Use of a 3-Item Short-Form Version of the Barthel Index for Use in Stroke

Systematic Review and External Validation

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Background and Purpose—There may be a potential to reduce the number of items assessed in the Barthel Index (BI), and shortened versions of the BI have been described. We sought to collate all existing short-form BI (SF-BI) and perform a comparative validation using clinical trial data.

Methods—We performed a systematic review across multidisciplinary electronic databases to find all published SF-BI. Our validation used the VISTA (Virtual International Stroke Trials Archive) resource. We describe concurrent validity (agreement of each SF-BI with BI), convergent and divergent validity (agreement of each SF-BI with other outcome measures available in the data set), predictive validity (association of prognostic factors with SF-BI outcomes), and content validity (item correlation and exploratory factor analyses).

Results—From 3546 titles, we found 8 articles describing 6 differing SF-BI. Using acute trial data (n=8852), internal reliability suggested redundancy in BI (Cronbach α, 0.96). Each SF-BI demonstrated a strong correlation with BI, modified Rankin Scale, National Institutes of Health Stroke Scale (all ρ≥0.83; P<0.001). Using rehabilitation trial data (n=332), SF-BI demonstrated modest correlation with quality of life measures Stroke Impact Scale and 5 domain EuroQOL (ρ≥0.50, P<0.001). Prespecified prognostic factors were associated with SF-BI outcomes (all P<0.001). Our factor analysis described a 3 factor structure, and item reduction suggested an optimal 3-item SF-BI comprising bladder control, transfer, and mobility items in keeping with 1 of the 3-item SF-BI previously described in the literature.

Conclusions—There is redundancy in the original BI; we have demonstrated internal and external validity of a 3-item SF-BI that should be simple to use. **(*Stroke*. 2017;48:618-623. DOI: 10.1161/STROKEAHA.116.014789.)**

Key Words: activities of daily living ■ adult ■ language ■ registries ■ stroke

The Barthel Index (BI) is a 10-item measure of basic activities of daily living (ADL).[1] The BI is the second most commonly used functional assessment scale in stroke trials and the most commonly used ADL assessment in adult rehabilitation.[2,3] BI quantifies ADL in an ordinal, hierarchical scale that ranges from 0 to 20 or 0 to 100 depending on the scoring used.[4] BI is recommended as an outcome measure by various professional societies and guidelines.[3] BI has proven prognostic utility,[5] it is used in clinical practice to inform rehabilitation and care planning, and it is used in research both to describe outcomes and as case-mix adjuster. The BI has proven a useful scale, but there is scope for improvement, for example, floor and ceiling effects of BI scoring are well described.[6] For any assessment, there is a trade-off between the time and effort required for testing and the validity of the data acquired.[7] Although administration time for BI assessment is modest, there is still opportunity cost, particularly in busy clinical settings.[8]

Issues with time taken to complete a scale are important to the assessor (longer time spent in assessment gives less time for other clinical activity) and are important to the patient (test burden is a particular issue in the context of acute stroke). These issues will be more apparent in patients with physical, cognitive, or communication difficulties, yet this is exactly the population that requires robust assessment of function. In the National Health Service (NHS) England and Wales National Stroke Audit, completion rate of BI measures was ≈60%, with lack of time cited as the reason for

Received July 20, 2016; final revision received December 12, 2016; accepted December 19, 2016.

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Guest Editor for this article was Eric E. Smith, MD, MPH.

Presented in part at the International Stroke Conference, Nashville, TN, February 11–12, 2015.

The online-only Data Supplement is available with this article at http://stroke.ahajournals.org/lookup/suppl/doi:10.1161/STROKEAHA.116.014789/-/DC1.

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poor completion.[9] The problem is not unique to assessment of BI, and in large registries, completion of the modified Rankin Scale (mRS) was around 75% with lesser completion in those with more severe impairments.[10] In a rehabilitation study, completion of the Stroke Impact Scale was limited with potential to bias results.[11]

In this situation, the ideal would be a shortened form of the BI that offered prompt assessment without sacrificing clinical properties. The high internal reliability of the BI suggests that certain component items of BI are redundant, and there is potential to condense the scale.[6]

We sought to describe and compare properties of published short-form versions of BI (SF-BI), using a 2-stage approach, first, systematically searching the literature for SF-BI and then validating and comparing the various forms using an independent data set.

Methods

Systematic Review

Our primary question for the systematic review was which items are included in short-form versions of BI for use in patients in stroke? As the purpose of the search was to find SF-BI, we did not perform quantitative summary analyses or quality assessment of primary articles.

We devised a focused search strategy using validated search terms across multidisciplinary electronic databases. After initial scoping searches, we opted to use a concept-based approach with search strings based on concepts of BI/ADL assessment and short forms/psychometric properties of scales. Search strings were based on MeSH and other controlled vocabulary (Material I in the online-only Data Supplement).

We searched across 3 electronic databases (Medline [Ovid], Embase [Ovid], and Health and Psychosocial Instruments [Ovid]) all from inception to December 2015. We used citation searching (backwards searching) and assessed all articles that had cited the index article (forwards searching).

We included any article that described a shortened (<10 items) version of the BI. We limited to studies of patients with stroke or brain injury but operated no restrictions with respect to language, date, or study design.

Titles and abstracts generated from the electronic database searches were screened for relevance. Irrelevant titles and abstracts were excluded and full-text articles inspected to determine eligibility. As a test of external validity, we preselected 2 studies[12,13] relevant to the study question from a previous review of BI properties,[6] and we assessed whether the search included these studies.

We extracted details of studies meeting inclusion criteria to a prespecified pro forma. We described the items included in the short form, the derivation sample, the method used for item reduction, and any validation. We included data in the primary publications and supplementary materials but did not contact study authors for additional detail.

