

Relying on Raw Scores? You Might Be Missing the Full Picture: A Clinical Guide to Transforming Raw Scores into Meaningful Measures and Detecting Change

- Your patient scored higher on a standardized assessment, but did they really get better?
- Your patient scored lower on a standardized assessment, should you be concerned?
- Could you be missing real improvement (or decline) by relying on total scores?



Picture 1. Communicating raw scores with family members is complicated, especially in conditions with a lot of uncertainty, like severe brain injury.

Why This Matters

- Patients recovering from TBI, stroke, or critical illness show complex and variable progress.
- As a rehabilitation profession, **we rely on assessment scores to guide care** – but all scores contain error!
- For some patients, relying on total, raw scores may mask **real change** (i.e., beyond measurement error), resulting in delays in care or even denial of rehabilitation services.^{1,2}
- This guide provides a four-step, simple guide to easily **detect real change** using advanced measurement concepts (Figure 1).

Clinical Scenario

Jared (28) sustained a severe TBI. You are using the Coma Recovery Scale – Revised (CRS-R) to track his neurobehavioral recovery. At admission to rehab, Jared's CRS-R score was 2 out of 23 points. Two weeks later, Jared's CRS-R score was 6 out of 23 points. Based on how the CRS-R has been mapped to states of consciousness in severe brain injury, this means that he is still in the unresponsive wakefulness syndrome (Picture 1). The CRS-R raw score tells us that Jared is improving but we cannot determine if this change is 'true' change beyond measurement error because raw scores do not describe the magnitude of change.

