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Goal attainment scaling (GAS) in rehabilitation: a practical guide
Lynne Turner-Stokes

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Erratum

In the paper by L. Turner-Stokes, there were errors in the formulas presented on pages 364 and 367. The correct formulas are published below. The publisher apologises for this error and the inconvenience caused to the author, editors, and readers.

Page 364 Column 1:

$$\text{Overall GAS} = 50 + \frac{10 \sum (w_i x_i)}{\sqrt{((1 - \rho) \sum w_i^2 + \rho(\sum w_i)^2)}}$$

Where w_i = the weight assigned to the *i*th goal (if equal weights, $w_i = 1$), x_i = the numerical value achieved (between -2 and $+2$), ρ (rho) = the expected correlation of the goal scales.

Page 364 Column 2:

$$\text{Overall GAS} = 50 + \frac{10 \sum (w_i x_i)}{\sqrt{(0.7 \sum w_i^2 + 0.3(\sum w_i)^2)}}$$

Page 367 Box 1:

$$\text{Overall Goal Attainment Score} = 50 + \frac{10 \sum (w_i x_i)}{\sqrt{(0.7 \sum w_i^2 + 0.3(\sum w_i)^2)}}$$

Starting with: $\sqrt{(0.7 \sum w_i^2 + 0.3(\sum w_i)^2)}$

Goal attainment scaling (GAS) in rehabilitation: a practical guide

Lynne Turner-Stokes Kings college London, School of Medicine, Regional Rehabilitation Unit, Northwick Park Hospital, Harrow, UK

Goal attainment scaling is a mathematical technique for quantifying the achievement (or otherwise) of goals set, and it can be used in rehabilitation. Because several different approaches are described in the literature, this article presents a simple practical approach to encourage uniformity in its application. It outlines the process of setting goals appropriately, so that the achievement of each goal can be measured on a 5-point scale ranging from −2 to +2, and then explains a method for quantifying the outcome in a single aggregated goal attainment score. This method gives a numerical *T*-score which is normally distributed about a mean of 50 (if the goals are achieved precisely) with a standard deviation of around this mean of 10 (if the goals are overachieved or underachieved). If desired, the approach encompasses weighting of goals to reflect the opinion of the patient on the personal importance of the goal and the opinion of the therapist or team on the difficulty of achieving the goal. Some practical tips are offered, as well as a simple spreadsheet (in Microsoft Excel) allowing easy calculation of the *T*-scores.

Introduction

Measuring the effectiveness of brain injury rehabilitation poses major challenges due to the heterogeneity of patients' deficits and desired outcomes. Particularly at the level of social function (handicap; participation), goals are very much dependent on the individual's lifestyle and aspirations, and standardized measures become increasingly difficult to apply.

Patient-derived outcomes are a generic method[1] for overcoming some of these problems; they will reflect whatever is important to the patient. In rehabilitation, and indeed in any health care process involving a multidisciplinary team, the measurement of effectiveness should take into account the patient's goals. Goal setting with a patient offers an opportunity for deriving a patient-generated outcome. It has become a central component of effective rehabilitation practice. There is substantial literature which demonstrates its usefulness, both as part of the communication and decision-making process, and as a person-centred outcome measure for rehabilitation[2] and in other settings.[3]

One way of quantifying the achievement of goals is through goal attainment scaling; this allows more discrimination than simply recording achievement as a 'pass' or 'fail'. An accompanying article[4] gives guidance on how to set goals suitable

Address for correspondence: Professor Lynne Turner-Stokes, Herbert Dunhill Chair of Rehabilitation, King's College London, Regional Rehabilitation Unit, Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3UJ, UK e-mail: lynne.turner-stokes@dial.pipex.com

for scaling. This article gives practical guidance on measuring outcome using this method.

What is goal attainment scaling?

Goal attainment scaling (sometimes abbreviated to 'GAS'), is a method of scoring the extent to which patient's individual goals are achieved in the course of intervention. In effect, each patient has their own outcome measure, but this is scored in a standardized way as to allow statistical analysis.

