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What Are the Minimally Important Changes of Four Commonly Used Patient-reported Outcome Measures for 36 Hand and Wrist Condition-Treatment Combinations?

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Abstract

Background Patient-reported outcome measures (PROMs) are frequently used to assess treatment outcomes for hand and wrist conditions. To adequately interpret these outcomes, it is important to determine whether a statistically significant change is also clinically relevant. For this purpose, the minimally important change (MIC) was developed, representing the minimal within-person change in outcome that patients perceive as a beneficial treatment effect. Prior studies demonstrated substantial differences in MICs between condition-treatment combinations, suggesting that MICs are

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context-specific and cannot be reliably generalized. Hence, a study providing MICs for a wide diversity of condition-treatment combinations for hand and wrist conditions will contribute to more accurate treatment evaluations.

Questions/purposes (1) What are the MICs of the most frequently used PROMs for common condition-treatment combinations of hand and wrist conditions? (2) Do MICs vary based on the invasiveness of the treatment (nonsurgical treatment or surgical treatment)?

Methods This study is based on data from a longitudinally maintained database of patients with hand and wrist conditions treated in one of 26 outpatient clinics in the Netherlands between November 2013 and November 2020. Patients were invited to complete several validated PROMs before treatment and at final follow-up. All patients were invited to complete the VAS for pain and hand function. Depending on the condition, patients were also invited to complete the Michigan Hand outcomes Questionnaire (MHQ) (finger and thumb conditions), the Patient-rated Wrist/Hand Evaluation (PRWHE) (wrist conditions), or the Boston Carpal Tunnel Questionnaire (BCTQ) (nerve conditions). Additionally, patients completed the validated Satisfaction with Treatment Result Questionnaire at final follow-up. Final follow-up timepoints were 3 months for nonsurgical and minor surgical treatment (including trigger finger release) and 12 months for major surgical treatment (such as trapeziectomy). Our database included 55,651 patients, of whom we excluded 1528 who only required diagnostic management, 25,099 patients who did not complete the Satisfaction with Treatment Result Questionnaire, 3509 patients with missing data in the PROM of interest at baseline or follow-up, and 1766 patients who were part of condition-treatment combinations with less than 100 patients. The final sample represented 43% (23,749) of all patients and consisted of 36 condition-treatment combinations. In this final sample, 26% (6179) of patients were managed nonsurgically and 74% (17,570) were managed surgically. Patients had a mean ± SD age of 55 ± 14 years, and 66% (15,593) of patients were women. To estimate the MIC, we used two anchor-based methods (the anchor mean change and the MIC predict method), which were triangulated afterward to obtain a single MIC. Applying this method, we calculated the MIC for 36 condition-treatment combinations, comprising 22 different conditions, and calculated the MIC for combined nonsurgical and surgical treatment groups. To examine whether the MIC differs between nonsurgical and surgical treatments, we performed a Wilcoxon signed rank test to compare the MICs of all PROM scores between nonsurgical and surgical treatment.

Results We found a large variation in triangulated MICs between the condition-treatment combinations. For example, for nonsurgical treatment of hand OA, the MICs of VAS pain during load clustered around 10 (interquartile range 8 to 11), for wrist osteotomy/carpectomy it was around 25 (IQR 24 to 27), and for nerve decompression it was 21. Additionally, the MICs of the MHQ total score ranged from 4 (nonsurgical treatment of CMC1 OA) to 15 (trapeziectomy with LRTI and bone tunnel), for the PRWHE total score it ranged from 2 (nonsurgical treatment of STT OA) to 29 (release of first extensor compartment), and for the BCTQ Symptom Severity Scale it ranged from 0.44 (nonsurgical treatment of carpal tunnel syndrome) to 0.87 (carpal tunnel release). An overview of all MIC values is available in a freely available online application at: https://analyse.equipezorgbedrijven.nl/shiny/mic-per-treatment/. In the combined treatment groups, the triangulated MIC values were lower for nonsurgical treatment than for surgical treatment ($p < 0.001$). The MICs for nonsurgical treatment can be approximated to be one-ninth (IQR 0.08 to 0.13) of the scale (approximately 11 on a 100-point instrument), and surgical treatment had MICs that were approximately one-fifth (IQR 0.14 to 0.24) of the scale (approximately 19 on a 100-point instrument).

Conclusion MICs vary between condition-treatment combinations and differ depending on the invasiveness of the intervention. Patients receiving a more invasive treatment have higher treatment expectations, may experience more discomfort from their treatment, or may feel that the investment of undergoing a more invasive treatment should yield greater improvement, leading to a different perception of what constitutes a beneficial treatment effect.

Clinical Relevance Our findings indicate that the MIC is context-specific and may be misleading if applied inappropriately. Implementation of these condition-specific and treatment-specific MICs in clinical research allows for a better study design and to achieve more accurate treatment evaluations. Consequently, this could aid clinicians in better informing patients about the expected treatment results and facilitate shared decision-making in clinical practice. Future studies may focus on adaptive techniques to achieve individualized MICs, which may ultimately aid clinicians in selecting the optimal treatment for individual patients.

Introduction

In recent years, the use of patient-reported outcome measures (PROMs) has become standard practice in clinical research and daily clinics for interpreting treatment results from the patient's perspective [28]. Unfortunately, clinicians are often faced with evidence that is challenging to interpret clinically as conclusions about treatment effects are often made from a statistical point of view [15, 16, 23, 27]. Statistically significant changes do not provide information about the magnitude of a treatment effect and therefore may not be meaningful to patients or clinicians. To interpret whether a statistically significant treatment effect is also clinically relevant, the minimally important change (MIC) concept is essential [23, 30, 40]. The MIC refers to the smallest change from baseline to post-treatment that patients perceive as important. Although often used interchangeably with the minimum clinically important difference (MCID), the MCID indicates the importance of a difference in outcomes between treatment groups (such as, fasciectomy versus collagenase) and thus represents a distinct entity [23, 30, 40].