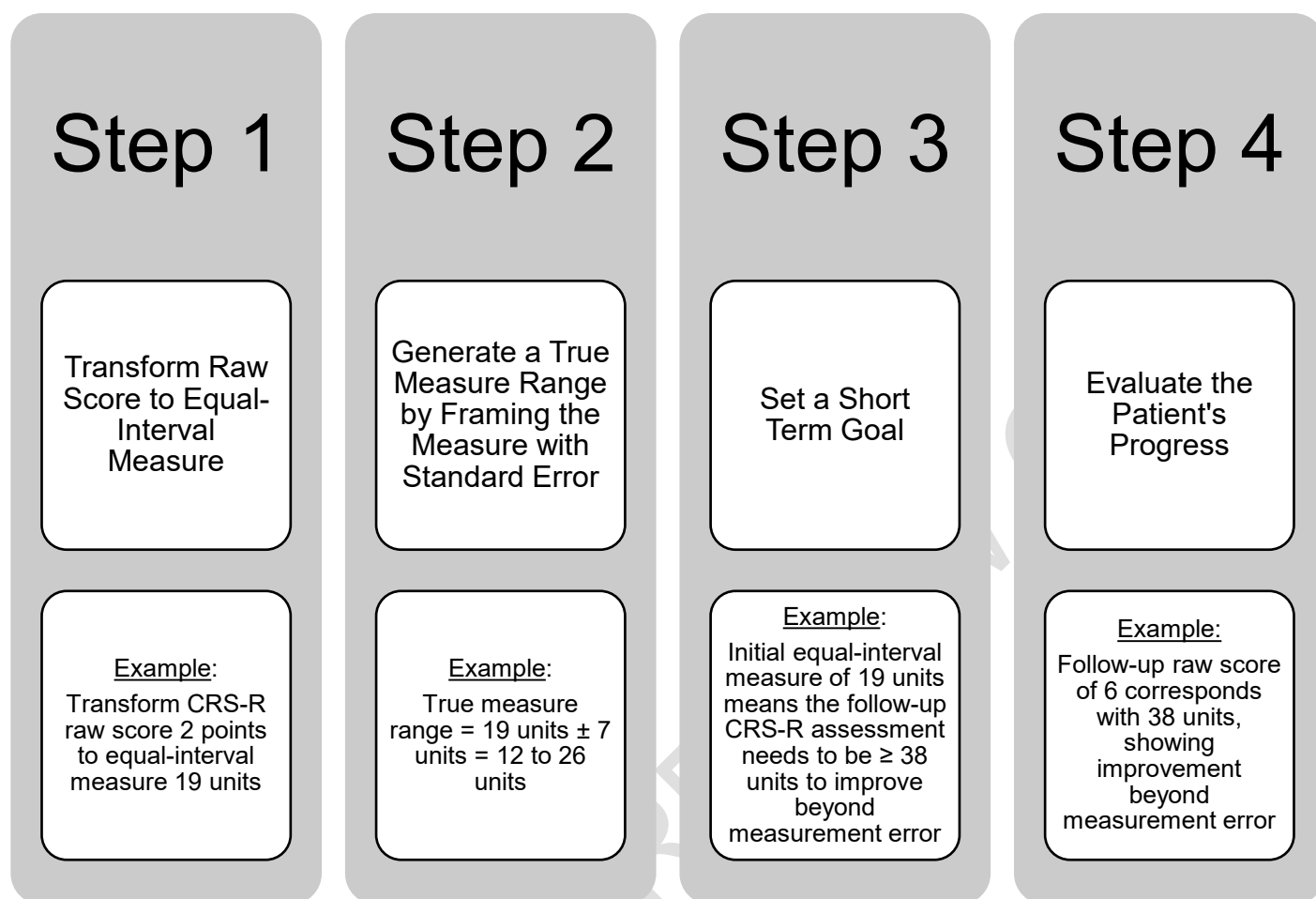


Figure 1. A four-step process for detecting real change using standardized assessment scores.

How to Incorporate These Four Steps into your Clinical Practice & Documentation

Step 1: Transform Raw Scores to Equal-Interval Measures

- Raw scores are **ordinal**. This means that they show *direction* of change, but not *magnitude*.
- Rasch-transformed **equal-interval measures** show *direction and magnitude* of change.^{1,3}
- Clinical Documentation: Jared's initial CRS-R score of 2 out of 23 points can be transformed to an equal-interval measure of 19 units.
- How do I do this? Use **Table 1**. Find your patient's initial raw score in Column 1. Look to Column 2 for the transformed measure.

Step 2: Generate a True Measure Range by Framing the Measure with Standard Error

- Every score/measure has a **standard error (SE)**, which represents the estimated uncertainty around that point.⁴
- The patient's true measure range is the **observed measure $\pm$ SE**
- When using Rasch-transformed measures, SE is usually larger at ends of the scale.
- Clinical Documentation: Jared's initial measure of 19 out of 100 units is associated with an SE of 7 units. His true measure range is between 12 and 26 units.

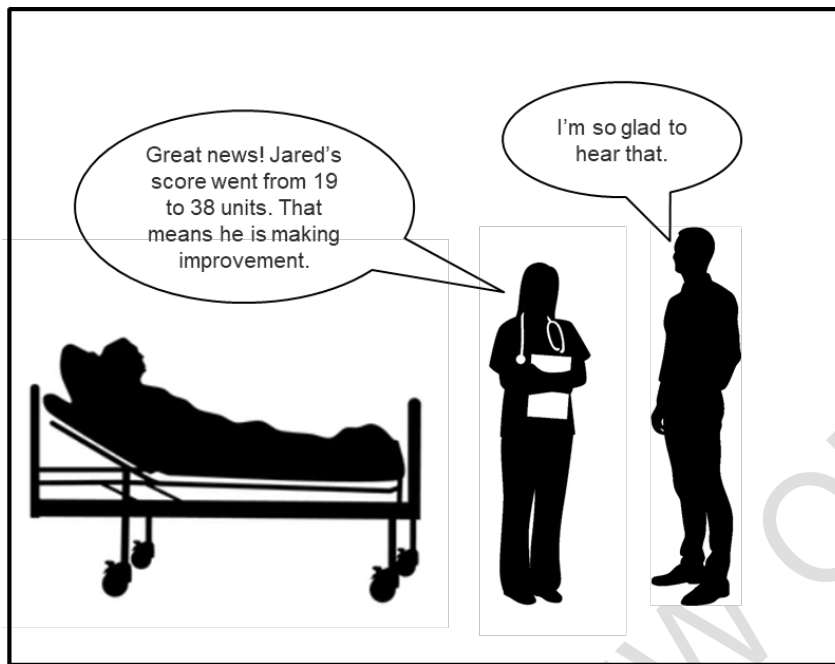
- How do I do this? Use **Table 1**. Find your patient's transformed measure in Column 2. Look to Column 3 for the SE for that measure.

Step 3: Set a Short Term Goal Using the Conditional Minimal Detectable Change

- **Conditional minimal detectable change (cMDC)** look-up tables can help you identify the change needed to exceed the tool's measurement error.
- **cMDCs** are adjusted for where the patient's first and follow-up measure.^{2,5}
- cMDCs can help you set realistic goals and identify when the patient is making a change that exceeds measurement error.
- Clinical Documentation: Jared's initial equal-interval measure of 19 units (true measure range 12 to 26 units) means that his follow-up CRS-R assessment needs to be at 38 units to improve beyond measurement error.
- How do I do this? Use **Table 1**. Find your patient's initial measure in Column 2. Then, look across the table to identify what the next measure needs to be to indicate improvement (Column 6).

