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# Closing the loop: a 10-year experience with routine outcome measurements to improve treatment in hand surgery

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- Routine outcome measurements as a critical prerequisite of value-based healthcare have received considerable attention recently. There has been less attention for the last step in value-based healthcare where measurement of outcomes also leads to improvement in the quality of care. This is probably not without reason, since the last part of the learning cycle: ‘Closing the loop’, seems the hardest to implement.
- The journey from measuring outcomes to changing daily care can be troublesome. As early adopters of value-based healthcare, we would like to share our 10 years of experience in this journey.
- Examples of feedback loops are shown based on outcome measurements implemented to improve our daily care process as a focused hand surgery and hand therapy clinic.
- Feedback loops can be used to improve shared decision making, to monitor or predict treatment progression over time, for extreme value detection, improve journal clubs, and surgeon evaluation.
- Our goal as surgeons to improve treatment should not stop at the act of implementing routine outcome measurements.
- We should implement routine analysis and routine feedback loops, because real-time performance feedback can accelerate our learning cycle.

**Keywords:** dashboard; patient-reported experience measurements; patient-reported outcome measurements; scorecard; surgeon feedback loop; value-based healthcare

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## Introduction

Routine outcome measurements have been the mantra in healthcare for the past ten years and have been instigated to yield better outcomes.<sup>1</sup> However, in order to improve care, the outcome measurements must alter the way treatments are selected, shared decisions are made, or the treatments are executed. This process requires four consecutive steps: collecting the data, valuing the data, interpreting data, and using the data to change patient care.<sup>2</sup>

In 2008, we founded a private hand surgery clinic offering public service in the Netherlands. The startup position allowed for a complete redesign of hand surgery care. Early on, we added value-based healthcare (VBHC) principles such as integrated care, healthcare network, focused clinic, and routine outcome measurement.<sup>3</sup> In addition, management, hand surgeons, and a hand therapist attended Harvard Business School in collaborative teams to adopt the VBHC strategy.

While we successfully collected outcome data and used these for analysis and scientific research,<sup>4</sup> the most persistent part of this endeavour was to change our current practice based on these outcomes. Porter stated in his article on value-based healthcare that a feedback loop is essential for improving outcomes:<sup>3</sup> ‘Without such a

feedback loop, providers lack the requisite information for learning and improving'. We sought precise moments in the regular delivery of care to insert user-friendly feedback loops for patients, surgeons and hand therapists.

In this article, we review examples of strategies to implement feedback within the care process and describe how this has influenced our daily practice. We demonstrate improvements implemented in the following areas of shared decision making: baseline thresholds, individual prediction, progression over time, journal club, physician evaluation and extreme value detection.

## Patient cohort

Our integrated practice unit works as a fully integrated team of both hand surgeons and hand therapists entirely focused on hand and wrist care. We developed a web-based and open-source information system named Pulse<sup>5</sup> to collect data from patients, doctors, and therapists. Pulse provided us the necessary platform and tools to follow the outlined VBHC principles.

We started routine outcome monitoring in 2011 and have successfully integrated this with our daily care. Selles et al describe in our article in 2020<sup>4</sup> how we set out to measure the variety of treatments in our clinics. Our clinic currently consists of over 23 level 3 to 5 trained hand surgeons,<sup>6</sup> over 150 hand therapists, and 22 centres for hand and wrist surgery.

We have currently gathered baseline and follow-up information of more than 86,000 surgical and non-surgical treatments, with over 500,000 patient-reported outcomes. Data analysis and peer-reviewed publications are guided by the Hand Wrist Study Group, a partnership of Xpert Clinics, Erasmus MC – University Medical Centre Rotterdam, and other national and international collaborators. Currently, we publish over 15 peer-reviewed articles a year.

This review includes data from patients treated conservatively or surgically between December 2011 and December 2020. These data are prospectively gathered on a consecutive cohort of patients treated in daily hand surgery practice. Patients were invited to be part of a routine system for outcome measurement after their first consultation with a surgeon. Upon agreement, they received questionnaires distributed via email. Patients were asked to complete validated Dutch versions of hand-specific patient-reported outcome measurements (PROMs) at baseline and after surgery depending on the type of treatment.<sup>7</sup> Amongst other PROMs, we use the Boston Carpal Tunnel Questionnaire (BCTQ), Patient Rated Wrist/Hand Evaluation (PRWE),<sup>8</sup> and Michigan Hand outcome Questionnaire (MHQ). Additionally, patients receive questionnaires on satisfaction with the treatment results, their return to work, and patient-reported

experience measurements (PREMs). This routine system also included measurements by trained hand therapists of the range of motion and grip strength for the more extensive surgical treatments.

We collect the data reported in this review as part of routine clinical care and ask all patients for permission to use their data anonymously for scientific research. If a patient does not provide informed consent, the data are only used for direct healthcare purposes but not for scientific analysis. Patients can always withdraw their consent. Approval from the local medical ethical review board is obtained for each scientific study that uses the data.