In contrast to 'traditional' standardized measures (e.g. the Barthel ADL Index[5]) which comprise a standard set of tasks (items) each rated in a standard way according to pre-set 'levels', when using goal attainment scaling, tasks are individually identified to suit the patient, and the levels are individually set around their current and expected levels of performance.

Measurement through goal attainment scaling was first introduced in health care in the 1960s by Kiresuk and Sherman[6] for assessing outcomes in mental health settings. Since then it has been modified and applied in many other areas including:

- elderly care settings,[7,8]
- chronic pain,[9]
- cognitive rehabilitation,[10]
- amputee rehabilitation.[11]

This method offers a number of potential advantages as an outcome measure for rehabilitation. First, because goal setting is already a part of routine clinical practice in many centres, it builds on this already established process to encourage:

- communication and collaboration between the multidisciplinary team members as they meet together for goal setting and scoring, and
- patient involvement.

There is emerging evidence that goals are more likely to be achieved if patients are involved in setting them. Moreover, there is also evidence that using goal attainment scaling may have

positive therapeutic value in encouraging the patients to reach their goals.[9] In particular, the more formalized process of goal setting before the start of intervention, and defining and agreeing expected levels of achievement with the patient and their family, supports the sharing of information at an early stage of rehabilitation and the negotiation of realistic goals.

Second, there is growing evidence that goal attainment scaling is a good measure of outcome, being at least as sensitive to change (and probably more so) when compared with standard measures.[12–15] It potentially avoids some of the problems of standardized measures including:

- floor and ceiling effects;
- lack of sensitivity – particularly of global measures, where individuals make change in one or two important items but this change is lost in the overall scores, because a large number of irrelevant items do not change; and
- disjunction between a patient's main concerns and the domain(s) of the standard measure.

The literature encompasses a range of different approaches to scaling and measuring the achievement of goals, ranging from simple recording of goals achieved, partially achieved or not achieved[16] to rating scales of up to seven points.[17] The procedure described below is based on that used in the context of upper limb spasticity by Ashford and Turner-Stokes.[15] It represents an attempt to establish a more consistent approach.

How is achievement rated?

An important feature of goal attainment scaling is the establishment of criteria for a 'successful' outcome for that individual, which are agreed with the patient and family before intervention starts so that everyone has a realistic expectation of what is likely to be achieved, and agrees that this would be worth striving for.

Each goal is rated on a 5-point scale, with the degree of attainment captured for each goal area:

- If the patient achieves the expected level, this is scored at 0.

- If they achieve more than the expected outcome this is scored at:
  +1 (somewhat more)
  +2 (much more)
- If they achieve less than the expected outcome this is scored at:
  −1 (somewhat less) or
  −2 (much less)

Note that this scaling can apply both when improvement and when deterioration is the expected direction of change. The important point is to ensure that doing better than expected is associated with a positive score, and vice versa.

Some goals will be more important to the patient than others; and some goals set may be more difficult for the rehabilitation process to attain than others. Goals may therefore be weighted to take account of the relative importance of the goal to the individual, and/or the difficulty that the rehabilitation team anticipates in achieving it.[11] Whilst Kiresuk and Sherman allowed for goal weighting in the formula below, the benefits of goal weighting remain uncertain (see below),[18] and it should be regarded as optional.

How is the overall goal attainment scaling score calculated?

The method allows one to set as many or as few goals as wished, and still gives a single numerical outcome. However, goal setting can be time-consuming and, in our experience, three to five goals usually represent a feasible number to capture the patient's key priorities. The goal outcome scores are then incorporated into the single aggregated *T*-score by applying the following formula:

$$\text{Overall GAS} = 50 + \frac{10\Sigma(W_i X_i)}{\sqrt{\left((1-\rho)\Sigma W_i^2 + \rho(\Sigma W_i^2)\right)}}$$

where W_i is the weight assigned to the *i*-th goal (if equal weights, $W_i = 1$), X_i is the numerical value achieved (between −2 and +2), ρ is the expected correlation of the goal scales.

For practical purposes, according to Kirusek and Sherman, ρ most commonly approximates to 0.3, so the equation simplifies to:

$$\text{Overall GAS} = 50 + \frac{10\Sigma(W_i X_i)}{\sqrt{\left(0.7\Sigma W_i^2 + 0.3(\Sigma W_i^2)\right)}}$$

(NB: Mathematically challenged readers take heart – there are calculation tables in the book by Kiresuk.[19] Alternatively, a simple spreadsheet calculator is available on the *Clinical Rehabilitation* server or from the author!)