In hand surgery, the MIC has been determined for multiple PROMs, including the Michigan Hand outcomes Questionnaire (MHQ) [13, 18, 20-22, 35], the Patient-rated Wrist/Hand Evaluation (PRWHE) [31, 36], and Boston Carpal Tunnel Questionnaire (BCTQ) [21, 25, 32]. However, we noticed in previous evidence that MIC values for each PROM differ substantially not only between hand conditions, but also between different treatments for the same hand condition. For example, the MIC for the MHQ total score ranges from 9 for patients undergoing trigger finger release [13] to 18 for patients after proximal interphalangeal joint arthroplasty [22]. In addition, patients with carpal tunnel syndrome treated surgically yielded a higher MIC than patients receiving steroid injections [32].

Rationale

These findings suggest that MICs are context-specific and cannot always be reliably generalized to other condition-treatment combinations. For example, as treatments differ in invasiveness, rehabilitation periods, and discomfort experienced by patients, it is plausible that patients undergoing surgical treatment require a larger improvement before being satisfied compared with those undergoing nonsurgical treatment. Hence, a study providing specific MICs for various condition-treatment combinations for hand and wrist conditions will contribute to more accurate treatment evaluations in clinical research. As a result, this could aid clinicians in better informing patients about the expected treatment results, which may facilitate shared decision-making in clinical practice.

Therefore, we asked: (1) What are the MICs of the most frequently used PROMs for common condition-treatment combinations of hand and wrist conditions? (2) Do MICs vary based on the invasiveness of the treatment (nonsurgical treatment or surgical treatment)?

Patients and Methods

Study Design

This study is based on data from a longitudinally maintained database of patients with hand and wrist conditions (the Hand-Wrist Study Cohort), reported according to the Strengthening the Reporting of Observational Studies in Epidemiology statement [41]. The cohort and data collection [34] and their use in daily clinical care [11] have been described in more detail.

Setting

Between November 2013 and November 2020, we collected data at Xpert Clinics Hand and Wrist Care and Xpert Clinics Hand Therapy. Xpert Clinics currently comprises 26 locations, 23 European Board-certified hand surgeons, and more than 150 hand therapists. As part of routine outcome measurements, we invited all patients to complete PROMs before and at fixed timepoints after treatment based on the measurement track [34, 43].

Participants

For each outcome, we included all condition-treatment combinations consisting of at least 100 patients with data for the PROMs of interest at baseline and at the final follow-up examination. For nonsurgical treatments (such as hand therapy for thumb base osteoarthritis or a steroid injection for trigger finger) and minor surgical treatments (such as trigger finger release or carpal tunnel release), the final follow-up was at 3 months post-treatment. For major surgical treatments (for example, trapeziectomy or proximal row carpectomy), the final follow-up was 12 months post-treatment (Supplementary Table 1; http://links.lww.com/CORR/A707).

To prevent ceiling effects, we excluded patients with a baseline score of 90 or more points for the MHQ total or subscale scores or VAS pain, at most 10 points for the PRWHE total score or VAS hand function, 5 points or less for the PRWHE pain and hand function score, or no more than 1.4 points for the BCTQ subscales because this may result in an underestimation of the MIC [18]. The exact number of included patients for each PROM subscale and each condition-treatment combination can be found in our freely available online application at: https://analyse.equipezorgbedrijven.nl/shiny/mic-per-treatment/.

During the study period, 55,651 patients were treated for a hand or wrist condition. We excluded 1528 patients who only required diagnostic management (such as, diagnostic wrist arthroscopy), 25,099 patients who did not complete the Satisfaction with Treatment Result Questionnaire, 3509 patients with missing data in the PROM of interest at baseline or follow-up, and 1766 patients who were part of condition-treatment combinations with less than 100 patients. Our final sample represented 43% (23,749 of 55,651) of all patients and consisted of 36 condition-treatment combinations

(Fig. 1). Of these, 26% (6179 of 23,749) received nonsurgical treatment and 74% (17,570 of 23,749) received surgical treatment (Table 1). The mean ± SD age of the nonsurgically managed patients was 57 ± 15 years, and 72% (4479) were women. The surgically managed patients had a mean ± SD age of 55 ± 14 years, and 63% (11,114) were women.

Variables and Measurements

As part of routine follow-up, we invited all patients to complete the VAS for pain and hand function, regardless of the condition-treatment combination. Additionally, patients were invited to complete a more disease-specific PROM (the MHQ, the PRWHE, or the BCTQ). This was dependent on the condition-treatment combination and associated measurement track [34]. In brief, wrist conditions were assessed with the PRWHE, finger and thumb conditions with the MHQ, and nerve conditions with the BCTQ.

We used the VAS to examine pain (scale of 0-100; higher scores indicate more pain) and function (scale of 0-100; higher scores indicate poorer function). The VAS for pain was measured for three situations: pain at rest, pain during physical load, and average pain during the past week. The VAS has high test-retest reliability, good ability to detect change, and acceptable concurrent validity [12].