We followed, where appropriate, Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) best practice guidance for design, conduct, and reporting of this systematic review.[14] All aspects of title selection, assessment, and data extraction were performed by 2 independent researchers trained in systematic review (T.J.Q., M.T.-R.). The review protocol was registered with Research Registry (http://www.researchregistry.com, researchregistry1213).

Validation of SF-BI

Validity is the extent to which a rating scale measures what it purports to measure.[15] We used multiple, complementary, approaches to validation of each of the SF-BI identified by literature searching, all prespecified and described in our protocol. On the basis of peer-review advice, we added a further assessment of divergent validity. For these analyses, we used the VISTA (Virtual International Stroke Trial Archive) resource. All analyses used SAS version 9.4 (SAS Institute, Cary) software.

VISTA is a not-for-profit repository for stroke trial data, containing study quality, and anonymized individual patient-level data on thousands of participants. These data have been used to investigate novel hypotheses, including analyses of stroke assessment scale properties.[16,17] We selected all patient-level data that contained BI along with any other functional outcome measure. Within VISTA, we had access to data sets from acute stroke settings and rehabilitation studies. We ensured that studies included in our VISTA data sets had not been used to develop any of the published SF-BI found on literature searching. A priori we decided to treat data from acute stroke trials and from rehabilitation studies separately because we thought that they may have differing outcome measures and differing case-mix of participants.

We described clinical and demographic features of the acute and rehabilitation data sets. Where data were collected at >1 time point, we used the time point that gave largest data set. We assessed internal consistency of standard (10 items) BI using Cronbach α.

Concurrent, Convergent, and Divergent Validity

We described concurrent validity by assessing the agreement (Spearman rank correlation) of each SF-BI with the standard BI and with the various other short forms. We assessed convergent validity by describing agreement with other functional outcome assessments. After initial scoping of available data, our chosen comparator outcomes for acute data were mRS and National Institutes of Health Stroke Scale (NIHSS). For rehabilitation data, we used the health-related quality of life tools 5 domain EuroQOL (visual analogue scale) and the Stroke Impact Scale. Five domain EuroQOL data were transformed into a single index using the Europe visual analogue scale data set. For divergent validity, we described association with an aphasia scale, the Sheffield Screening Test for Acquired Language Disorders. We hypothesized that agreement with SF-BI would be greater for the other activity/impairment level scales (mRS and NIHSS), less for the quality of life scales (5 domain EuroQOL, visual analogue scale, and Stroke Impact Scale), and lowest for the aphasia scale.

Predictive Validity

We used ordinal univariate regressions to assess association of each SF-BI with, where data were available, clinical and demographic features known to influence stroke outcome (age, baseline stroke severity, physiological variables, comorbidity, previous stroke, and use of thrombolytic therapy). In the first analysis, we described cross-sectional association of point change in various SF-BI with clinical and demographic factors known to be associated with outcome. In the second analysis, we described odds of a point change in SF-BI associated with unit change in NIHSS or mRS at 90-day follow-up.

Content Validity

As a final test, we explored the most discriminating BI items in the acute VISTA data set. We performed exploratory factor analysis to suggest a minimum number of items for a short form and further analyses to determine the optimal items for this short form. Because of the larger sample size, factor analysis was restricted to the acute data set. We first described correlation, using Spearman ρ, for each BI item relative to the total score. Correlations between individual items were explored to investigate item redundancy, and exploratory factor analysis was performed to investigate the underlying structure of the BI. As a final test of content validity, we derived a short form from the VISTA data. First we used exploratory factor analysis to outline the minimum number of factors needed for SF-BI. We then used a stepwise selection process sequentially removing the poorest performing individual item (based on the correlation with total BI and Cronbach α) and comparing properties to find the 3 items within VISTA that had optimal properties. We compared the resulting VISTA-derived

short form (herein referred to as SF-BI VISTA) with the short forms identified from the systematic review.

Results

Systematic Review

From 3546 titles, we found 8[12,13,18–23] titles describing 6 differing short forms of the BI (PRISMA diagram, Figure I in the online-only Data Supplement). Some of the articles were validations of previously described scores,[19,20] although it was not always clear in the text if the SF-BI presented was derivation or validation. The validity of our search was proven as our 2 prespecified articles[12,13] were included in the original search results.

The short forms differed in the number of included items, the nature of the items included, and in the methodology used for item reduction. The short forms included a variety of BI items, and all BI items were included in at least one of the short forms. Ability to perform transfers was a feature in most of the SF-BI, although dressing was included in only 1 SF-BI (Figure). The short forms described by Bohannon and Landes[19] and Ellul et al[13] required additional computation to assign a total score, and we added these formulae to correct the score before any of the validation analyses.

The authors used various approaches to the derivation of the SF-BI, and methods of derivation and validation were not consistently described. One of the articles described a short form with no reference to derivation or validation.[23] Only the 5-item SF-BI described by Hobart and Thompson[12] and 3-item SF-BI described by Ellul et al[13] had robust derivation, multimodal validation, and further validation of the unmodified scale in an external data set (Table 1).

Validation Analyses

The VISTA database had 8852 acute strokes with a recorded measurement of BI at 90 days (919 intracerebral hemorrhage, 7933 ischemic), 8493 of whom had a complete BI measurement for day 30. The rehabilitation data set had 332 participants with a recording of BI at baseline. For these rehabilitation studies, baseline assessments were predominantly at 4 weeks post ictus. The included patients were broadly representative of trial populations, mean age 68.1 years (SD, 12.4), n=3943 (44.5%) female for the acute data set and 65.7 years (SD, 11.0), n=107 (32%) female for the rehabilitation data set. Both populations had prevalent comorbidity, for example, ischemic heart disease and diabetes mellitus (Tables I and II in the online-only Data Supplement).

