provide a change of 10 for the 100 mm pain VAS signify a clinically important improvement or deterioration, and a VAS of 33 or less signifies acceptable pain control (i.e. a responder), after surgery.

Key words: analgesia; pain measurement; surgery
**Editor’s key points**

- The 100 mm visual analog scale (VAS) score is widely used to measure pain intensity after surgery, but the minimal clinically important difference in the VAS is not clear.
- A change of 10 for the 100 mm pain VAS would be the minimal clinically important difference, and the VAS of 33 or less signifies acceptable pain control after surgery.

important difference (MCID) of the pain VAS. 25 26 that is, what minimal change in a pain VAS score would indicate a real change in a patient’s pain intensity. 16 17 Several studies have attempted to define the MCID or clinically useful effect in the postoperative setting, 18–20 but the methods used did not comply with existing standards nor did they include patient evaluation. 15

The clinically important difference of the numerical rating scale (NRS) has been estimated for various chronic pain states, 13 15 21 22 as has the MCID of the VAS in chronic pain 23 and in the emergency department setting. 24 25 but it is unclear whether these results can be applied in the acute postsurgical pain setting. One study has determined the MCID of the pain VAS in patients after shoulder rotator cuff surgery. 26 The Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) recently reviewed and recommended specific methods that can be used for interpreting the clinical importance of treatment outcomes in chronic pain trials, 14 but there are currently no recommendations for acute postoperative pain.

The patient acceptable symptom state (PASS) is the value beyond which patients consider themselves well. 15 27 28 The PASS can therefore be used to define responders and non-responders to analgesic treatment in postoperative pain studies. 34 The PASS of the pain VAS score in this setting is often assumed, but has not been determined according to current recommendations. 15 The aim of this study was to determine the MCID and PASS for the pain VAS in patients recovering from surgery.

**Methods**

This prospective observational study evaluated adult patients recovering from surgery, using the 100 mm VAS to measure pain on two occasions, along with a generic Likert scale of overall recovery (see next subsection). Most patients (n=204) enrolled in this study participated in a concurrent study evaluating quality-of-recovery scales. 29 The study settings were the surgical wards at three hospitals in Australia (Alfred, Royal Women’s, and Shepparton Hospitals) representing tertiary adult, tertiary obstetric/gynaecology, and rural/regional hospitals. Ethics approval was obtained from the institutional ethics committee at each hospital, and patient consent was obtained in all instances.

Patients were eligible to participate in the study if they were >18 yr of age and recovering from a surgical procedure requiring general or major neuraxial block anaesthesia. Patients were excluded if they had poor English comprehension, drug or alcohol dependence, psychiatric disorder, uncontrolled pain, or a concurrent serious medical disorder impairing completion of the VAS and questionnaire. Baseline patient characteristics and perioperative data were collected on a case report form and later de-identified and transcribed onto an electronic database.

**Determination of the MCID for pain**

There is currently no consensus on the optimal method for MCID estimation. As such, we chose to include a triangulation (average) of several methodologies, 15 16 as we have done previously when evaluating quality-of-recovery scales. 29 Previous methods used to determine MCID have included the SD/2 rule, 10 and 0.2 SD, 13 0.3 SD, 25 and the standard error of measurement (SEM), 23 others have used 5–10% of the instrument range. 34 We chose to include three distribution-based measures: the 0.3 SD, SEM, and 5% range. 35 In addition, we used an anchor-based method with a global rating-of-change questionnaire. 36 This uses a 15-point Likert scale ranging from −7 (a very great deal worse) to +7 (a very great deal better). 15 16 36

A 100 mm VAS, ranging from 0 (no pain) to 100 (very severe pain), was used to measure pain intensity throughout the previous 24 h on two occasions in the days after surgery. At the second visit, patients were asked to assess the following (adapted from Tubach and colleagues). 15 “Think only about your pain you have felt over the past 24 h. Compared with yesterday, is your pain: −5, a great deal worse; −3, moderately worse; −2, a little worse; −1, almost the same, hardly any worse at all; 0, no change; 1, almost the same, hardly any better at all; 2, a little better; 3, somewhat better; 4, moderately better; 5, a good deal better; 6, great deal better; or 7, a very great deal better?”

Patients whose score on the global rating-of-change questionnaire was 0, 1, or −1 were classified as unchanged. 36 Patients whose score was 2, 3, −2, or −3 were considered to have experienced a small change equivalent to the MCID; those with scores of 4, 5, −4, and −5 were considered to have experienced moderate change, and those with scores of 6, 7, −6, and −7 were considered to have experienced large change. 36 Absolute (i.e. we changed the sign of the scores for those who deteriorated) mean changes in pain VAS scores according to patient-rated change in postoperative recovery health status were then calculated. All four estimates (0.3 SD, SEM, 5% range, and global rating of change) were then averaged.