In effect, therefore, the composite goal score (the sum of the attainment levels × the relative weights for each goal) is transformed into a standardized measure or *T*-score with a mean of 50 and standard deviation of 10. If goals are set in an unbiased fashion so that results exceed and fall short of expectations in roughly equal proportions, over a sufficiently large number of patients, one would expect a normal distribution of scores.

Demonstrating that the mean goal attainment *T*-score for the study population is around 50 is a useful quality check of the team's ability to set and negotiate achievable goals. If a team attempts to inflate their results by setting goals over-cautiously, the mean score will be >50. Similarly, if they are consistently overambitious it will be <50. In some contexts, it may be argued that setting more challenging goals may be associated with greater improvement and therefore that mean scores of <50 are not necessarily a bad thing.[3] In others, however, it may reflect a less than perfect understanding of the factors (including external factors) that mitigate against goal attainment, or a failure to negotiate realistic expectations for outcome.[20]

Procedure

The procedure needed is as follows.

(1) Identify the goals
Interview the patient to identify the main problem areas and establish an agreed set of

priority goal areas (with the help of the team) for achievement by an agreed date (usually discharge or the end of the programme). Set goals should follow the SMART principle – that is, they should be specific, measurable, attainable, realistic and timely. The patient largely determines the domains of goals, and the team determines the levels likely to be achieved. More detail is given by Bovend'Erdt et al.[4]

(2) Weight the goals (optional)

Goals may be weighted by asking the patient to rank them in order of importance or by applying a simple weighting scale, using the 4-point scale in Table 1. Similarly the team may rank or weight the goals the terms of the anticipated difficulty in achieving them. The weight then attributed to a goal is the multiplicand of importance and difficulty: weight = importance × difficulty.

Using this system and scoring, goals that carry a zero weighting are effectively cancelled out of the formula, so that the weighting scale resolves to a score of 1–3.

If goal weighting is not used, values of '1' are simply applied to 'weight' in the formula.

(3) Define expected outcome

The 'expected outcome' is the most probable result if the patient receives the expected treatment Ideally descriptors should also be pre-defined for each of the achievement levels (−2, −1, 0, +1, +2) and recorded in a 'follow-up guide'.[12,21]

Each goal level is defined by the team or investigator, and should be as objective and observable as possible. This process also provides an opportunity to negotiate with the patient if they have unrealistic expectations. For example if the patient wants active hand

function, but realistically using the affected hand as a prop is the expected outcome, then the active function task can be set at level +2, and use as a prop at level 0. This way, the patient's goal is not totally dismissed, but is clearly defined as beyond the level of expectation.

(4) Scoring baseline

Because change is built into the way that goal attainment scaling is derived, the outcome T-score is by definition a measure of change, and avoids the computation of change scores which may be unreliable where baseline and outcome scores are highly correlated.[22] Nevertheless, some authors advocate the recording of baseline scores.[10,11,13] These are usually rated −1, unless there is no clinically plausible worse condition with respect to that goal, in which case the baseline rating is −2. An aggregated baseline score may then be calculated using the same formula.

(5) Goal attainment scoring

Finally, the outcome score for each goal is rated at the appointed review date, judging actual performance against the predefined levels. Ideally, this is undertaken by the team in conjunction with the patient/family.

The goal attainment 'T-score' is then calculated by applying the formula (or by using the simple spreadsheet calculator).

If baseline ratings were recorded, goal attainment change scores may be determined by subtracting the baseline aggregate score from that at outcome.[10,11,13] However, in practice the change score is usually highly correlated with the T-score,[23] and offers little further advantage.

Worked example

An example will be used to illustrate the method. Patient AB was referred for rehabilitation following a stroke. Her goals for treatment were:

- to reduce her shoulder pain,

Table 1 Suggested weighting scale for importance and difficulty

Importance	Difficulty
0 = not at all (important)	0 = not at all (difficult)
1 = a little (important)	1 = a little (difficult)
2 = moderately (important)	2 = moderately (difficult)
3 = very (important)	3 = very (difficult)

- to improve independence in dressing. and
- to be able to drive.