There was a spread of BI scores across both data sets; for acute data median, BI day 90 was 80 (interquartile range, 60), and for rehabilitation data, median BI baseline was 75 (interquartile range, 35). Internal consistency for complete BI was high in the acute data set, with α 0.95 (BI days 30 and 90). For the rehabilitation data set, α is 0.85 (BI baseline).

In both data sets, we described concurrent validity as the correlation of each individual BI item with the full scale (Table 2; Table III in the online-only Data Supplement).

We assessed convergent validity of each SF-BI in our data sets. Agreement of SF-BI with full BI was excellent in both data sets (Table 3). Each SF-BI showed significant (P<0.0001) correlations with all our chosen outcome measures. For acute data, correlations with mRS and NIHSS were strong. SF-BI at baseline showed weaker correlation with quality of life measures in the rehabilitation data set, albeit correlations were roughly equivalent to those seen for full BI. Correlations were strongest for Stroke Impact Scale, a measure that includes assessment of ADL, and weakest for the VAS. Correlations with the aphasia measure (divergent validity) were weak (Table 3).

Our assessment of predictive validity was limited to the acute data set, because of small numbers of common follow-up assessments in the rehabilitation data set. On ordinal univariate analyses, several factors known to predict outcome were independently associated (P<0.0001) with SF-BI (Table IV in the online-only Data Supplement). Each SF-BI was independently predictive of mRS at day 90 and NIHSS at day 90 in univariate ordinal regressions (Table V in the online-only Data Supplement). This association persisted when adjusting for the relevant clinical attributes suggested in univariate analysis (age, sex, and stroke type; Table 4).

As a test of content validity we derived a correlation matrix, we found between item analyses suggested redundancy with correlations of >0.7 for most individual items (Material III in the online-only Data Supplement). Exploratory factor analysis identified 2 independent factors within BI, with a potential third cross-loading factor (Table VI in the online-only Data Supplement). On the basis of this, we derived a 3-item SF-BI and for comparison a 5-item SF-BI. The optimal 3-item scale comprised bladder control, transfer, and mobility, that is, the items used in Ellul et al.[13] The optimal 5-item scale compromised dressing, toileting, transfers, mobility, and stairs.

As a post hoc exploratory analysis, we compared the use of a simple sum of the 3 items, as used in SF-VISTA, and compared with the scores generated using the formulae suggested

	Bohannon* (two papers[14,15])	Cho[19]	Ellul[9]	Hobart[8] 5 item	Hobart[8] 4 item	Hobart[8] 3 item	Granger[17]	Hseuh[16]	Lekamwasam*[18]
Bathing				■	■	■		■	■
Bladder	■		■				■		
Bowels							■		
Dressing		■							
Feeding		■					■		
Grooming							■		
Mobility	■		■	■				■	■
Stairs		■		■	■			■	■
Toileting				■	■	■		■	■
Transfers	■		■	■	■	■		■	■

Figure. Items included in short forms of Barthel Index.

Table 1. Articles Describing Short Forms of the BI

	Populations Assessed	Derivation Cohort, n	Item Reduction Method	Validation Method	Tested in External Data Set
Bohannon 3-item (2 articles)[14,15]	Stroke unit admissions	251, 275	N/A	Multiple validation analyses	Validation of Ellul scale with modifications
Cho[19]	Acute ischemic stroke	N/A	N/A	N/A	N/A
Ellul 3-item[9]	Stroke unit admissions	169	Predictive ability of combinations of items	Unclear	Stroke RCT
Granger 4-item[17]	Stroke rehabilitation outcome study	539	Four items associated with independence	Predictive (discriminant) validity	No
Hobart 5-,4-, and 3-items[8]	Neurological rehabilitation unit	844	Corrected item total correlation, effect size	Multiple validation analyses	Data set split 50:50 derivation validation
Hseuh 5-item[16]	Stroke unit admissions	125	N/A	Multiple validation analyses	Validation of the Hobart scale
Lekamwasam 5-item[18]	Medical and orthopedic clinics	286	Factor analysis	Correlation with standard BI	Validation of Hobart scale (modified)

BI indicates Barthel Index; NA, not available; and RCT, randomized controlled trial.

by Ellul et al.[13] In the context of our validation analyses, we found that, compared with the Ellul formula, there was no evidence that the simple sum score used in SF-VISTA correlated less well with other BI-derived scales (Table 3) or was less strongly associated with mRS or NIHSS (Table 4).

Discussion

Using systematic review and secondary analyses of existing data, we have described the validity of various published SF-BI. Our review of the literature found various SF-BI with differing number of items, differing components included, and differing scoring. The derivation and validation of these scales was inconsistently described. However, our independent validation using a large data set confirmed the potential item redundancy within BI (high internal reliability) and suggested the use of a short form (the form originally described by Bohannon et al[18,19] and Ellul et al[13]) comprising three 3 assessed variables.

On the basis of our analyses, we would recommend a 3-item SF-BI that assesses bladder control, mobility, and transfers. We feel this offers parsimony, while still capturing key aspects of ADL. Comparing the existent 3-, 4-, and 5-item SF-BI, there was no obvious increase in our measures of validity with increasing number of items. We note that the ability to perform transfers appeared in almost all the short forms and suspect that any short form should include this item. The component items of the 3-item SF-BI should be relatively simple to score, and our post hoc analysis suggests that item scored can be added to give a total score without the need for additional calculations.