The MHQ consists of six domains (overall hand function, work performance, activities of daily living, pain, aesthetics, and satisfaction with hand function), each with a score ranging from 0 to 100 [4]. Higher scores indicate better performance, except for the subscale of pain. For interpretability, we reverted the pain subscale such that higher scores indicate less pain. We analyzed scores of the affected hand. The MHQ has been shown to have a high test-retest reliability, internal consistency, internal validity, and good responsiveness to change [4, 35].

The PRWHE is a validated questionnaire [19] with high internal consistency and reliability [26]. The PRWHE assesses the domains of pain and function, with scores ranging from 0 to 50 (higher scores indicate worse outcomes). The total score is calculated as the sum of both domains.

The BCTQ is a validated questionnaire comprising two domains: the Symptom Severity Scale and Functional Status Scale, with scores ranging from 1 to 5 (higher scores indicate more complaints) [17]. The BCTQ has good validity, reliability, and responsiveness [14].

To assess satisfaction with treatment results, we invited all patients to answer an additional question from the Satisfaction with Treatment Result Questionnaire: "How satisfied are you with the treatment result thus far? [7]. Responses were limited to one of the following items, scored on a Likert scale: excellent, good, fair, moderate, or poor. This questionnaire has recently been reported to be reliable and has good construct validity [7].

Primary and Secondary Study Outcomes

The primary aim of this study was to determine the MICs of four PROMs for a variety of condition-treatment combinations of hand and wrist conditions. To achieve this, we estimated the MICs of all PROMs for each condition-treatment combination using two anchor-based methods: the anchor mean change method and the MIC predict method [38, 39]. The weighted mean of both methods was considered to represent the MIC.

Our secondary aim was to examine whether the MIC differs based on the invasiveness of the treatment (nonsurgical treatment or surgical treatment). To achieve this, we performed a Wilcoxon signed rank test to compare the MICs of the PROM scores of nonsurgical and surgical treatments.

Ethical Approval

Ethical approval for this study was obtained from the Erasmus MC University Medical Center, Rotterdam, the Netherlands (MEC-2018-1088).

Study Size and Statistical Methods

To our knowledge, there are no recommendations regarding sample size for calculating an MIC. However, we considered that 100 patients would be sufficient to calculate a condition and treatment-specific MIC. In general, the MIC can be determined with distribution-based, anchor-based, or qualitative methods [33, 37]. Although the ideal method is still under discussion, anchor-based methods are the most frequently used and preferred approaches [15, 29, 33, 40]. We used two anchor-based methods to determine the MICs for each PROM: the anchor mean change method and the MIC predict method [38, 39]. For both methods, we used satisfaction with treatment result as an anchor.

Anchor mean change methods determine the MIC based on the group of patients reporting minimal improvement on the anchor question [29]. Using the satisfaction with the treatment result as anchor question, the response option "fair" was considered a minimal improvement. Hence, the MIC was defined as the mean change in the PROM of interest of patients rating their satisfaction with treatment results as fair in the anchor mean change method. To determine whether the anchor was suitable for further analyses, we calculated the Spearman correlation coefficient between the anchor question and change on the PROM of interest. Following current standards, an absolute correlation at least 0.3 was considered sufficient [29].