Step 4: Evaluate the Patient's Progress

- The cMDC matrix (Figure 2) allows you to quickly evaluate whether the difference between two measures is within or beyond measurement error.^{2,5}
- Knowing whether changes are within or beyond measurement error can help you make clinical decisions, such as continuing or revising a plan of care, or consulting with interdisciplinary team members.
- Clinical Documentation: Jared's CRS-R measure of 38 units indicates improvement beyond measurement error from his previous assessment on [insert date].
- How do I do this? Use **Figure 2**. Find your patient's **initial score** on the left side and the **follow-up score** across the top. Then locate the intersecting cell in the matrix.
 - If the cell is in the white upper triangle, the patient has likely **improved beyond measurement error**.
 - If the cell is in the white lower triangle, the patient has likely **declined beyond measurement error**.
 - If the cell is along or near the diagonal (in the grey area), the change likely falls **within measurement error**.
- Other Actions: Now you can confidently communicate his improvement in your documentation and with his family (Picture 2).



Picture 2. Communicating transformed measures can enhance transparency and clarity.

What if I can't find Rasch transformations or a conditional minimal detectable change matrix for the instrument I want to use?

- Many common rehabilitation assessments do not (yet) have Rasch-transformed scores.
- However, for most assessments, the **standard error of measurement (SEM)** and **minimal detectable change (MDC)** can be found in the instrument manual.
- **SEM** and **MDC** are applied in the same way as Rasch-based **SE** and **cMDC**, but the same value is used no matter where the patient started.
- To apply SEM, true score is Observed Score $\pm$ SEM.
- To apply MDC:
 - The patient has improved beyond measurement error if **follow-up score is $\geq$ initial score + MDC**
 - The patient has declined beyond measurement error if **follow-up score is $\leq$ initial score - MDC**
- Because they do not account for variation in measurement error across the scale range, SEM and MDC should be interpreted with caution.

Table 1. The CRS-R Raw Score Transformed to an Equal-Interval Measure ²					
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Raw Score	Transformed Measure	Standard Error	Decline beyond measurement error	Within measurement error	Improvement beyond measurement error
0	0	15	—	0 to 33	≥ 34
1	11	9	—	0 to 33	≥ 34
2	19	7	—	0 to 37	≥ 38
3	24	6	—	0 to 41	≥ 42
4	29	6	—	0 to 44	≥ 45
5	34	6	≤ 18	19 to 48	≥ 49
6	38	6	≤ 23	24 to 52	≥ 53
7	42	5	≤ 28	29 to 54	≥ 55
8	45	5	≤ 33	34 to 56	≥ 57
9	47	4	≤ 33	34 to 59	≥ 60
10	49	4	≤ 37	38 to 62	≥ 63
11	51	4	≤ 37	38 to 65	≥ 66
12	53	4	≤ 41	42 to 65	≥ 66
13	55	4	≤ 44	45 to 68	≥ 69
14	57	4	≤ 46	47 to 72	≥ 73
15	60	5	≤ 48	49 to 76	≥ 77
16	63	5	≤ 50	51 to 81	≥ 82
17	66	5	≤ 54	55 to 88	≥ 89
18	69	5	≤ 56	57 to 88	≥ 89
19	73	6	≤ 59	60 to 100	—
20	77	6	≤ 62	63 to 100	—
21	82	7	≤ 65	66 to 100	—
22	89	9	≤ 72	73 to 100	—
23	100	15	≤ 72	73 to 100	—