We chose to validate existing SF-BI rather than focus on creating our own de novo SF-BI. A priori we suspected that various SF-BI would be available, and we recognize the difficulty of establishing a novel assessment into routine use.[24] We designed analyses that assessed concurrent, convergent, predictive, and content validity. The ideal for convergent validity would have been another ADL assessment. Such data were not available within VISTA, this concurs with our previous findings that BI is the most prevalent ADL assessment in trials, and other measures are infrequently used.[2] We assessed agreement with similar outcome assessment scales (mRS and NIHSS) and with assessments that measure differing constructs (5 domain EuroQOL, Sheffield Test). Assessing BI against mRS and NIHSS is in keeping with previous work looking at stroke outcome properties.[25] The weaker agreement with the aphasia and quality of life scales supports the short forms as tools describing ADL rather than generic measures of stroke recovery.

We feel confident of the properties of the 3-item SF-BI that we recommend because it performed well in our validation analyses, and previous derivation and validation studies have been described. We note also that for some of our convergent validity analyses, the short forms performed better than the full BI. This may suggest that as a prognostic tool or case-mix adjuster, baseline short forms of the BI may be preferable to the full assessment.

In creating a shorter version of an existing scale, there is a compromise between ease of use and richness of data captured. Standard BI is already a reasonably short assessment scale; in fact, various groups have suggested that BI lacks granularity and have proposed additional items be added to the scoring or the scale.[26,27] We do not envisage the SF-BIs being used for individual clinical assessment, rather we think

Table 2. Correlation (Spearman ρ) for Each Barthel Index Item With Total Barthel Index Score

Barthel Index Attribute	Day 90 Acute Data
1. Feeding	0.82
2. Bathing	0.84
3. Grooming	0.72
4. Dressing	0.89
5. Bowel control	0.66
6. Bladder control	0.70
7. Toilet use	0.85
8. Transfer	0.85
9. Mobility	0.85
10. Stairs	0.88

Table 3. Correlation of Various Forms of BI With Other Outcomes

Scale	BI Full Scale	Cho 3-Item	Ellul 3-Item	Granger 4-Item	Hobart 5-Item	Hobart 4-Item	Hobart 3-Item	VISTA 3-Item
BI90 full scale	1.00	0.95	0.90	0.88	0.95	0.94	0.92	0.90
mRS 90	−0.90	−0.89	−0.85	−0.81	−0.90	−0.89	−0.87	−0.85
NIHSS 90	−0.81	−0.81	−0.74	−0.74	−0.79	−0.79	−0.78	−0.75
EQ-5D M3	0.53	0.48	0.47	0.42	0.49	0.48	0.48	0.47
EQ-5D VAS M3	0.24	0.23	0.19	0.17	0.21	0.23	0.21	0.19
SIS full scale	0.62	0.60	0.52	0.48	0.57	0.58	0.55	0.53
SSTALD	0.31	0.28	0.28	0.36	0.27	0.28	0.27	0.28
Cho 3-item	0.95	1.00	0.87	0.88	0.94	0.94	0.91	0.87
Ellul 3-item	0.89	0.87	1.00	0.85	0.92	0.90	0.90	0.99
Granger 4-item	0.88	0.88	0.85	1.00	0.83	0.83	0.84	0.85
Hobart 5-item	0.95	0.94	0.92	0.83	1.00	0.99	0.97	0.92
Hobart 4-item	0.94	0.94	0.90	0.83	0.99	1.00	0.97	0.91
Hobart 3-item	0.92	0.91	0.90	0.84	0.97	0.97	1.00	0.90
VISTA 3-Item	0.90	0.87	1.00	0.85	0.92	0.91	0.90	1.00

Correlation coefficient (ρ) between each outcome measure and SF-BI. For nonstandardized variables, Spearman rank correlation coefficient was used. All significant at prespecified level (P<0.001). BI indicates Barthel Index; EQ-5D, EuroQOL 5 dimension; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; SF-BI, short-form Barthel Index; SIS, Stroke Impact Scale; SSTALD, Sheffield Screening Test for Acquired Language Disorder; VAS, visual analogue scale; and VISTA, Virtual International Stroke Trials Archive.

the short scales will have use in large-scale audit, epidemiology, and clinical research. Time required for testing is a major factor in determining acceptability of a scale to therapists.[28] The SF-BIs described in the literature had a minimum of 3 items, but assessments could be made shorter still. Our factor analysis suggests 2 main factors within BI, in keeping with previous descriptions.[29] There is a literature describing the use of single-question assessments for certain disease states.[30]

Having suggested a promising 3-item SF-BI, the next step would be to use this short-form assessment and describe whether it offers any benefit over traditional BI in terms of feasibility, acceptability, and completion rates. We speculate that a 3-item SF-BI will lessen assessment time, lessen test burden for patients, and lead to fewer data transcription errors, but all of this remains to be proven. We are encouraged that large audits, registries, and clinical trials are already incorporating SF-BI into their test batteries, and we would encourage any groups using the short form to share their experiences with the stroke community.

There is emerging best practice guidance on derivation and validation of short-form assessments.[31] The articles included in our review predate this guidance, and so the variation in conduct and reporting across the studies is understandable. There is no consensus tool for quality assessment of such studies. We felt, as a minimum, articles should describe their derivation cohort and method, use at least 2 differing validation techniques, and have further validation in an independent data set. Few of the SF-BI described in the literature fulfilled all these criteria, and our VISTA-based analysis assists by providing robust, multimodal validation in a large, external data set.