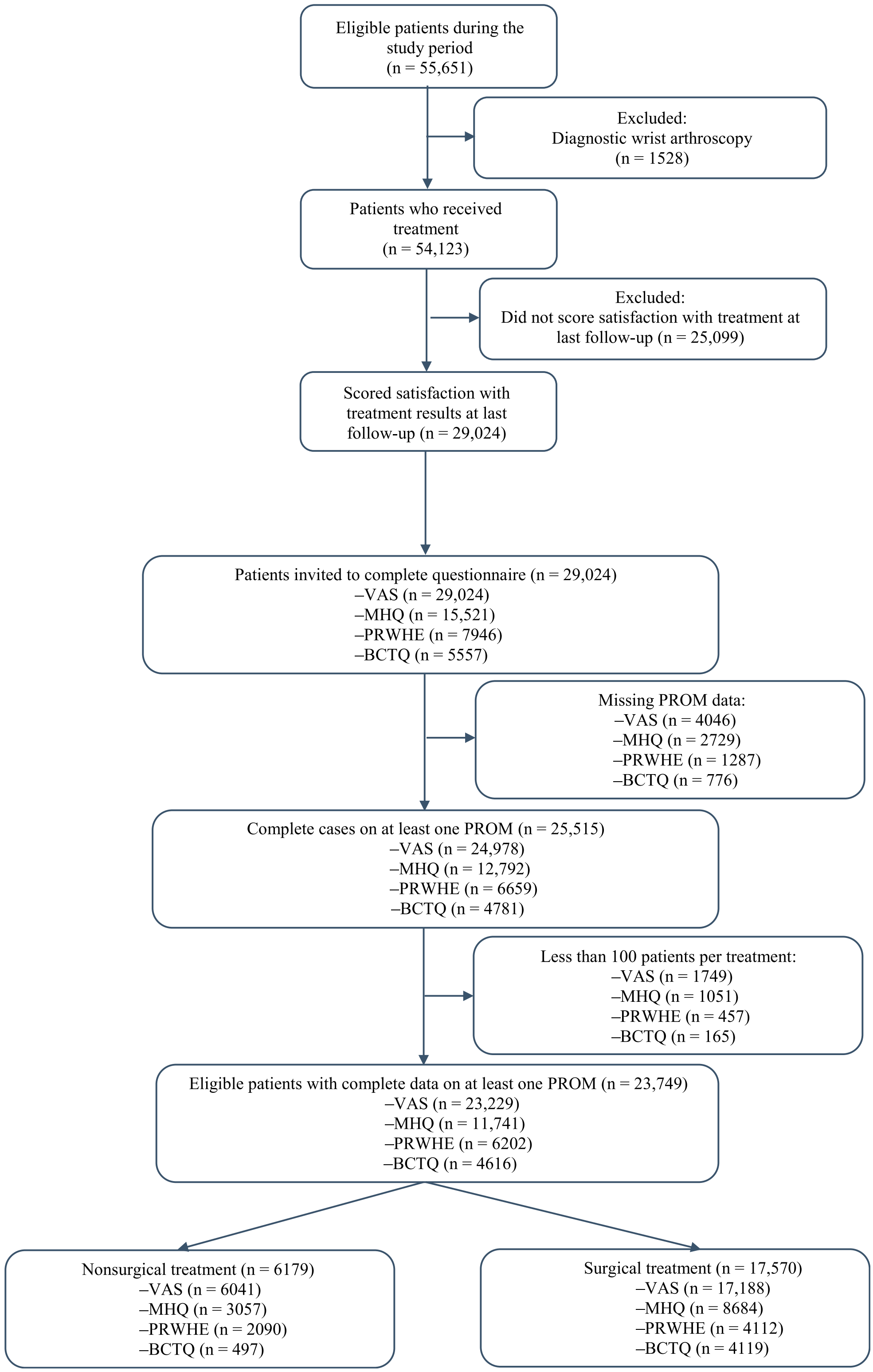

Fig. 1. This flowchart shows the patients who were included in our study. As patients were invited to complete the VAS and one other PROM most suitable for their diagnosis, the total number indicated at the top of the box is less than the total number of PROM responses.

Table 1. Patient characteristics per treatment group for patients with complete data for at least one PROM and satisfaction with treatment results

Parameter	All included patients (n = 23,749)	Nonsurgical treatment (n = 6179)	Surgical treatment (n = 17,570)
Age in years	55 ± 14	57 ± 15	55 ± 14
Gender			
Women	66 (15,593)	72 (4479)	63 (11,114)
Duration of symptoms in months	11 (5-24)	6 (3-15)	12 (6-24)
Hand dominance			
Right	88 (20,888)	89 (5488)	88 (15,400)
Left	9 (2107)	8 (500)	9 (1607)
Both	3 (754)	3 (191)	3 (563)
Affected side			
Right	55 (12,977)	52 (3239)	55 (9738)
Left	43 (10,242)	40 (2445)	44 (7797)
Both	2 (530)	8 (495)	0.2 (35)
Occupational intensity			
Not employed	38 (8920)	35 (2134)	39 (6786)
Light (such as working in an office)	27 (6346)	28 (1713)	26 (4633)
Moderate (such as working in a shop)	24 (5760)	26 (1635)	23 (4125)
Heavy (such as working in construction)	11 (2723)	11 (697)	12 (2026)
Involved in a personal injury claim[a]			
Yes	2 (311)	2 (102)	2 (209)

Data presented as mean ± SD, % (n), or median (IQR).
[a]This information was available for a selection of patients (all included patients: n = 17,413, nonsurgical treatment: n = 5193, surgical treatment: n = 12,220); PROM = patient-reported outcome measure.

Because MIC values depend on baseline values [1], we also reported the baseline values of all PROMs before nonsurgical treatment, minor surgery, and major surgery (Table 2).

The MIC predict method is a receiver operating characteristic method that provides more accurate estimates when the groups of satisfied and dissatisfied patients are not equal in size [38, 39]. Because receiver operating characteristic curve methods require dichotomization of the anchor question, patients rating their satisfaction with the treatment results as fair, good, or excellent were classified as satisfied. In contrast, we classified patients as dissatisfied if they rated their satisfaction as moderate or poor. We used the receiver operating characteristic curve method to determine the change in score on the PROM of interest that distinguished between satisfied and dissatisfied patients with the highest sensitivity and specificity, based on the Youden index [45]. Discriminative ability was considered sufficient if the area under the curve was at least 0.75 [10]. As mentioned, the MIC predict method allows for correction of imbalance in group sizes of satisfied and dissatisfied patients, because unequal group sizes may lead to biased MIC estimates [38, 39]. In our study, a larger proportion of patients were satisfied with their treatment (78% [4832 of 6179] for nonsurgical treatment and 86% [15,077 of 17,570] for surgical treatment). We therefore corrected the number of satisfied patients using logistic regression analysis, as described by Terluin et al. [38, 39]. To obtain a single MIC value, we triangulated the MIC estimates of both methods, assigning more weight (2:1) to the MIC predict method. The weighted mean of both methods was determined to represent the MIC.

To examine whether the MIC differs based on the invasiveness of the treatment, we compared the MICs of all PROM scores that were available for both nonsurgical and surgical treatment using a Wilcoxon signed rank test. We performed a nonresponder analysis to compare the characteristics of patients who completed all questionnaires of interest (47% [25,515 of 54,123] responders) and patients who did not (53% [28,608 of 54,123] nonresponders). For normally distributed continuous variables, we used t-tests. For nonnormally distributed continuous variables, we used the Wilcoxon test. Chi-square tests were used to compare categorical variables. Additionally, effect sizes for differences were calculated. We calculated the Cohen d for continuous variables and the Cliff delta for categorical variables. In the nonresponder analysis, we found differences in the type of treatment, age, gender, and

Table 2. Baseline PROM scores per type of treatment are shown to provide a reference on symptom severity before treatment and the relativity of the MIC