**Patients’ opinion of their improvement**

The PASS was determined using the direct opinion-based approach, 15 37 in which patients were asked to define any improvement: ‘In your opinion, have you made a good recovery from your operation?’, with response options of yes, no, or unsure. Patients responding in the affirmative were classified as having made a good recovery, and those who responded negatively or were unsure were classified as having a poor recovery.

**Statistical analysis**

We could not reliably estimate a required sample size for this study. Given that previous relevant studies had enrolled 40–100 subjects, 30 36 we planned to enrol at least 150 subjects to provide an adequate number for subgroup testing.

Data are presented as mean (SD) or number (%) unless otherwise specified. Selected results are reported with a 95% confidence interval (CI), with the mean (95% CI) VAS score for minimal change calculated using 1000 bootstrap samples. The SEM was calculated as the SD multiplied by the square root of one minus the intraclass correlation coefficient. 33 Changes in pain...
scores at each interview were compared with the Wilcoxon signed rank test, and according to extent of surgery using the Kruskal–Wallis test. Both Student’s unpaired t-test and independent-samples median test were used to compare pain scores in those with a good or poor recovery. We defined the PASS as the 25th centile of the pain VAS in those who rated their recovery as good at the second postoperative interview. The predictive utility of the pain VAS in achieving a good recovery was assessed using a receiver operating characteristic curve (ROC).38 The association between the change in pain VAS score and the global rating-of-change score was quantified by the Spearman rank correlation coefficient (ρ). We determined test-retest reliability in those who had rated their pain state as unchanged or almost the same (global rating scores of −1, 0 or 1) using the intraclass correlation coefficient. Responsiveness was measured in those with global rating-of-change scores of at least 4 using standardized response means, calculated as the mean change divided by its SD.39 40 All statistical analyses were performed using SPSS for Windows V23.0 (SPSS Australasia Ltd, Sydney, NSW, Australia). A P-value of <0.05 was considered significant; no correction was made for multiple comparisons.

Results

We enrolled 224 patients with varying degrees of postoperative pain and recovering from a broad range of surgical procedures; there were no refusals, but five were unavailable at the second postoperative visit (Table 1). Patients undergoing more extensive surgery tended to have higher VAS scores (Table 2).

Most patients improved their pain score ratings at the second postoperative visit (Table 3). The median pain VAS scores reduced from 26 (13–47) to 20 (11–36), P = 0.002. The distribution-based estimates of the MCID for the VAS score were 6.9 (0.3 SD), 4.7 (5% range), and 12.4 (IQR). The association between the change in pain VAS score and the global rating-of-change score was ρ = 0.48, P < 0.0005. The absolute mean changes (95% CI) in VAS scores according to patient-rated change in postoperative pain intensity are reported in Table 4. The anchor-based estimate of the MCID for the pain VAS was 15.7. This results in an averaged MCID of 9.9.

Those who rated themselves as having had a poor postoperative recovery [n = 22 (11%)] had significantly lower pain VAS scores at the second postoperative visit compared with those who reported a good postoperative recovery [n = 177 (89%)]; see Table 5 and Fig. 1. The 75th centile for the pain VAS score in those with a good recovery was 33; the 25th centile for the pain VAS score in those with a poor recovery was 20. The area under the ROC curve was 0.72 (95% CI: 0.60–0.85).

Test–retest reliability (n = 22) of the pain VAS was high, intra-class correlation coefficient 0.79 (95% CI: 0.49–0.91). The standardized response mean (n = 125) of the pain VAS was 0.36, indicating a mild-to-moderate degree of responsiveness to change.

Discussion

We studied a broad range of surgical and obstetric patients to quantify the MCID and PASS for the pain VAS as a measure of pain intensity in the postoperative setting. These findings can guide the conduct and interpretation of studies evaluating analgesic therapies in surgical patients. Each can be used to define a ‘responder’ (effective analgesia) as a standard metric to be used across acute pain studies.

It is generally accepted that a pain VAS score of 30, 70, and 100 indicates the upper boundaries of mild, moderate, and severe pain intensity. Several studies have found that a pain scale PASS value of 40 can be used as an outcome criterion for osteoarthritis and various chronic rheumatic diseases with pain.41 27 Pooled data from two postoperative analgesic studies found that pain VAS scores of up to 44 are consistent with a patient rating of pain being mild.42 Current guidelines recommend titrating analgesia to achieve a pain VAS score of 40 or less,43 and postoperative pain studies using patient-controlled analgesia typically titrate to a VAS or NRS score of ~30.44 Our PASS estimate of 33 for the pain VAS is consistent with these results.