A description of her baseline, expected and achieved goal levels are shown in Table 2.

A summary of the goal weightings and her baseline scores is shown in Table 3. Her baseline scores for the three goals were -1, -1 and -2 respectively. All goals were rated as 'moderately difficult' (weight 2) and she rated pain reduction as 'very important' (3), dressing as 'moderately important' (2) and driving as only 'a little important'. (Although in this example the goals appear to be ranked in importance, importance was rated independently for each goal. She could therefore have rated all goals as 2 or 3 if she had wished.) Box 1 shows the application of the formula to derive the baseline and outcome aggregate scores, both with and without goal weighting.

Some practical tips

Many have reported that applying goal attainment scaling in the way originally described by Kiresuk is too time-consuming for routine clinical use. On the Regional Rehabilitation Unit at Northwick

Park Hospital we have successfully introduced goal attainment scaling in our everyday clinical practice by reducing some of the more time-consuming steps. In conjunction with an international working party to develop goal attainment scaling for routine use in evaluating management of spasticity, our team has now run over 20 workshops in the UK, Switzerland, Australia, New Zealand and Asia and through feedback from clinicians has developed a simplified process for application of goal attainment scaling in routine clinical practice, which others may also find helpful.

(a) 'Objective' setting

On our unit, a set of defined 'objectives' (medium-term goals) to be achieved during the

Table 3 Worked example patient AB: summary of weighting and baseline scores

Goal	Importance	Difficulty	Weight ($I \times D$)	Baseline score	Outcome score
Pain	3	2	6	-1	$+2$
Ease of dressing	2	2	4	-1	0
Driving	1	2	2	-2	-1
			Sum = 12		

Table 2 Worked example patient AB: baseline, expected and achieved goal levels

Goals	At baseline	Expected outcome (Level required to achieve score 0)	Achieved outcome
(1) Reducing shoulder pain	She had severe shoulder pain rating 8/10 at rest, on movement and also disturbing her sleep at night (Score -1)	We expected to reduce her pain to around 4/10 and to limit her night time waking to once a night	Her pain had completely resolved, both day and night so she scored $+2$, since the outcome could not have been any better
(2) Ease of dressing	She needed help to dress her upper body (Score -1)	We expected that she would be able to dress her upper body unaided	She achieved her goal of being able to dress her upper body without help (Score 0)
(3) Able to drive	She was unable to drive (Score -2)	We expected that she would be able to return to driving using an adapted car	Although she had had a successful driving assessment she was still waiting for her adapted car to arrive and so was not driving at the point of discharge – she therefore scored -1, even though this was beyond our control

Box 1 shows the application of the GAS formula

Applying the formula:

Overall Goal Attainment Score $= 50 + \dfrac{10\Sigma(W_i X_i)}{\sqrt{\left(0.7\Sigma W_i^2 + 0.3(\Sigma W_i)^2\right)}}$

Starting with: $\sqrt{\left(0.7\Sigma W_i^2 + 0.3(\Sigma W_i)^2\right)}$ we have:

$\sqrt{\left(0.7 \times (36 + 16 + 4) + 0.3 \times (12)^2\right)}$

$= \sqrt{(39.2 + 43.2)}$

$= 9.07$

Then applying the full formula:

The baseline score is $50 + \dfrac{10(-14)}{9.07} = 50 + (-140/9.07)$
  $= 50 - 15.4 = 34.6$

The outcome score is $50 + \dfrac{10(+10)}{9.07} = 50 + (100/9.07)$
  $= 50 + 11.0 = 61.0$

The change in score, should one wish to measure it, is therefore 26.4

Without the goal weighting, the baseline outcome and change scores would be 31.7, 54.6 and 22.8, respectively

In this particular case, goal attainment scoring shows a better than expected result, but not all cases will be as positive as this.

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programme or admission is agreed with the patient/family at the start of the programme. These are then broken down into a series of 'staged' (short-term) goals towards these objectives, which are reviewed at fortnightly intervals throughout the programme.