## The team

To close the loop between the data entered by patients and hand therapists and the provided care, we have constructed a team of IT specialists, epidemiologists, statisticians, and researchers who work with the hand surgeons and hand therapists to provide meaningful analyses of the data. In this collaboration, physicians' questions and requests are translated into research questions, data analyses, and, ultimately, into improvements in care delivery.

## Results

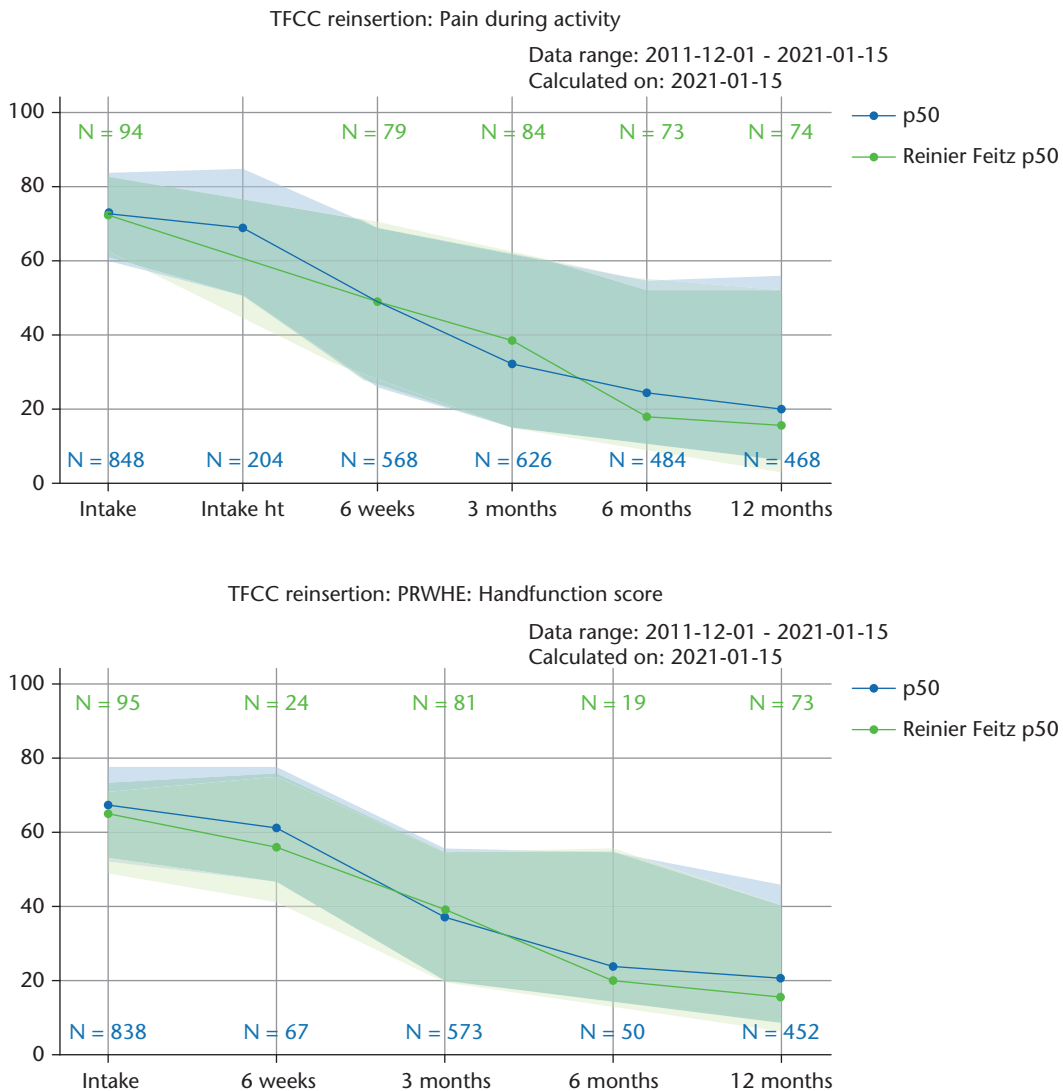
Below, we will first illustrate how we use the outcome data to improve care by directly returning outcome data to our patients for shared decision making, patient selection by baseline thresholds, individual prediction of treatment results, and outcome progression over time for an individual patient. Second, we will describe how our surgeons and therapists use feedback loops as part of their ongoing learning process in our journal club and physician evaluation. Finally, we show how we use extreme value detection to intervene when needed to support the role of patients, physicians, and management.

## Shared decision making

In shared decision making, the healthcare provider discusses the diagnosis and treatment options together with the patient. The patient describes his or her goals and wishes, and the healthcare provider discusses the outcomes and uncertainties of the different treatment options.