Clinical trials ought to focus more strongly on the patient’s response to pain treatments; that is, the proportion of patients who are responders to treatment.44 Clearly, giving sufficient analgesia to eliminate all pain for all patients is a wrong target,45 but so is undertreatment. We thus recommend a pain VAS score of 33 be used as a suitable target for optimal analgesic titration. As outlined by Moore and colleagues,18 a dichotomous pain outcome (‘responder’ and ‘non-responder’) allows for the estimation of clinically useful statistics, such as absolute and relative risk reduction, and number needed to treat. This can then provide more useful information for clinicians and patients.

Table 1 Patient and surgical characteristics (n=224). Number (% or median (interquartile range), unless otherwise stated. *New Zealand, South Africa, UK, or USA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age (yr)</th>
<th>Mean (SD)</th>
<th>Range</th>
<th>Female sex</th>
<th>148 (66)</th>
<th>19–86</th>
<th>White-collar worker</th>
<th>95 (42)</th>
<th>Country of birth</th>
<th>160 (71)</th>
<th>Other English-language country*</th>
<th>30 (13)</th>
<th>Non-English-speaking country</th>
<th>34 (15)</th>
<th>ASA physical status</th>
<th>4.7 (5% range), and 12.4 (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yr)</td>
<td>53 (17)</td>
<td>19–86</td>
<td></td>
<td>Female sex</td>
<td>148 (66)</td>
<td></td>
<td>White-collar worker</td>
<td>95 (42)</td>
<td>Country of birth</td>
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<td>Other English-language country*</td>
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<td>34 (15)</td>
<td>ASA physical status</td>
<td>4.7 (5% range), and 12.4 (IQR)</td>
</tr>
<tr>
<td>Duration of surgery (min)</td>
<td>112 (58–161)</td>
<td></td>
<td></td>
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<td>112 (58–161)</td>
<td></td>
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<td>112 (58–161)</td>
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</tbody>
</table>
Table 2 Summary statistics for pain visual analog scale scores at the first postoperative visit, expressed as mean (SD). VAS, visual analog scale. *Kruskal–Wallis test

<table>
<thead>
<tr>
<th>Extent of surgery</th>
<th>Pain VAS scale (range of scores)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor (n=17)</td>
</tr>
<tr>
<td></td>
<td>(n=100)</td>
</tr>
<tr>
<td>VAS score (0–100)</td>
<td>19 (24)</td>
</tr>
</tbody>
</table>

Table 3 The frequency of each level of patient-reported change in pain intensity between the first and second postoperative visits (n=219)

<table>
<thead>
<tr>
<th>Extent of change</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A very great deal worse</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>A great deal worse</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>A good deal worse</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Moderately worse</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>Somewhat worse</td>
<td>4 (1.8)</td>
</tr>
<tr>
<td>A little worse</td>
<td>11 (5.0)</td>
</tr>
<tr>
<td>Almost the same, hardly any worse at all</td>
<td>8 (3.7)</td>
</tr>
<tr>
<td>No change</td>
<td>23 (11)</td>
</tr>
<tr>
<td>Almost the same, hardly any better at all</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>A little better</td>
<td>23 (11)</td>
</tr>
<tr>
<td>Somewhat better</td>
<td>20 (9.1)</td>
</tr>
<tr>
<td>Moderately better</td>
<td>30 (14)</td>
</tr>
<tr>
<td>A good deal better</td>
<td>41 (19)</td>
</tr>
<tr>
<td>A great deal better</td>
<td>28 (13)</td>
</tr>
<tr>
<td>A very great deal better</td>
<td>12 (5.5)</td>
</tr>
</tbody>
</table>

Table 4 Mean change in pain visual analog scale scores according to patient-rated change in postoperative pain intensity (n=219). CI, confidence interval; VAS, visual analog scale. *Used to define the anchor-based estimate of the minimal clinically important change (see main text for details)

<table>
<thead>
<tr>
<th>Change categories</th>
<th>Mean change</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) According to change categories of improvement or deterioration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large improvement (n=40)</td>
<td>14.8</td>
<td>8.0 to 21.6</td>
</tr>
<tr>
<td>Moderate improvement (n=71)</td>
<td>11.0</td>
<td>6.8 to 15.1</td>
</tr>
<tr>
<td>Minimal improvement (n=43)</td>
<td>6.7</td>
<td>1.3 to 12.0</td>
</tr>
<tr>
<td>No change (n=36)</td>
<td>0.8</td>
<td>-5.8 to -4.1</td>
</tr>
<tr>
<td>Minimal deterioration (n=15)</td>
<td>-19.1</td>
<td>-26.4 to -11.7</td>
</tr>
<tr>
<td>Moderate deterioration (n=6)</td>
<td>-10.3</td>
<td>-20.2 to -0.5</td>
</tr>
<tr>
<td>Large deterioration (n=8)</td>
<td>-34.5</td>
<td>-56.9 to -12.1</td>
</tr>
<tr>
<td>(B) Absolute change categories</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No change (n=36)</td>
<td>0.8</td>
<td>-5.8 to -4.1</td>
</tr>
<tr>
<td>Minimal change (n=58)*</td>
<td>15.7</td>
<td>12.9 to 18.8</td>
</tr>
<tr>
<td>Moderate change (n=77)</td>
<td>15.1</td>
<td>12.3 to 18.1</td>
</tr>
<tr>
<td>Large change (n=48)</td>
<td>20.1</td>
<td>14.5 to 26.4</td>
</tr>
</tbody>
</table>