Table 4. Association of Various Forms of BI at Baseline With 90-Day Outcomes

	mRS			NIHSS		
Variable	OR (95% CI)	R-Sq	C Statistic	OR (95% CI)	R-Sq	C Statistic
BI	1.24 (1.23–1.25)	0.84	0.91	1.08 (1.08–1.085)	0.69	0.83
Cho 3-item	1.52 (1.49–1.55)	0.80	0.90	1.26 (1.25–1.28)	0.68	0.83
Ellul 3-item	1.19 (1.18–1.20)	0.76	0.87	1.07 (1.07–1.07)	0.62	0.80
Granger 4-item	1.35 (1.33–1.38)	0.85	0.67	1.20 (1.19–1.21)	0.59	0.80
Hobart 5-item	1.39 (1.36–1.41)	0.82	0.90	1.13 (1.12–1.13)	0.67	0.82
Hobart 4-item	1.44 (1.41–1.47)	0.81	0.90	1.18 (1.170–1.19)	0.67	0.82
Hobart 3-item	1.55 (1.51–1.58)	0.78	0.88	1.24 (1.23–1.25)	0.65	0.82
VISTA 3-item	1.50 (1.47–1.54)	0.76	0.87	1.18 (1.17–1.18)	0.62	0.80

Multivariate ordinal regressions showing the relationships between each SF-BI and outcome measures. Values are odds of better outcome on mRS and NIHSS, adjusted for age, sex, and stroke type. BI indicates Barthel Index; CI, confidence interval; mRS, modified Rankin scale; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio; SF-BI, short-form Barthel Index; and VISTA, Virtual International Stroke Trials Archive.

The strengths of our approach include a robust literature search with internal and external validity checks and access to a large data set of study quality data. The size of the VISTA resource allowed us to look at properties of BI with a greater precision than previously described. We recognize that our literature review included a relatively limited scope of databases, with no meta-analyses or quality assessment. The purpose was to discover SF-BI, and our internal checks suggest we achieved this. A limitation of our study is around generalizability of the VISTA population. VISTA data are from randomized controlled trials and participants may not be representative of unselected stroke admissions. This is less of an issue as we propose that the SF-BI be used for audit and research purposes rather than individual patient clinical assessment. Our focus was stroke, as VISTA is a stroke-specific resource, and BI is often used in stroke trials. We suspect that our SF-BI could be used in nonstroke populations. However, we found few published articles describing SF-BI in nonstroke settings. Where data were available properties seemed favorable,[32] but further validation work would be needed before we recommend SF-BI for other conditions. We recognize that validating a short form does not address some of the inherent limitations of the BI as a measure of ADL,[33] but the shortened scale should, at least, address the issue of efficiency of assessment.

Our data support use of a shortened Barthel for assessment of stroke populations. On the basis of multimodal validation analyses, we recommend a 3-item scale that sums ability to transfer, ability to mobilize, and bladder control. We hope that this short form may prove useful in future large-scale trials, registries, and audit.

Sources of Funding

This work was supported by Greater Glasgow and Clyde Endowments; funder had no role in analysis. Dr Quinn is supported by a Stroke Association/Chief Scientist Office Senior Clinical Lectureship.

Disclosures

None.