We use our data in various ways to optimize this shared decision making process. For example, we have developed graphs to show our outcomes for all treatments we provide (see Fig. 1). These graphs allow patients to understand the average recovery of previous patients and the variation in results. In this way, we can transparently discuss the outcome based on our actual data and manage the patient's expectations, enabling us to objectively answer the questions that insurers, patient organizations,

Treatment: TFCC reinsertion | Location: n/a | Physician: Reinier Feitz | Patient: n/a



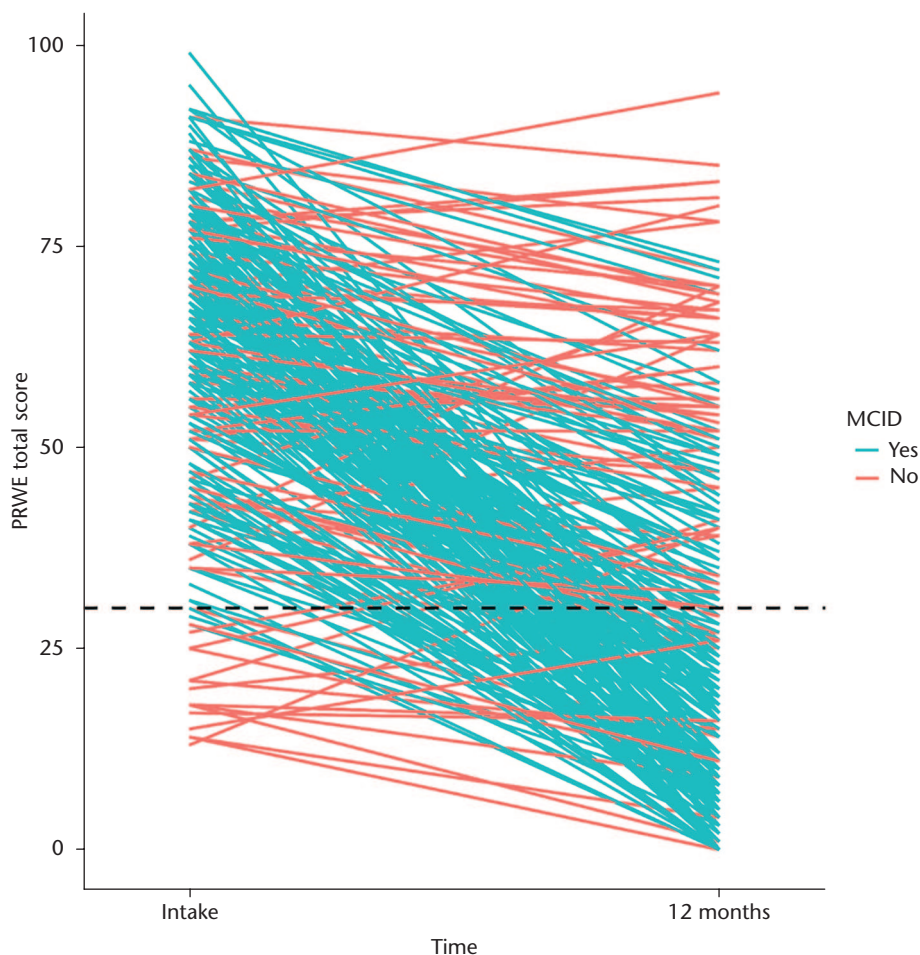
**Fig. 1** Results of triangular fibrocartilage complex (TFCC) surgery of one specific surgeon. The graph depicts the outcome for open TFCC surgery from baseline to 12 months post surgery for pain during activity and function via the PRWE score. The green line is the median (p50) surgeon’s personal result (1st author) of his 94 cases versus the total of 848 patients in the database. The shaded areas illustrate the range of the 25th to 75th percentile for both the surgeon and the population. Also shown are the numbers of filled-in questionnaires as each time point used to calculate the graph. These outcome pictures are used in shared decision making to help the patient decide whether or not to opt for this procedure.

Note. PRWE, Patient Rated Wrist/Hand Evaluation.

and patients’ family members instruct patients nowadays to ask: ‘What are the expected outcomes?’ and ‘How often do you do this particular surgery?’. Formerly, we would answer these questions by citing literature mixed with personal opinion and personal experiences. With these tools, we can give an exact and real-time answer to these questions using our routine outcome measurements.

### Baseline thresholds

Baseline PROM values can guide indication for surgery.<sup>9,10</sup> Installing thresholds for baseline values that are necessary to obtain a successful outcome of surgical intervention may improve the overall result. For example, a patient may demand a specific surgical procedure while



**Fig. 2** Plot of individual patients on PRWE results after open TFCC surgery. Chances of reaching a Minimal Clinical Important Difference (MCID) are minimal for a baseline PRWE lower than 34. Blue lines are patients who reached MCID, red lines for patients who failed to reach MCID (< 17).

Note. PRWE, Patient Rated Wrist/Hand Evaluation; TFCC, triangular fibrocartilage complex.

the treating physician thinks that the indication is weak. Arguments against such a demand for intervention can be difficult and often imply weighing a patient’s complaints on scales for pain and activity. This process may feel subjective for both patient and physician. However, low baseline levels of pain and slightly impaired function give little room for improvement in pain or function post surgery. When we looked at the specific situation of open surgery for triangular fibrocartilage complex (TFCC) problems, we found examples of this situation (see Fig. 2). The communication of a tear in the TFCC at wrist arthroscopy might provoke a response in the patient that this tear needs to be repaired<sup>11</sup> even though initial complaints might occasionally occur. When we analysed our series of open surgery for TFCC, the baseline PRWE proved to be a good indicator of the outcome. More specifically, chances of reaching a Minimal Clinical Important Difference (> 17 points on the PRWE scale) are minimal for a baseline PRWE lower than 34.