Parameter	PROM Range	Nonsurgical treatment, mean ± SD (n = 6179)	Surgical treatment, mean ± SD (n = 17,570)	Effect size
VAS pain during load	0-100	59 ± 25	55 ± 30	0.15
VAS pain at rest	0-100	35 ± 26	38 ± 28	-0.09
VAS average pain	0-100	49 ± 24	48 ± 27	0.07
VAS hand function	0-100	52 ± 25	50 ± 26	0.09
MHQ total score	0-100	62 ± 15	64 ± 18	-0.19
MHQ pain	0-100	50 ± 19	56 ± 24	-0.24
MHQ hand function	0-100	59 ± 18	62 ± 19	-0.12
MHQ work	0-100	63 ± 26	69 ± 28	-0.23
MHQ ADL	0-100	70 ± 20	74 ± 23	-0.20
MHQ aesthetics	0-100	82 ± 20	79 ± 20	0.17
MHQ satisfaction	0-100	46 ± 23	49 ± 26	-0.12
PRWHE total score	0-100	56 ± 21	60 ± 21	-0.20
PRWHE pain	0-50	30 ± 11	32 ± 10	-0.19
PRWHE hand function	0-50	26 ± 12	28 ± 12	-0.19
BCTQ symptom severity scale	1-5	2.6 ± 0.7	2.9 ± 0.7	-0.35
BCTQ functional status scale	1-5	2.3 ± 0.8	2.5 ± 0.8	-0.19

PROM = patient-reported outcome measure; MIC = minimum important change; MHQ = Michigan Hand outcomes Questionnaire; ADL = activities of daily living; PRWHE = Patient-Rated Wrist/Hand Evaluation; BCTQ = Boston Carpal Tunnel Questionnaire.

duration of symptoms (Supplementary Table 2; http://links.lww.com/CORR/A708), with absolute effect sizes ranging from 0.00 to 0.14, indicating very small effects [5]. All analyses were performed using R statistical software, version 4.0.1 (R core team). A p value smaller than 0.05 was considered statistically significant.

Results

MICs for Common Condition-Treatment Combinations

We observed substantial variation in the MICs for different condition-treatment combinations. For example, the MICs of VAS pain during load for nonsurgical treatment of hand osteoarthritis (OA) (including CMC-1 OA, STT OA, and MCP/PIP/DIP OA) clustered around 10 (interquartile range 8 to 11), for wrist osteotomy/carpectomy (including corrective osteotomy distal radius, ulnar shortening osteotomy, and proximal row carpectomy) the MIC was around 25 (IQR 24 to 27), and for nerve decompression (including cubital tunnel release and carpal tunnel release) it was 21 (Table 3). Additionally, the MICs of the MHQ total score ranged from 4 (nonsurgical treatment of CMC1 OA) to 15 (trapeziectomy with LRTI and bone tunnel) (Table 4), for the PRWHE total score it ranged from 2 (nonsurgical treatment of STT OA) to 29 (release of first extensor compartment) (Table 5), and for the BCTQ Symptom Severity Scale it ranged from 0.44 (nonsurgical treatment of carpal tunnel syndrome) to 0.87 (carpal tunnel release) (Table 6).

MIC values per calculation method and triangulated MIC values are freely available in an online application at https://analyse.equipezorgbedrijven.nl/shiny/mic-per-treatment/. This online application allows users to select a treatment for which all MIC values and more details of the MIC calculation for all available PROM subscales are shown.

MICs Vary with the Invasiveness of Treatment

We found that MICs among the combined treatment groups were lower for nonsurgical treatment compared with surgical treatment ($p < 0.001$) (Fig. 2). The MICs for nonsurgical treatment can be approximated to be one-ninth (IQR 0.08 to 0.13) of the scale (approximately 11 on a 100-point instrument), and surgical treatment had MICs that were approximately one-fifth (IQR 0.14 to 0.24) of the scale (approximately 19 on a 100-point instrument).

Discussion

Because the use of PROMs has become standard practice in clinical research, further insight into MICs for specific

Table 3. Triangulated MIC values per treatment (group) for VAS subscales pain during load, pain at rest, average pain, and hand function[a]

Parameter	VAS pain during load (0-100)	VAS pain at rest (0-100)	VAS average pain (0-100)	VAS hand function (0-100)
All	20	20	19	17
Nonsurgical treatment	13	12	11	10
Surgical treatment	23	23	23	19
Nonsurgical treatment				
Carpal tunnel syndrome	13	17	14	NA[b]
Cubital tunnel syndrome	-3	NA[c]	NA[c]	4
Tendinitis or tenosynovitis wrist	19	15	18	16
Trigger finger	13	12	10	10
Trigger thumb	17	11	15	10
CMC-1 OA	8	9	8	6
CMC-1 instability	14	13	13	14
STT OA	10	10	6	8
MCP/PIP/DIP OA	11	12	11	NA[b]
UCL/RCL/VP injury MCP/PIP/DIP	19	NA[c]	16	15
Mallet finger	NA[c]	NA[b]	NA[c]	12
Midcarpal instability or laxity	15	15	14	12
Minor surgical treatments				
Carpal tunnel release	21	28	25	18
Cubital tunnel release	21	21	21	17
Release of the first extensor compartment	32	27	28	24
Trigger finger release	24	21	21	18
Trigger thumb release	28	23	25	22
Excision of volar wrist ganglion	22	23	21	21
Excision of dorsal wrist ganglion	24	24	21	16
Mucoid cyst excision finger	13	17	12	13
Percutaneous needle aponeurotomy (possibly with lipofilling)	12	14	14	NA[b]
Major surgical treatments				
Corrective osteotomy distal radius	25	20	23	26
Ulnar shortening osteotomy	24	22	22	24
TFCC reinsertion	25	22	22	22
Proximal row carpectomy	27	21	25	18
Osteosynthesis for nonunion of scaphoid fracture	NA[b]	NA[c]	NA[b]	22
Pisiformectomy	25	20	23	21
Dorsal capsulodesis wrist (possibly combined with dorsal ganglion excision)	27	23	26	19
Three-ligament tenodesis (Brunelli)	23	17	19	19
Limited fasciectomy (possibly with skin graft)	14	18	14	19
Trapeziectomy with LRTI using the FCR (Weilby technique)	29	26	28	21