References

1. Mahoney FI, Barthel DW. Functional evaluation: the BARTHEL Index. *Md State Med J*. 1965;14:61–65.
2. Quinn TJ, Dawson J, Walters MR, Lees KR. Functional outcome measures in contemporary stroke trials. *Int J Stroke*. 2009;4:200–205. doi: 10.1111/j.1747-4949.2009.00271.x.
3. Quinn TJ, McArthur K, Ellis G, Stott DJ. Functional assessment in older people. *BMJ*. 2011;343:d4681.
4. Wade DT, Collin C. The Barthel ADL Index: a standard measure of physical disability? *Int Disabil Stud*. 1988;10:64–67.
5. Granger CV, Dewis LS, Peters NC, Sherwood CC, Barrett JE. Stroke rehabilitation: analysis of repeated Barthel index measures. *Arch Phys Med Rehabil*. 1979;60:14–17.
6. Quinn TJ, Langhorne P, Stott DJ. Barthel index for stroke trials: development, properties, and application. *Stroke*. 2011;42:1146–1151. doi: 10.1161/STROKEAHA.110.598540.
7. Ritchie CW, Terrera GM, Quinn TJ. Dementia trials and dementia tribulations: methodological and analytical challenges in dementia research. *Alzheimers Res Ther*. 2015;7:31. doi: 10.1186/s13195-015-0113-6.
8. Stone SP, Ali B, Auberleek I, Thompsell A, Young A. The Barthel index in clinical practice: use on a rehabilitation ward for elderly people. *J R Coll Physicians Lond*. 1994;28:419–423.
9. Irwin P, Rutledge Z, Lowe DA. *Report on the National Sentinel Audit of Stroke*. London, United Kingdom: Royal College of Physicians; 1999.
10. Kwok CS, Potter JF, Dalton G, George A, Metcalf AK, Ngeh J, et al; Anglia Stroke Clinical Network Evaluation Study (ASCNES) Group. The SOAR stroke score predicts inpatient and 7-day mortality in acute stroke. *Stroke*. 2013;44:2010–2012. doi: 10.1161/STROKEAHA.113.001148.
11. Murray J, Forster A, Young J. Response and completion rates for postal outcomes booklets in stroke rehabilitation. *Int J Ther Rehabil*. 2007;14:440–445.
12. Hobart JC, Thompson AJ. The five item Barthel index. *J Neurol Neurosurg Psychiatry*. 2001;71:225–230.
13. Ellul J, Watkins C, Barer D. Estimating total Barthel scores from just three items: the European Stroke Database 'minimum dataset' for assessing functional status at discharge from hospital. *Age Ageing*. 1998;27:115–122.
14. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ*. 2009;339:b2535. doi: 10.1136/bmj.b2535.
15. Wright JG, Feinstein AR. A comparative contrast of clinimetric and psychometric methods for constructing indexes and rating scales. *J Clin Epidemiol*. 1992;45:1201–1218.
16. MacIsaac R, Ali M, Peters M, English C, Rodgers H, Jenkinson C, et al. Derivation and validation of a modified short form of the Stroke Impact Scale. *J Am Heart Assoc*. 2016;5:e003108.
17. Ali M, Fulton R, Quinn T, Brady M; VISTA Collaboration. How well do standard stroke outcome measures reflect quality of life? A retrospective analysis of clinical trial data. *Stroke*. 2013;44:3161–3165. doi: 10.1161/STROKEAHA.113.001126.
18. Bohannon RW. Re: estimating total Barthel scores from just three items. *Age Ageing*. 2004;33:321–322. doi: 10.1093/ageing/afh080.
19. Bohannon RW, Landes M. Reliability, validity, and responsiveness of a 3-item Barthel for characterizing the physical function of patients hospitalized for acute stroke. *J Neurol Phys Ther*. 2004;28:110–113.
20. Hsueh IP, Lin JH, Jeng JS, Hsieh CL. Comparison of the psychometric characteristics of the functional independence measure, 5 item Barthel index, and 10 item Barthel index in patients with stroke. *J Neurol Neurosurg Psychiatry*. 2002;73:188–190.
21. Granger CV, Hamilton BB, Gresham GE, Kramer AA. The stroke rehabilitation outcome study: Part II. Relative merits of the total Barthel index score and a four-item subscore in predicting patient outcomes. *Arch Phys Med Rehabil*. 1989;70:100–103.
22. Lekamwasam S, Karunatilake K, Kankanamge SK, Lekamwasam V. Physical dependency of elderly and physically disabled; measurement concordance between 10-item Barthel index and 5-item shorter version. *Ceylon Med J*. 2011;56:114–118.
23. Cho HJ, Kim YJ. Efficacy and safety of oral citicoline in acute ischemic stroke: drug surveillance study in 4,191 cases. *Methods Find Exp Clin Pharmacol*. 2009;31:171–176. doi: 10.1358/mf.2009.31.3.1364241.
24. Shah S. In praise of the biometric and psychometric qualities of the Barthel Index. *Physiotherapy*. 1994;80:769–771.
25. Uyttenboogaart M, Luijckx GJ, Vroomen PC, Stewart RE, De Keyser J. Measuring disability in stroke: relationship between the modified Rankin scale and the Barthel index. *J Neurol*. 2007;254:1113–1117. doi: 10.1007/s00415-007-0646-0.
26. Shah S, Vanclay F, Cooper B. Improving the sensitivity of the Barthel Index for stroke rehabilitation. *J Clin Epidemiol*. 1989;42:703–709.
27. Fortinsky RH, Granger CV, Seltzer GB. The use of functional assessment in understanding home care needs. *Med Care*. 1981;19:489–497.
28. McAvoy E. The use of ADL indices by occupational therapists. *Brit J Occup Therapy*.1991;54:383–385.
29. de Morton NA, Keating JL, Davidson M. Rasch analysis of the Barthel Index in the assessment of hospitalized older patients after admission for an acute medical condition. *Arch Phys Med Rehabil*. 2008;89:641–647. doi: 10.1016/j.apmr.2007.10.021.
30. Hendry K, Hill E, Quinn TJ, Evans J, Stott DJ. Single screening questions for cognitive impairment in older people: a systematic review. *Age Ageing*. 2015;44:322–326. doi: 10.1093/ageing/afu167.
31. Goetz C, Coste J, Lemetayer F, Rat AC, Montel S, Recchia S, et al. Item reduction based on rigorous methodological guidelines is necessary to maintain validity when shortening composite measurement scales. *J Clin Epidemiol*. 2013;66:710–718. doi: 10.1016/j.jclinepi.2012.12.015.
32. Tagharrobi Z, Sharifi K, Sooky Z, Tagharrobi L. Abstract: Psychometric evaluation of the Barthel Index short forms in Iranian elderly people residing in nursing homes. Presented at "Controversies in Longevity, Health and Aging (CoLONGY)". Barcelona, Spain, 2010.
33. Harrison JK, McArthur KS, Quinn TJ. Assessment scales in stroke: clinimetric and clinical considerations. *Clin Interv Aging*. 2013;8:201–211. doi: 10.2147/CIA.S32405.

Stroke
Journal of the American Heart Association

Use of a 3-Item Short-Form Version of the Barthel Index for Use in Stroke: Systematic Review and External Validation

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Stroke. 2017;48:618-623; originally published online February 2, 2017;
doi: 10.1161/STROKEAHA.116.014789
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0039-2499. Online ISSN: 1524-4628

Supplementary materials:

SI) Search Strategy for systematic review

SII) PRISMA flow diagram and questionnaire

SIII) Clinical and demographic features of the acute stroke trial dataset split by stroke type

SIV) Clinical and demographic features of the rehabilitation study dataset.

SV) Correlations between each of the BI attributes.

SVI) Ordinal univariate regressions to see which variables are associated with each sf-BI.

SVII) Univariate ordinal regressions showing the relationships between each sf-BI and each primary outcome measure.

SVIII) Results from exploratory Factor analysis.