To select the patients who benefit from our surgical intervention, we designed a warning system that informs our surgeons to reconsider when scheduling a patient with baseline PRWE below 34.

### Individual prediction of treatment results

As a next step to provide patients with information about the results of previous patients, we are in the process of implementing individual prediction models of expected outcomes based on our data. This will further detail the predictions since it can take other predictive variables into account, such as age, gender, the severity of complaints, and duration of complaints. We have currently developed prediction models for Dupuytren’s disease<sup>11</sup> and carpal tunnel release (CTR).<sup>12</sup> While these are at present stand-alone online tools, they will be coupled to our data collection systems and patient dashboards in the near future.

Preliminary predicted outcome

1. Complete the following questions to see a prediction

BCTQ symptom severity scale  
Scale for the severity of complaints, you can enter the score that has already been calculated. It is also possible to calculate the score by clicking below this box, when you do, it will automatically be inserted here. The score will be between 1.0 and 5.0

2.3

Click to calculate BCTQ score

To what extent do you experience pain or discomfort? Moderately

How did you experience your hand function the past week?  
20 = no function, 100 = complete function

Have you had problems with local anesthesia?  
(e.g., at the dentist?) Yes

Do you now or have you ever smoked? No, never

Are you currently being treated by a medical doctor? No

How many hours do you currently work each week? Between 20 and 30

Calculate predicted outcome

2. See the prediction here

Probability that your symptoms will improve\* six months postoperatively:

■ Improved

■ Not improved

The probability of improvement is 72%

\* This percentage is the probability of a relevant improvement in symptoms six months after carpal tunnel release surgery. We combine all different types of symptoms, such as tingling, pain, numbness, and poor sleep.

**Fig. 3** Prediction model carpal tunnel release (CTR). Patients and caregivers fill in several items, for example, the Symptom Severity Scale of the BCTQ and the degree of pain. A chance is then displayed that the complaints will improve after CTR. This tool has been made publicly available online: <https://analyse.equipezorgbedrijven.nl/shiny/cts-infographic/>

Note. BCTQ, Boston Carpal Tunnel Questionnaire.

This way, the patient's data can be sent directly to the prediction model to predict whether the individual patient will reach the Minimal Clinically Important Difference, for example, on the BCTQ score following a CTR (Fig. 3).

### Outcome progression over time

During follow-up visits at the outpatient clinic, clinicians are informed beforehand about the patient's progress if they have answered all questionnaires. The patient's results are plotted in a graph against all previous patients (see Fig. 4). This can help us to understand the phase of recovery of the individual patient. For example, many patients will experience some residual pain in the early weeks after surgery and may want to know if that is normal or acceptable. The graph thereby serves as a tool for discussing and evaluating the patient's goals during rehabilitation. Based on the results of outcome measurements, therapy can be adjusted. For example, if strength is still clearly reduced compared to the preoperative situation, hand therapists and patients may focus more on strength training. Also, it motivates the patients to keep answering the questionnaires we send them.

### Utilization of the journal club

Having the possibility to conduct real-time or almost real-time analysis of our cohort also created new dimensions for our journal club. Just as other groups of clinicians, we discuss current literature in hand surgery on a monthly basis. Typically, clinicians discuss published