Goal attainment scaling is not applied to every staged goal, but just to three to five key objectives that form key priorities for the patient. Baseline rating is undertaken within the first 7–10 working days of admission; the outcome level of achievement is rated just once at discharge (or at a defined team review date for long admissions) – usually about three months after the original goal setting.

(b) Wording of goals

Whilst we try to encourage the patient to identify personal goals that address areas not already covered by our routinely recorded standardized measures, some goals (such as walking and pain

reduction) tend to be critically important and so feature regularly on their wishlists.

The wording of individual goals can be time-consuming, and some of these goals are well-defined in existing hierarchical scales. For example, a goal to 'reduce pain' may be defined in terms of expected score on a 10-cm visual analogue score. Similarly, improved walking ability may typically be defined in terms of distance covered, the type of support needed, or the type of terrain. Over time we have developed some menus of pre-worded goal statements in these more common areas that span a wide range of abilities. Suitable goals may be chosen or adapted from these menus to save starting from scratch with each new patient. We have also undertaken mapping of goals onto the International Classification of Functioning Disability and Health (ICF).[24]

(c) Weighting

Although weighting for 'importance' has a consistent effect on overall GAS scores in the expected direction, weighting for 'difficulty' can, in some circumstances, lead to a perverse bias. In practice, the weighted and unweighted scores are very closely correlated.[18] Therefore, it is perfectly adequate, and simpler for many purposes, to use unweighted scores in the calculation (i.e. a weighting of 1 throughout).

On the other hand, recording the importance and difficulty of key goals can be helpful for qualitative interpretation. For example, if some goals were achieved and others not, it is pertinent to know which of them were most important to the patient. Similarly, if a goal was not achieved, it is often helpful for the team to reflect on the extent to which they had already identified this as a difficult goal with a correspondingly greater chance of failure. Over time, this team reflection may be expected to lead to more accurate prediction of goal attainment. Therefore in our unit, we record both 'importance' and 'difficulty' as in Table 1, for qualitative purposes, but currently we only include 'importance' in our goal-weighting for aggregate *T*-scores.

(d) Attainment score levels

From our substantial experience of running workshops in goal attainment scaling, there are a number of reasons why the method of application originally described by Kiresuk and Sherman can be difficult for clinicians to apply in the course of routine practice.

(1) Defining predetermined levels for each of the five outcome score levels (-2, -1, 0, $+1$ and $+2$) in a 'follow-up guide'[21] is very time-consuming, when ultimately only one level will be used.
(2) The designation of zero and minus scores can be discouraging to patients and their teams; the numbers can sometimes appear more threatening than words.
(3) Teams who are used to rating goal attainment with reference to the baseline condition (e.g. achieved, partially achieved, no change, worse), often find it hard to accept the 5-point scoring method. If baseline scores are recorded and set at -1 to allow for a clinically worse condition, there is no way of recording when goals are partially achieved.

We have therefore developed a simple algorithm for use by clinicians, which avoids some of these problems. First, instead of preparing a full follow-up guide at initial goal setting, clinicians are advised to concentrate on defining very carefully the expected 'level 0' outcome. In our experience, providing that this level has been carefully documented, it is the quite easy for the team and patient to agree at the end of the programme whether this level was achieved (0); if it was slightly exceeded ($+1$) or greatly exceeded ($+2$); or if it was 'not quite achieved' (-1) or 'nowhere near' (-2). Preliminary evaluation against a pre-prepared follow-up guide suggested that this method provided acceptable accuracy (86–92%) and saved a lot of time (unpublished data). For clinical purposes, we believe this is adequate. However, when using goal attainment scoring for research, we would still recommend preparing the full follow-up guide to ensure due rigour.

Second, if numerical scoring is challenging to the team and/or patients for reasons 2 or 3

above, we recommend a simple verbal rating scale for clinicians to record goal attainment (as shown in Figure 1) which may then be converted to numerical scores by computerization, only after it has left the clinical arena.

(e) Score calculation

We have also developed an electronic calculation sheet, written in Microsoft Excel which automatically calculates the baseline, achieved and change scores when the scores are input. This is freely available from the author on request, and is available on the Internet.