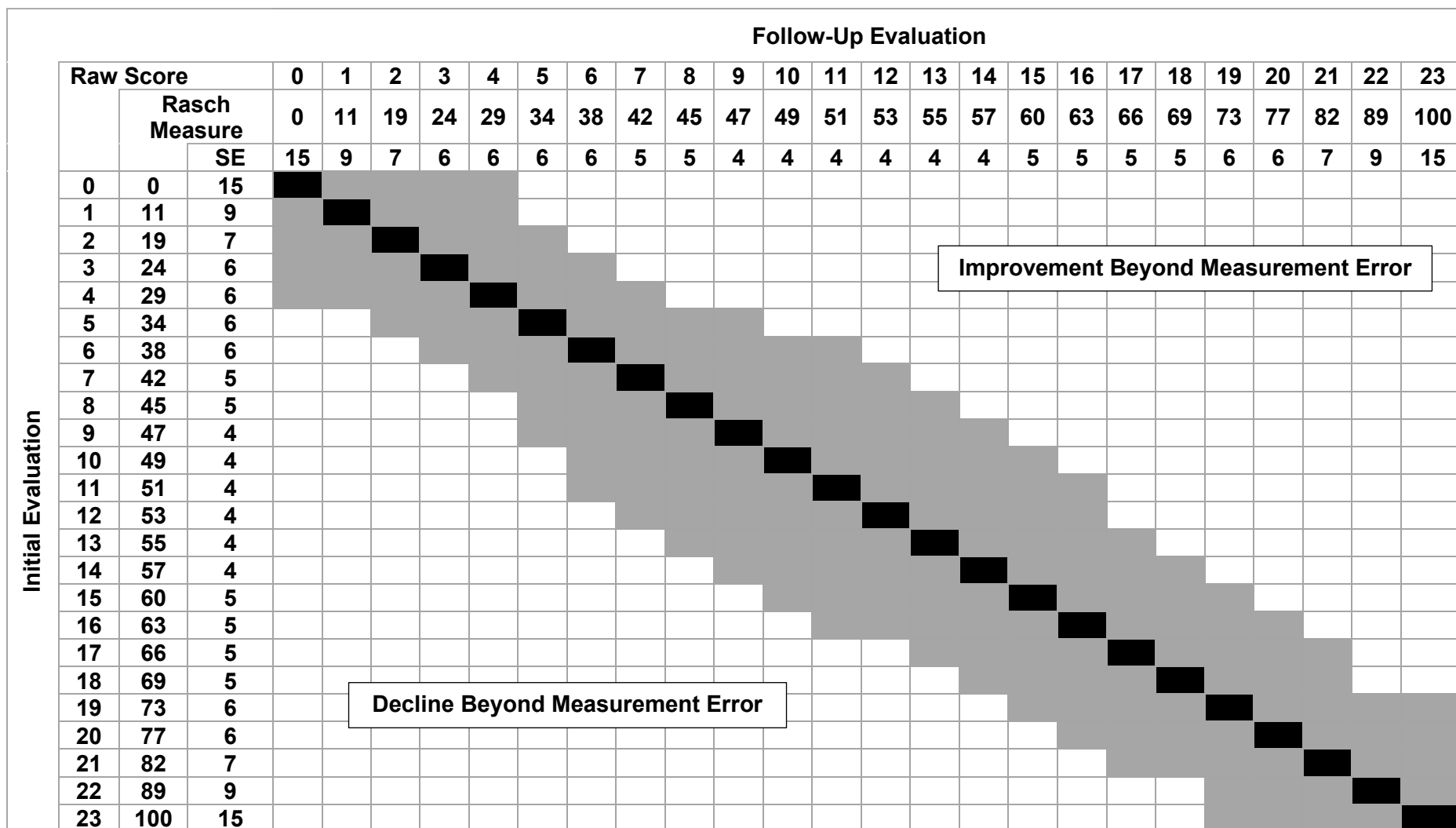


Figure 2. Conditional minimal detectable change interpretation matrix.² If the cell is in the white upper triangle, the patient has likely **improved beyond measurement error**. If the cell is in the white lower triangle, the patient has likely **declined beyond measurement error**. If the cell is along or near the diagonal (in the grey area), the change likely falls **within measurement error**.

References

1. Merbitz C, Morris J, Grip JC. Ordinal scales and foundations of misinference. *Arch Phys Med Rehabil.* 1989;70(4):308-312.
2. Weaver JA, Cogan A, Kozlowski A, et al. Interpreting change in disorders of consciousness using the Coma Recovery Scale - Revised. *Journal of Neurotrauma.* Published online April 13, 2024;neu.2023.0567. doi:10.1089/neu.2023.0567
3. Salzberger T. Does the rasch model convert an ordinal scale into an interval scale? *Rasch Measurement Transactions.* 2010;24(2):1273-1275.
4. Linacre J. Standard errors and reliabilities: Rasch and raw score. *Rasch Measurement Transactions.* 2007;20(4):1086.
5. Kozlowski AJ, Cella D, Nitsch KP, Heinemann AW. Evaluating individual change with the Quality of Life in Neurological Disorders (Neuro-QoL) Short Forms. *Arch Phys Med Rehabil.* 2016;97(4):650-654.e8. doi:10.1016/j.apmr.2015.12.010