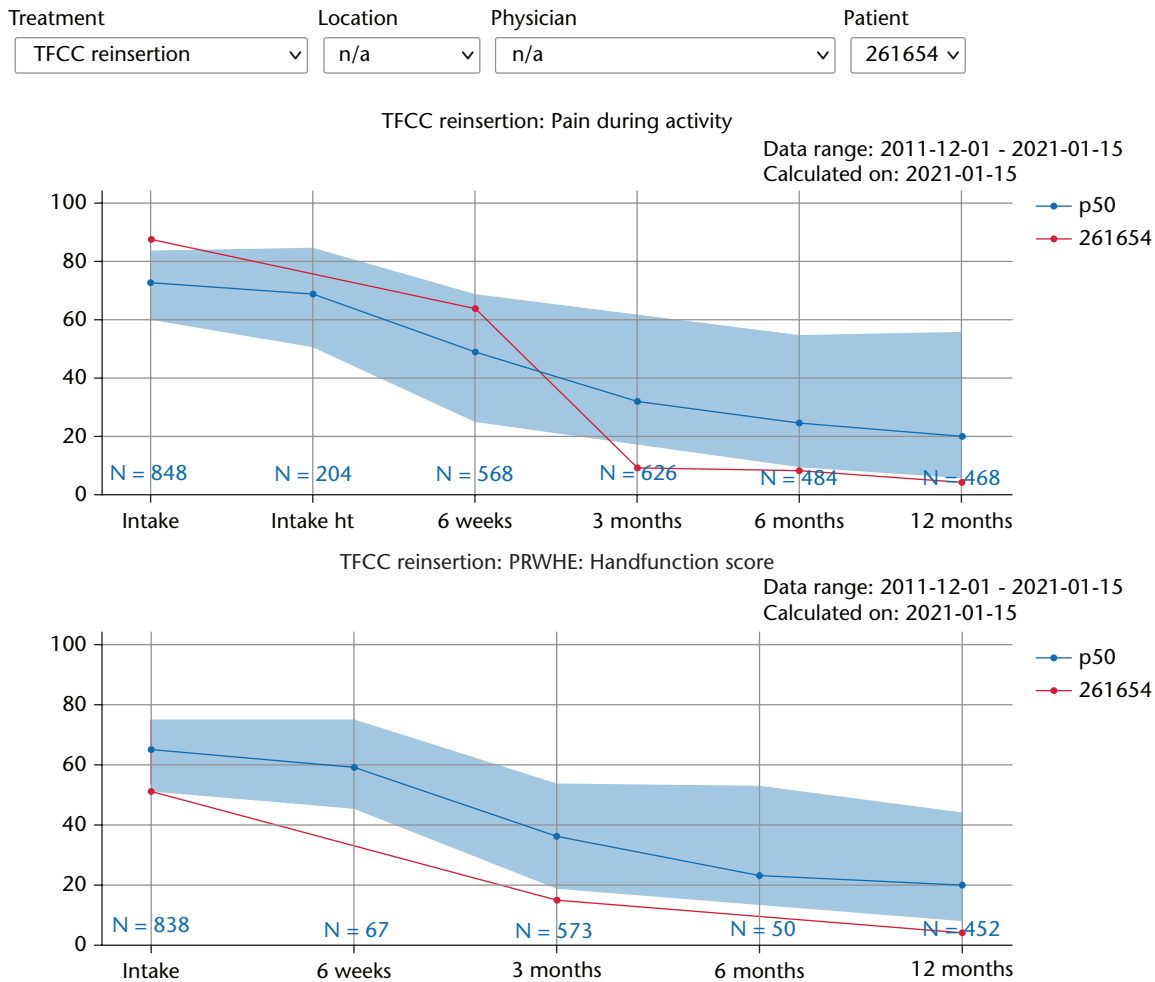
literature and whether we should alter our treatment algorithms. Personal opinion and experience would direct discussions at large.

We improved learning by adding our own outcomes to the arguments. To do so, one of our PhD candidates or researchers is present at these meetings and can analyse our database in real time or prepare a more complex analysis. For example, during the journal club about radial tunnel release, the researcher made a plot (Fig. 5) to show the BCTQ over time of our results. Another example was during a journal club where we evaluated a change in the postoperative regime. Based on surgeon preferences, patients received a shorter, less postoperative regiment. During the journal club, the researcher showed that both regimens yielded equal outcomes. Based on this, we reached a consensus for immobilization following surgery for thumb-base osteoarthritis. Specifically, we now give patients a cast for three to five days, followed by a removable thermoplastic orthosis. This allowed for earlier onset of hand therapy and more comfort after surgery for our patients. In turn, these discussions led to the publication of a peer-reviewed article.<sup>13</sup>

### Physician evaluation

The outcome data also provide surgeons with regular updates about their overall performance. To do so, surgeons receive quarterly updates about their performance across the following domains: financial and operational excellence, communication and service, and medical outcomes of three commonly performed surgical procedures.





**Fig. 4** Results of patient 261654 routinely plotted against the overall outcome for TFCC injury. The red line shows the patient’s progress for the pain during activity and the PRWHE score. The shaded areas illustrate the range of the 25th to 75th percentile for the total population. These outcome pictures are used to evaluate the rehabilitation of each individual patient.

Note. TFCC, triangular fibrocartilage complex; PRWHE, Patient Rated Wrist/Hand Evaluation.

By using a Plan-Do-Check-Act (PDCA) cycle, we can continuously improve on these domains.