Table 5 Comparison of the pain visual analog scale scores in those who rated their recovery at the second postoperative visit, expressed as mean (SD) and median (interquartile range). CI, confidence interval; IQR, interquartile range; VAS, visual analog scale. *Levene’s test P=0.01, so equal variances not assumed. †Mann–Whitney U-test

<table>
<thead>
<tr>
<th>Patient-rated good recovery</th>
<th>Pain intensity</th>
<th>Difference (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes (n=177)</td>
<td>No/Unsure (n=22)</td>
<td></td>
</tr>
<tr>
<td>Pain VAS scale</td>
<td>24 (20)</td>
<td>45 (27)</td>
<td>21 (8.2–33)</td>
</tr>
<tr>
<td>Median (IQR)</td>
<td>20 (10–33)</td>
<td>51 (20–63)</td>
<td>—</td>
</tr>
</tbody>
</table>

Anchor-based methods have been used to determine the MCID for scales used in many medical conditions, and we have recently done this for several quality-of-recovery scales. Our approach, using a combination of distribution- and anchor-based methods, suggests that the MCID for pain in a surgical population is smaller than previously assumed.

Studies of patients presenting to emergency departments with various pain states found an MCID for the VAS score of 124 and 13, and a change of 18 correlated with the patient being a ‘little bit better’. Slightly higher values have been found for the pain NRS in chronic pain conditions, with an MCID of 2 (comparable to VAS 20 mm). The MCID for the pain VAS was 14 in patients treated for shoulder rotator cuff disease, and ranged from 4 to 21 in patients with degenerative cervical spine disease undergoing surgery, but in the latter study the evaluation was done by the clinician (not the patient). For patients recovering from minimally invasive spine surgery, an MCID for the VAS was 12 for back pain and 16 for leg pain. Others have found that a change in VAS of ~20 represented satisfactory pain relief in patients after surgery. Some authors have suggested that a 33% decrease, or a change in VAS score of 15–20, would indicate a clinically important change in pain intensity. Taken
together, these results largely support our estimate of the MCID for the pain VAS being 10 in the postoperative setting.

Although the VAS and NRS are incomplete representations of the pain experience and cannot fully reflect the multidimensional aspects of pain, they remain the most widely used metrics of pain after surgery. In view of the high correlations between the VAS and NRS reported in many studies, it is reasonable to accept that the MCID can be applied to either instrument. The MCID can be used to guide the non-inferiority margin for clinical trials\(^49\) and for determining the sample size in a clinical trial.\(^49\)

This study has limitations. Pain is both subjective and multidimensional and so the VAS (and NRS) cannot capture the complete pain experience. But clinical decisions are made on the basis of existing pain scales, and so it is important to know how much reduction in a VAS score is likely to be clinically meaningful from the patient’s perspective. The extremes of pain indicated on a VAS, typically ‘no pain’ and ‘worst pain ever’, may not truly represent absolute limits of perception. Our data (Table 4A) suggest that there is a difference in the MCID for those who have improvement or deterioration in their pain status, in that a larger reduction in a VAS score might be needed to indicate true improvement. A similar finding has been previously reported\(^49\) and is consistent with studies of loss aversion.

It is possible that the experience of change/improvement in pain is non-linear. A reduction of pain from 95 to 75 could indicate greater relief than a reduction of 30 to 10 (particularly as this is below the identified PASS). We determined the PASS by asking patients to rate their overall recovery after surgery; although pain is an important component of this, other factors will, of course, influence recovery.

In conclusion, we have shown that in patients with acute pain after surgery, including women recovering from Caesarean section, the MCID and PASS for the pain VAS score is 9.9 (rounded to 10) and 33, respectively.

**Authors’ contributions**

Study concept and protocol development, analysis of results, first draft and revision of manuscript: P.M., D.M.

Patient consent and enrolment, data collection:

Ethics committee application, liaison with obstetric staff, and oversight of the conduct of the study at the Royal Women’s Hospital: A.D., N.M.

Critical review and revisions of the manuscript: P.M., D.M., W.G., D.B., C.C., N.M., A.D.

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**Declaration of interest**

P.M. is an editor of the BJA; none of the other authors report any competing interests relating to the topic of this paper.

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