Table 3. continued

Parameter	VAS pain during load (0-100)	VAS pain at rest (0-100)	VAS average pain (0-100)	VAS hand function (0-100)
Trapeziectomy with LRTI using the FCR and bone tunnel (Burton-Pellegrini technique)	32	31	27	23
Other surgical treatments for CMC-1 OA	33	27	33	23
CMC-1 instability treated surgically	25	20	23	19
PIP prosthesis	30	NA[b]	NA[b]	13
UCL reinsertion MCP-1	25	NA[c]	NA[c]	23

[a]These scores represent the MIC per condition-treatment combination and for nonsurgical and surgical treatment overall.
[b]Insufficient correlation.
[c]Insufficient number of patients; MIC = minimum important change; CMC-1 = first carpometacarpal joint; OA = osteoarthritis; STT = scaphotrapeziotrapezoid joint; MCP = metacarpal joint; PIP = proximal interphalangeal joint; DIP = distal interphalangeal joint; UCL = ulnar collateral ligament; RCL = radial collateral ligament; VP = volar plate; TFCC = triangular fibrocartilage complex; LRTI = ligament reconstruction and tendon interposition; FCR = flexor carpi radialis tendon.

conditions and treatments is essential to accurately interpret whether a change is clinically relevant. In this large, multicenter study, we were able to provide condition-specific and treatment-specific MICs of four commonly used PROMs for hand and wrist conditions. This study shows that MICs differ between condition-treatment combinations. Furthermore, we found higher MICs for surgical treatments than for nonsurgical treatments. These findings indicate that the MIC is context-specific and that it may be misleading if applied inappropriately. Implementation of these condition-specific and treatment-specific MICs in clinical research allows for a better study design to achieve more accurate treatment evaluations. Consequently, this could aid clinicians in better informing patients about the expected treatment results and facilitate shared decision-making in clinical practice.

Limitations

This study also has several limitations. One limitation is that the observational design of this study was associated with a large proportion of missing data. However, although 53% (28,608 of 54,123) of patients did not complete all questionnaires of interest, our nonresponder analysis indicated that the differences between responders and nonresponders had very small effect sizes. Hence, we are confident that these small differences did not affect our findings.

A second limitation of the observational design with routine outcome measurement data is that the actual treatment may have deviated from these protocols based on the clinician's expertise and patient's preference despite our standardized treatment protocols. For example, there may be differences between patients in the number of hand therapy sessions or steroid injections. Although readers should be aware that the MICs we provided may be influenced by some variation in treatment strategies, these deviations are highly representative of actual daily practice, resulting in more generalizable MIC values.

Third, we only performed analyses on the effect of treatment invasiveness on the MIC. It is plausible that MICs also vary depending on cultural or sociodemographic characteristics [2]. To address this, two previous studies evaluated factors contributing to differences in MICs of several questionnaires in patients with adult spinal deformity [3, 46]. Interestingly, they demonstrated that MICs did not vary based on age or sex, whereas they found substantial differences based on the baseline severity [3]. Moreover, consistent with our findings, they found considerably higher MICs for surgical treatment than nonsurgical treatment on all questionnaires, suggesting that the invasiveness of the treatment may be a more influential factor than the sociodemographic characteristics [46].

Fourth, it is well-known that MICs can vary depending on the method used [24]. In this study, we only used anchor-based methods. Although the ideal method is still under discussion, anchor-based methods are generally preferred as these take into account relevant changes from the patient's perspective [15, 29, 33, 40]. We determined the MIC with an anchor question assessing satisfaction with the treatment result. Some authors recommend using an anchor question that is based on a scale that rates the change in outcome measured on that specific outcome domain [33]. However, the MIC is defined as "the smallest change in an outcome measure that patients perceive as important" [9]. Considering this definition, we believe that satisfaction with the treatment

Table 4. Triangulated MIC values per treatment (group) for the MHQ total score and MHQ subscales

Parameter	MHQ total score (0-100)	MHQ hand function (0-100)	MHQ work (0-100)	MHQ ADL (0-100)	MHQ pain (0-100)	MHQ aesthetics (0-100)	MHQ satisfaction (0-100)
All	8	5	11	12	12	11	16
Nonsurgical treatment	5	3	8	6	8	NA[a]	11
Surgical treatment	9	7	13	15	13	12	20
Nonsurgical treatment							
Trigger finger	7	5	7	NA[a]	11	8	14
Trigger thumb	7	5	10	7	12	NA[b]	14
CMC-1 OA	4	1	6	4	7	NA[a]	9
CMC-1 instability	5	7	12	6	10	NA[b]	14
MCP/PIP/DIP OA	6	NA[a]	7	NA[a]	9	NA[a]	12
UCL/RCL/VP injury MCP/PIP/DIP	7	NA[a]	NA[a]	12	8	NA[a]	11
Mallet finger	6	NA[b]	NA[b]	NA[b]	NA[b]	NA[b]	12
Minor surgical treatments							
Trigger finger release	8	8	10	14	13	11	19
Trigger thumb release	11	6	NA[a]	16	16	NA[a]	20
Mucoid cyst finger excision	4	1	NA[a]	NA[a]	6	10	6
Percutaneous needle aponeurotomy (possibly with lipofilling)	NA[a]	5	NA[a]	NA[a]	NA[a]	NA[a]	NA[a]
Major surgical treatments							
Limited fasciectomy (possibly with skin graft)	5	4	16	8	8	11	14
Trapeziectomy with LRTI using the FCR (Weilby technique)	14	9	12	19	19	NA[a]	24
Trapeziectomy with LRTI using the FCR and bone tunnel (Burton-Pellegrini technique)	15	9	16	19	18	NA[b]	24
Other surgical treatments for CMC-1 OA	15	10	112	21	22	NA[b]	25
CMC-1 instability treated surgically	13	9	18	13	18	NA[b]	21
PIP prosthesis	13	10	NA[a]	12	24	8	21
UCL reinsertion MCP-1	14	NA[b]	NA[b]	NA[b]	21	NA[b]	19