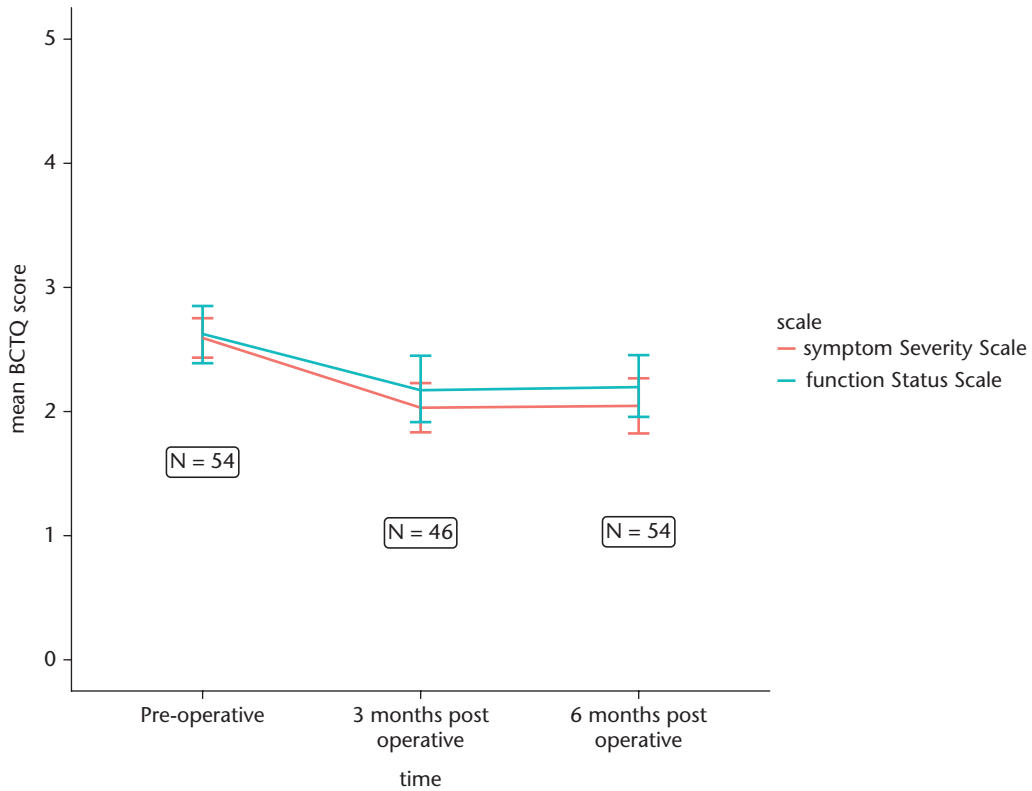
In the *Financial and operational excellence* domain, we provide information on several financial and operational parameters such as the number of new consultations, revenue in the outpatient clinic, revenue in the surgical theatre, number of procedures, total surgical fee, percentage of conservative treatment, and case-mix complexity.

In the *communication and service* domain, we provide information on PREM outcomes. We decided on the Net Promotor Score (NPS)<sup>14</sup> as a proxy for patient experience. The question asked is: ‘How likely would you be to recommend the clinic to other people with the same condition or symptoms on a 0–10 scale?’. The NPS is calculated by subtracting the percentage of detractors (rating 0–6) from the percentage of promoters (rating 9 or 10). Hence NPS can vary between –100 to +100. Our goal is to stay

above +50, whereas the average NPS for Dutch hospitals was +18 in 2019.<sup>15</sup> The NPS for the individual doctor (see Fig. 6) and regional network (see Fig. 7) are shown longitudinally to analyse trends.

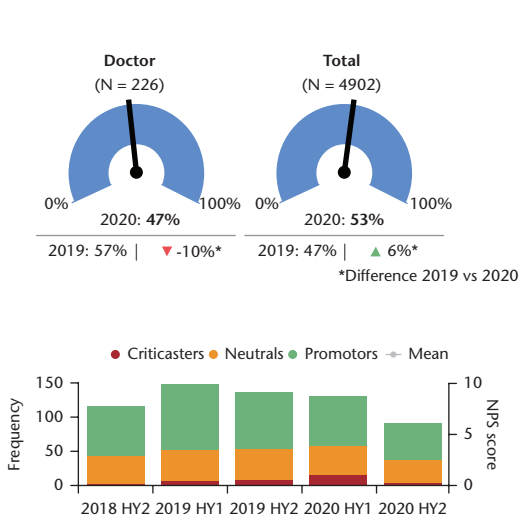
Various subdomains for patient experience are also monitored to provide surgeons and regional networks with actionable insights that can boost NPS score. Perception of the surgeon by the patient regarding knowledgeability, seriously listening, taking time, information about expected result, information about the treatment, opportunity to raise questions, understandable explanation, shared decision making, welcome at the clinic, cooperation between healthcare providers, and waiting time before the consultation are rated (see Fig. 8). Also, an overview of compliments and complaints is presented.

In the *medical outcomes* domain, we provide information on three commonly performed surgeries: trapeziectomy,

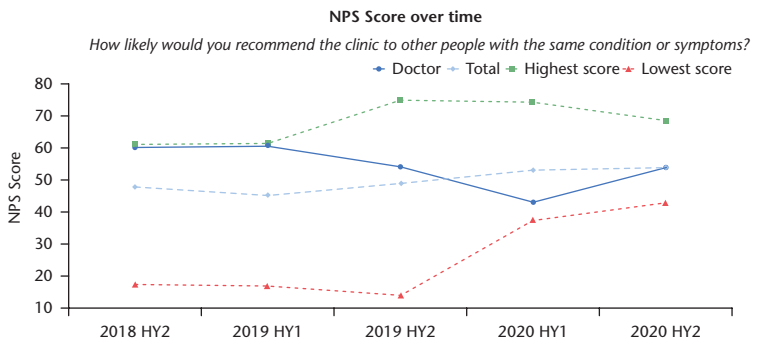


**Fig. 5** Results of a journal club. Surgeons were interested in the outcomes of radial tunnel releases. This figure depicts the outcome of radial tunnel releases on the BCTQ over time. The researcher made a plot of 54 patients, for whom data were available, and presented this figure at a journal club meeting.