In summary

Goal attainment scaling depends on two things: the patient's ability to achieve their goals and the clinician's ability to predict outcome, which requires knowledge and experience. Some people may find this challenging, but we believe that if a clinician is providing an intervention, they should have some idea about the likely outcome, and using this approach has helped us to develop our skills in outcome prediction.

This approach is conceptually different from standardized measures. If interval measures may be described as measuring with 'a straight ruler', and ordinal measures as 'a piece of string', then this method is the equivalent of measuring with a set of elastic bands! While many clinicians welcome this flexibility, others reared in the tradition of rigorous and objective measurement struggle with this concept. For those who prefer to consider linear models only, Tennant has made the helpful suggestion of establishing 'item banks' of goals which can be precalibrated onto a unidimensional metric such that linearized versions of the various scores could be imported into the process.[25] Our preliminary set of 'goal menus' may indeed represent a first step towards establishment of such item banks in the future.

To conclude, standardized measures still provide a useful yardstick for comparing different populations of patients on a level platform and it is not suggested that this method should
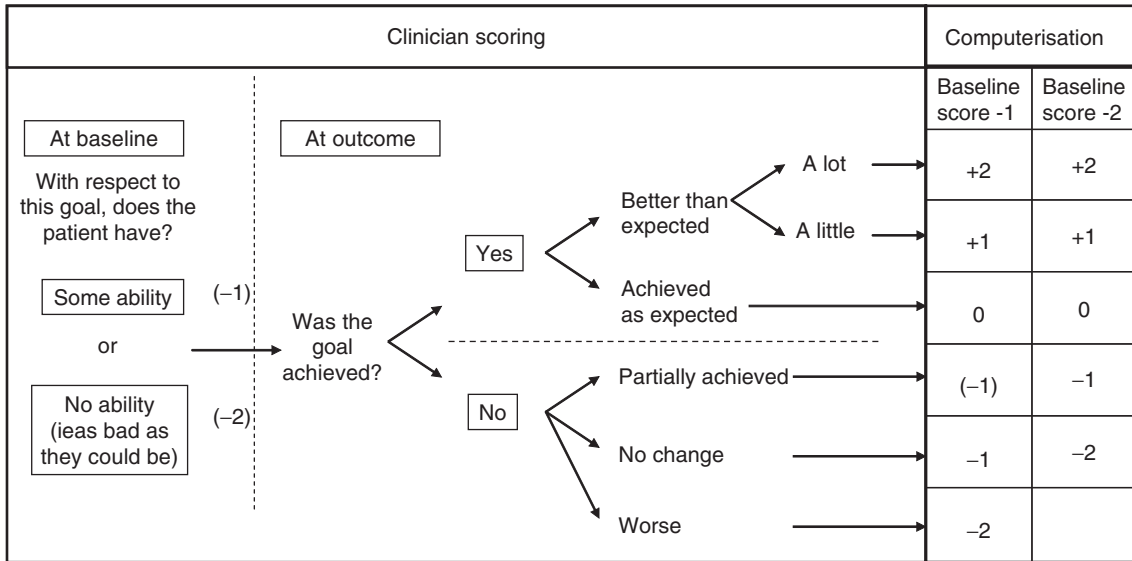
Figure 1 Algorithm for converting verbal scoring by clinicians to the 5-point goal attainment scores. This algorithm allows clinicians to record goal attainment without reference to the numeric scores, and so avoids the perceived negative connotations of zero and minus scores. Providing the level at baseline is known, 'partial achievement', 'no change' and worse can be translated by computerization outside the clinical arena. This incidentally offers the opportunity to compare the effect of using different scoring systems such as (−1, −2 and −3) or (−0.5, −1 and −2) and this work is currently underway.

replace them. However, it does provide a useful reflection of outcomes that are of critical importance to the patient in the context of their own lives, which is something not provided by traditional measures. For this reason we recommend that goal attainment scaling and standardized measures are used side by side.

Clinical messages

- Goal attainment scaling can be use to evaluate overall achievement of goals that are important to the patient.
- Using a simplified approach, it can be applied in clinical practice and supports the negotiation of realistic expectations for outcome.
- It does not replace the use of standardised outcome measures.

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