[a]Insufficient correlation.
[b]Insufficient number of patients; MIC = minimum important change; MHQ = Michigan Hand outcomes Questionnaire; ADL = activities of daily living; CMC-1 = first carpometacarpal joint; OA = osteoarthritis; MCP = metacarpal joint; PIP = proximal interphalangeal joint; DIP = distal interphalangeal joint; UCL = ulnar collateral ligament; RCL = radial collateral ligament; VP = volar plate; LRTI = ligament reconstruction and tendon interposition; FCR = flexor carpi radialis tendon.

Table 5. Triangulated MIC values per treatment (group) for the PRWHE total score and subscales

Parameter	PRWHE total score (0-100)	PRWHE pain score (0-50)	PRWHE function score (0-50)
All	20	10	11
Nonsurgical treatment	13	7	7
Surgical treatment	24	12	13
Nonsurgical treatment			
Tendinitis or tenosynovitis wrist	17	9	10
STT OA	2	2	1
Midcarpal instability or laxity	10	6	5
Minor surgical treatments			
Release of the first extensor compartment	29	14	16
Excision of volar wrist ganglion	16	9	9
Excision of dorsal wrist ganglion	20	11	10
Major surgical treatments			
Corrective osteotomy of the distal radius	26	11	15
Ulna shortening osteotomy	22	10	12
TFCC reinsertion	24	12	13
Proximal row carpectomy	21	12	10
Osteosynthesis for nonunion of scaphoid fracture	26	12	15
Pisiformectomy	24	11	13
Dorsal capsulodesis of the wrist (possibly combined with dorsal ganglion excision)	21	11	11
Three ligament tenodesis (Brunelli)	22	11	12

MIC = minimum important change; PRWE = Patient-Rated Wrist/Hand Evaluation; STT = scaphotrapeziotrapezoid joint; OA = osteoarthritis; TFCC = triangular fibrocartilage complex.

result is an accurate measure of patients' perceived improvement. This is also in line with prior studies in hand surgery, in which patient-reported satisfaction was commonly used as an anchor question [13, 18, 20, 21, 35]. However, by using this anchor question, we were unable to determine the MIC for all subdomains of all PROMs for all hand conditions because of a low correlation with the anchor question. This was primarily the case for the MHQ subdomain of aesthetics. Because the most profound complaints in these specific hand conditions are pain and difficulties with hand function, this subdomain might be irrelevant to these specific conditions, accounting for the low correlation with satisfaction.

Table 6. Triangulated MIC values per treatment (group) for BCTQ symptom severity scale and BCTQ functional status scale

	BCTQ symptom severity scale (1-5)	BCTQ functional status scale (1-5)
All	0.79	0.52
Nonsurgical treatment	0.43	0.32
Surgical treatment	0.84	0.56
Nonsurgical treatment		
Carpal tunnel syndrome	0.44	0.36
Cubital tunnel syndrome	NA[a]	NA[a]
Surgical treatment		
Carpal tunnel release	0.87	0.57
Cubital tunnel release	0.60	0.47

[a]Insufficient number of patients; MIC = minimum important change; BCTQ = Boston Carpal Tunnel Questionnaire.