Note. BCTQ, Boston Carpal Tunnel Questionnaire.



**NPS Score**



Half year	N doctor	N Total
2020 HY2	93	1,960
2018 HY2	120	1,659
2020 HY1	133	2,942
2019 HY2	139	2,236
2019 HY1	150	2,069

**Fig. 6** Screenshot of the Net Promotor Score (NPS) dashboard. The NPS is shown per year and overtime per half year. Also, the distribution of promoters, neutrals, and criticasters is shown.

CTR, and three-ligament tendon reconstruction of the wrist. For each treatment, medical outcome is shown for the individual physician relative to the overall average.

The graphs used are similar to the one shown in Fig. 1 for TFCC outcome. These physician scores may appear as the most direct exposure of an individual’s surgical talent but



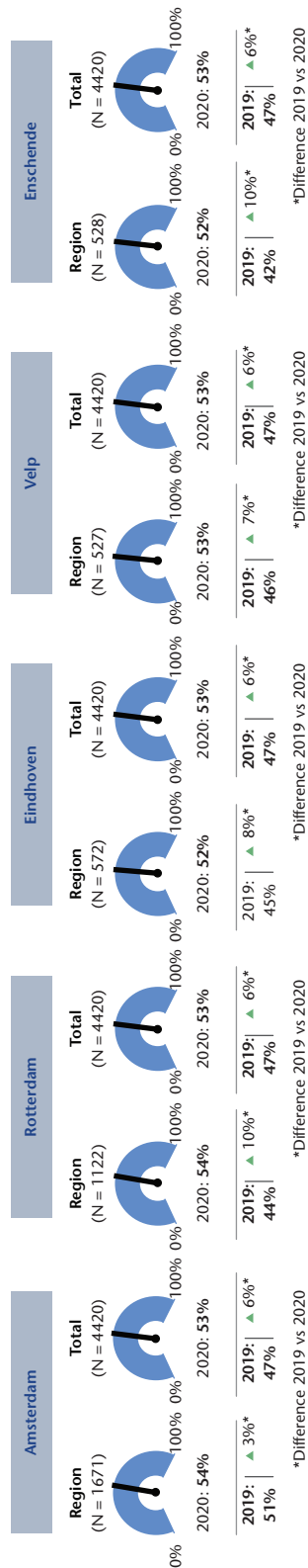


Fig. 7 Net Promotor Score (NPS) for each regional network in the Netherlands.

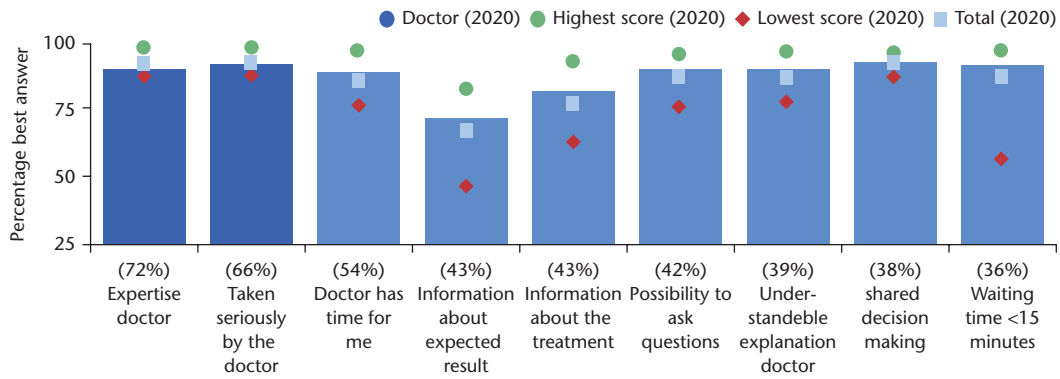
proved to be rather uneventful. The chosen commonly performed procedures are carried out in high volumes. In the last years, we learned that in our population of highly specialized surgeons, individual patients’ outcomes vary widely but that all our surgeons score close to the average with no outliers. Apart from this, an overview of complications is presented.

### Extreme value detection

Post-surgery complications that occur after discharge from the hospital or clinic often have a gradual onset. Developing an infection, or plaster of Paris that becomes tight due to postoperative swelling are examples of such problems. Therefore, we routinely monitor postoperative pain levels. Whenever a patient enters a visual analogue pain at rest score (VAS) equal to or above 70 (scale 0–100), this will trigger an email to the nursing staff. They will seek contact with the patient as soon as possible to evaluate whether a change in the treatment plan is needed. This module allows for early detection of potential complications. It diverts emergency calls or out of office hours visits into planned visits, early plaster release, or early start with antibiotic therapy. Another effect is that well-trained and knowledgeable medical staff, most commonly a hand therapist or nurse, handle these alerts at an overall lower cost. The same detection system is used for outlier negative experience that can lead to early detection and intervention of miscommunication or other reasons for a negative experience which would otherwise go unnoticed.