SIX) Steering group members of the Virtual International Stroke Trials Archive (VISTA)

SI) Search Strategy for systematic review

(C1 + C2) OR (C1 + C3) = topic results

[limit to humans, English language]

1. Barthel Index.ti,ab,kf
2. Barthel*.ti,ab,kf
3. BI.ti,ab,kf
4. Activties, Daily Living.ti,ab,kf
5. ADL.ti,ab,kf
6. (Activit* adj3 (daily living)) ti,ab,kf
7. 1 OR 2 OR 3 OR 4 or 5 OR 6 OR 7
8. short form*.ti,ab,kf
9. item reduction*.ti,ab,kf
10. minimum dataset. ti,ab,kf
11. Rasch*ti,ab,kf
12. 8 OR 9 OR 10 OR 11
13. psychometric*.ti,ab,kf
14. clinimetric*.ti,ab,kf
15. outcome assessment*.ti,ab,kf

16. outcomes research*.ti,ab,kf

17. 13 OR 14 OR 15 OR 16

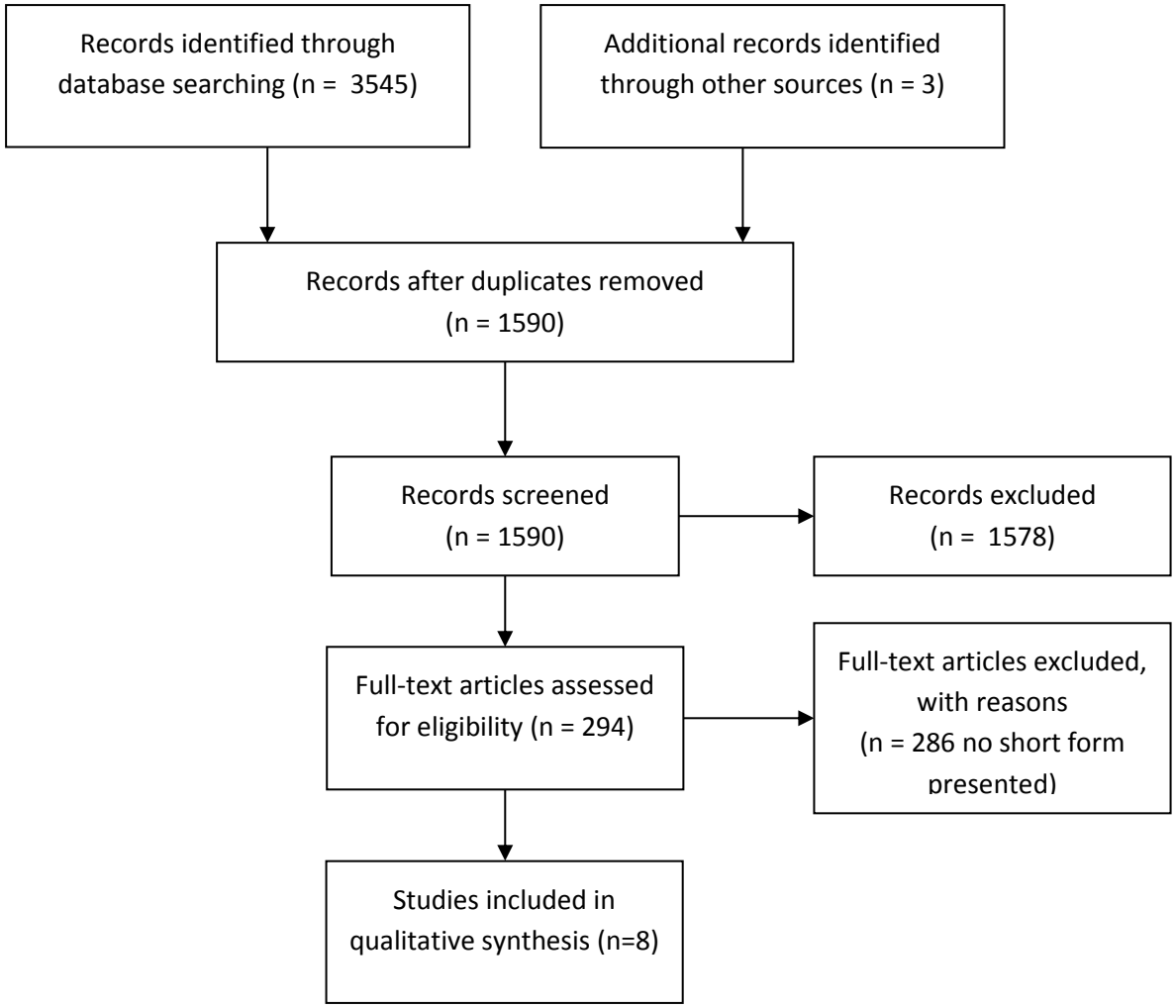
18. 7 AND 12

19. 7 AND 17

20. 18 OR 19

SII) PRISMA flow diagram and questionnaire for literature search

PRISMA 2009 Flow Diagram



Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	3
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4

Search	**8**	**Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.**	**SM**
Study selection	**9**	**State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).**	**4**
Data collection process	**10**	**Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.**	**N/A**
Data items	**11**	**List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.**	**4**
Risk of bias in individual studies	**12**	**Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.**	**N/A**
Summary measures	**13**	**State the principal summary measures (e.g., risk ratio, difference in means).**	**N/A**
Synthesis of results	**14**	**Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.**	**N/A**
Risk of bias across studies	**15**	**Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).**	**N/A**
Additional analyses	**16**	**Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.**	**N/A**
RESULTS			
Study selection	**17**	**Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.**	**SM**

Study characteristics	**18**	**For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.**	**Table1**
Risk of bias within studies	**19**	**Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).**	**N/A**
Results of individual studies	**20**	**For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.**	**N/A**
Synthesis of results	**21**	**Present results of each meta-analysis done, including confidence intervals and measures of consistency.**	**N/A**
Risk of bias across studies	**22**	**Present results of any assessment of risk of bias across studies (see Item 15).**	**N/A**
Additional analysis	**23**	**Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).**	**N/A**
DISCUSSION			
Summary of evidence	**24**	**Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).**	**7**
Limitations	**25**	**Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).**	**12**
Conclusions	**26**	**Provide a general interpretation of the results in the context of other evidence, and implications for future research.**	**7**
FUNDING			
Funding	**27**	**Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.**	**13**