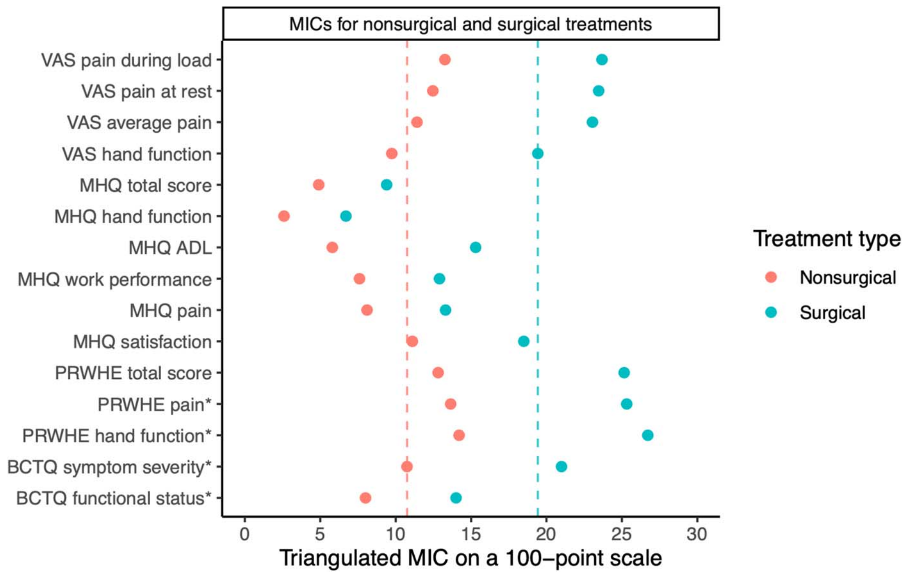

Fig. 2. This figure shows triangulated MIC values for the VAS, MHQ, PRWHE, and BCTQ, categorized by treatment group (nonsurgical and surgical). Results are presented as the triangulated MIC value (dots). For interpretability, we converted the PRWHE and BCTQ subscales (shown with an asterisk) to a 100-point scale. The dashed lines represent the median MIC values for nonsurgical (red) and surgical (blue) treatments. Overall, this figure shows that MIC values are higher for surgical treatments (median 19 points; IQR 14 to 24) compared with nonsurgical treatments (median 11 points; IQR 8 to 13). A color image accompanies the online version of this article.

Finally, we were unable to determine the smallest detectable change because patients were only asked to complete the PROMs once during the last measurement, which occurred post-treatment. Some MIC values we reported are low, and it is unclear whether these MIC values exceed the smallest detectable change for this specific outcome. This mostly occurred for nonsurgical treatments in combination with outcome domains that may not be the most relevant for these patients and where little improvement may be expected with treatment (for example, the VAS during load for nonsurgical treatment of cubital tunnel syndrome and MHQ hand function for nonsurgical treatment of CMC-1 osteoarthritis). However, as MICs should mainly be used to interpret clinically relevant changes on a group level, comparisons with the smallest detectable changes may be less important, because random measurement error may be canceled out at the group level [2].

MICs for Condition-Treatment Combinations

We found large differences in MICs for different condition-treatment combinations, indicating that MICs cannot be reliably applied to other condition-treatment combinations. This is in line with prior evidence, demonstrating substantial variation in MICs for different condition-treatment combinations. However, MICs for specific condition-treatment combinations are comparable to those reported in the evidence, including MICs for the BCTQ in patients undergoing carpal tunnel release [6] or cubital tunnel release [21] and for the MHQ in patients with a PIP prosthesis [22] or trigger finger release [13].

The comprehensive overview of MIC values provided in this study contributes to the application of more accurate MICs in clinical research, resulting in better treatment evaluations, which may improve patient counseling and management strategies [40]. For example, MICs can be used as a threshold to determine the percentage of patients reaching the MIC in clinical research. Insight into these percentages could aid clinicians in informing patients about the expected treatment results and may facilitate shared decision-making in clinical practice. However, although the percentage of patients reaching the MIC will probably be correct on a group level, this threshold may not apply to individual patients as all patients have an individual threshold of what they consider an important change. Therefore, it is highly recommended to use the MIC as a probabilistic value rather than a deterministic cutoff when applied to individual patients. Future studies may focus on adaptive techniques to achieve individualized MICs as proposed by Zhou et al. [47], which may ultimately aid clinicians in selecting the most appropriate treatment for individual patients.

MICs Vary with the Invasiveness of Treatment

The finding that MICs differ depending on the invasiveness of the intervention indicates that a more invasive treatment requires a larger improvement in these subdomains for patients to experience satisfaction with the treatment result. Patients receiving surgical treatment might experience more disability and discomfort from their treatment than patients receiving nonsurgical treatment. Consequently, patients treated nonsurgically may be more satisfied with their treatment result when they experience only a small improvement, resulting in a lower MIC.

Although it is plausible that the treatment invasiveness accounts for the variation in MICs, one might also suggest that differences in the groups being compared cause the variation. For example, the follow-up periods differed from 3 months for nonsurgical and minor surgical treatments to 12 months for major surgical treatments. A study in patients receiving decompression of ulnar neuropathy demonstrated that the MIC of the BCTQ was lower at 3 months than at 6 months [21]. However, they found no difference in the MIC at 6 and 12 months postoperatively, suggesting that the MIC is stable if the functional recovery period is reached. The follow-up periods we used in this study align with the International Consortium for Health Outcomes Measurement standard set for hand and wrist conditions, representing the clinical endpoints of the specific treatments [43]. Hence, despite differences in the follow-up periods between treatments, we believe these clinical endpoints are most suitable for assessing the final treatment effects.

In addition, another factor potentially contributing to these differences is variation in baseline characteristics [8, 42]. A study comparing the baseline characteristics of patients with CMC-1 osteoarthritis treated surgically and those treated nonsurgically found that surgically treated patients had worse baseline PROM scores, worse illness perceptions and catastrophization, and higher treatment expectations [44]. Although we only observed small differences in baseline scores between surgical and nonsurgical treatment groups, we did not take into account psychological characteristics and treatment expectations. It is plausible that patients with a worse psychological profile or higher treatment expectations may need more improvement to be satisfied with treatment results, resulting in a higher MIC. Future studies may examine factors contributing to these differences in MICs to improve expectation management for individual patients.

Conclusion

MICs differ between diagnosis-treatment combinations and particularly differ depending on the invasiveness of the intervention. These findings indicate that the MIC is context-specific and may be misleading if applied inappropriately. Hence, implementation of these condition-specific and treatment-specific MICs in clinical research allows for a better study design to achieve more accurate treatment evaluations. Consequently, this could aid clinicians in better informing patients about the expected treatment results and facilitate shared decision-making in clinical practice. Future studies may focus on adaptive techniques to achieve individualized MICs reflecting clinically relevant change to individuals instead of groups, which may ultimately aid clinicians in selecting the most appropriate treatment for individual patients.

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