### Discussion

How can individual patient treatment and outcomes benefit from routine outcome measurements? Outcome registration in general requires participation and altruistic effort from the individual patient to fill out questionnaires to benefit future patients. Our data and feedback have transformed our shared decision making process. We use our outcome registration to inform patients transparently about our outcomes in general, for individual prediction of outcome, and for their personal treatment progression over time. Usually, when patients participate in scientific research, it affects future patients’ treatment; whereas in our clinic it is an integrated part of their treatment experience. Patients undergo orthopaedic surgery in order to relieve pain or improve function. Therefore, our surgery and conservative treatment results should be monitored, and the results should ideally be fed back to inform our patients.<sup>16</sup> Compliance of our patients in answering the questionnaires and the medical staff’s compliance in using the feedback information presented have been, and still are, the biggest challenges we face.



**Fig. 8** Patient-reported experience measurements (PREM); perception of the surgeon by the patient regarding knowledgeability, seriously listening, taking time, information about expected result, communication over the treatment, opportunity to raise questions, understandable explanation, shared decision making, waiting time before the consultation.



**Fig. 9** The handwheel, ICHOM standard set for hand and wrist conditions. Reproduced with permission of ICHOM ([www.ichom.org](http://www.ichom.org)). Note. ICHOM, International Consortium for Health Outcomes Measurement.

In addition to the importance for our patients, the routine outcome measurements support clinicians to discuss expectations with patients and provide information about treatment results. They enable the clinicians to evaluate the rehabilitation progress of their individual patients as well as overall outcome per treatment. Our database helps to reference and guide discussions in our journal club. Surgeon scorecards give our surgical team feedback on their overall and individual performance in various domains. A question that comes to mind is the managerial consequence of the available data on physicians. Upfront, we asked our surgeons whether they wanted the information to be anonymized or to include individual surgeon names. Uniformly they decided on the latter. Up to this moment, the individual scores are only visible to surgeons and the medical director but are blinded for overall management or other staff. Literature shows that resistance among the professionals may exist for implementing scorecards or surgeon outcomes.<sup>17–20</sup> We did not experience any resistance and were, in fact, encouraged by our surgical staff. The intention was to install feedback loops without being judgmental. Surgeons, who experienced over 12 years of medical training, are, in general, competitive and need no further enhancement other than feedback information.

The last example shared in this article was extreme value detection. This feature demonstrated benefits for all parties involved. The patient with an outlier level of pain receives early intervention for this pain. The surgeon profits from early detection and intervention of possible complications or complaints. Management and clinic profit from a decline in hours needed for handling complications by less costly staff during regular hours.

We believe that there are also disease-independent lessons to be learned. We tend to be more cautious when a patient has low baseline scores (i.e. low pain, good hand function). Another important consideration is a very high baseline score on either pain or low functional score. We now know and can discuss with our patients that they are likely to end up with more than an average improvement on pain and function while they will still experience more than average postoperative pain and function loss. We have shown these effects for scapho-lunate ligament reconstruction,<sup>21</sup> carpal tunnel disease,<sup>22</sup> thumb osteoarthritis,<sup>23</sup> Dupuytren's,<sup>24</sup> Quervain's disease,<sup>25</sup> and open TFCC surgery.<sup>26</sup> Although it is hard to prove that we deliver better care than before the start of registering outcome data, we believe that these feedback loops improved our advice in the shared-decision process.

General evidence supporting PDCA cycles is abundant. Articles on individual surgeons' performance measurements are scarce and especially for data on the positive impact of measuring surgical performance on medical outcome.<sup>27</sup> Thoracic surgeons seem to lead the way<sup>18</sup> with

the obvious advantage of large databases and absolute outcome metrics such as cardiac failure or death. Direct feedback regarding urologists' percentage of positive resection margins led to an improvement of outcome in a study by R. S. Matulewicz.<sup>19</sup> A French study on a nationwide scale demonstrated a positive correlation with the outcome of care after implementing control cards.<sup>20</sup> Our future goals will be to implement the new International Consortium for Health Outcomes Measurement (ICHOM) set for hand wrist disorders<sup>28</sup> (see Fig. 9), improve dashboards for patients, surgeons, and therapists. And, finally, to get compliance up to 80% so we can collect data for level I studies continuously.

## Conclusion

Our goal as surgeons to improve treatment should not stop at the act of implementing routine outcome measurements. In addition, we should implement routine analysis and feedback loops so we accelerate our learning cycle and thus improve treatments. We share some practical examples of how routine outcome measurements with the right feedback loops can improve daily clinical care, which benefits patients, therapists, surgeons, and management. We realize that these examples give no evidence that they improve health outcomes. However, in order to improve outcomes, we first need to be informed about them. Adding real-time performance feedback has accelerated our learning cycle and has convinced us that we better understand our results.

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<sup>5</sup>For full details see Appendix 1.

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SERH reports he is a part-time practising hand surgeon and board member for Equipe Zorgbedrijven and payment for lectures including service on speakers bureaux from scientific institutions for lectures in general, all outside the submitted work.

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## Appendix 1

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