SIII) Clinical and demographic features of the acute stroke trial dataset split by stroke type

	ICH (919)	Ischaemic (7933)	All (8852)
Age (years); Mean (SD)/ N	65.94 (11.78)/ 919	68.30 (12.41)/7933	68.06 (12.37)/8852
Baseline NIHSS; Median (IQR)/ N	13 (8) / 919	12 (8) / 7933	12 (9) / 8852
BMI; Mean (SD)/ N	27.41 (5.76) /453	27.14 (4.74) /4415	27.17 (4.84) /4868
Height (cm); Mean (SD)/ N	167.56 (9.42) /884	168.13 (9.69) /7394	168.07 (9.66)/8278
Weight (Kg); Mean (SD)/ N	76.46 (18.10) /899	76.02 (15.61) /7862	76.07 (15.89)/8761
Systolic blood pressure (mmHg); Mean (SD)/ N	170.96 (28.27)/916	154.79 (25.80) /7261	156.60(26.58)/8177
Diastolic blood pressure (mmHg); Mean (SD)/ N	92.19 (17.76) /916	83.08 (15.83) /7259	84.10 (16.31) /8175
Glucose at baseline (mmol/L) ; Mean (SD)/ N	7.51 (2.78) /432	7.48 (3.06) /5083	7.48 (3.04) /5515
Onset to Treatment Time (hours); Mean (SD)/ N	4.52 (1.05) /919	4.39 (1.57) /7881	4.41 (1.52) /8800
Sex (Female); n (%)	361 (39.28)/919	3582 (45.15) /7933	3943 (44.54) /8852
IV thrombolysis (Yes); n (%)	0 (0) /919	2184 (27.52) /7933	2184 (24.67) /8852
Diabetes (Yes); n (%)	158 (17.19) /919	1619 (20.41) /7933	1777 (20.07) /8852
Hypertension (Yes); n (%)	686 (74.65) /919	5246 (66.13) /7933	5932 (67.01) /8852
Atrial Fibrillation (Yes); n (%)	58 (6.31) /919	1827 (23.03)/7933	1885 (21.29) /8852
Previous Stroke (Yes); n (%)	217 (23.61) /919	1949 (24.57) /7933	2166 (24.47) /8852
Transient Ischaemic Attack (Yes); n (%)	19 (2.07) /919	455 (5.74) /7933	474 (5.35) /8852
Ischaemic Heart Disease (Yes); n (%)	61 (6.64) /919	1338 (16.87) /7933	1399 (15.80) /8852
Myocardial Infarction (Yes); n (%)	41 (4.46) /919	1018 (12.83) /7933	1059 (11.96) /8852

SIV) Clinical and demographic features of the rehabilitation study dataset. Due to the sample size all stroke types were combined

Variable	All Stroke Types
Age (years) Mean (SD)	65.73 (10)
Baseline BI Median (IQR)	15 (7)
Sex (female) n (%)	107 (32%)
LACS n (%)	59 (18%)
PACS n (%)	118 (36%)
TACS n (%)	143 (43%)
Atrial Fibrillation n (%)	45 (13%)
Hypertension n (%)	243 (73%)
Diabetes Mellitus n (%)	44 (13%)
Ischemic Heart Disease n (%)	67 (20%)
Heart Failure n (%)	8 (2%)
Previous Stroke n (%)	57 (17%)
Intra-cerebral haemorrhage n (%)	46 (14%)

Data are in format “n” (%) for nominal data; mean (standard deviation) for other data unless otherwise stated.

NIHSS = National Institutes of Health Stroke Scale; LACS = lacunar stroke; PACS = partial anterior circulation stroke; TACS = total anterior circulation stoke

SV) Correlations between each of the BI attributes.

High correlations (>0.8) highlighted in pink.

	Feeding	Bathing	Grooming	Dressing	Bowel Control	Bladder Control	Toilet Use	Transfer	Mobility
1. Feeding									
2. Bathing	0.64690								
3. Grooming	0.66583	0.61836							
4. Dressing	0.76840	0.75256	0.72010						
5. Bowel Control	0.64369	0.46220	0.58940	0.63256					
6. Bladder Control	0.63763	0.50282	0.60071	0.65547	0.82088				
7. Toilet Use	0.74762	0.70607	0.73643	0.84572	0.69503	0.71767			
8. Transfer	0.75281	0.65920	0.71939	0.81344	0.70362	0.71148	0.88113		
9. Mobility	0.73161	0.67196	0.69643	0.81342	0.68621	0.70078	0.87043	0.88754	
10. Stairs	0.69589	0.75691	0.65945	0.80504	0.57984	0.61578	0.82283	0.81446	0.84995

SVI) Ordinal univariate regressions for association of clinical features with each SF-BI.

Odds ratios presented are odds of poor outcome

Variable	Coefficient (95% CI)							
	BI90 full scale	Cho 3-item	Ellul 3-Item	Granger 4-Item	Hobart 5-Item	Hobart 4-Item	Hobart 3-Item	VISTA 3-Item
Age	1.05(1.05, 1.05)	1.05 (1.04,1.05)	1.06(1.05, 1.06)	1.05(1.04,1.05)	1.05(1.05,1.06)	1.05(1.05,1.06)	1.05(1.05,1.06)	1.06 (1.05,1.06)
Base NIHSS	1.19(1.18, 1.20)	1.19 (1.18,1.20)	1.18(1.17, 1.19)	1.19(1.18,1.20)	1.18(1.18,1.19)	1.19(1.18,1.20)	1.19(1.18,1.20)	1.18 (1.17,1.19)
SBP	1.01(1.00, 1.01)	1.01 (1.00,1.01)	1.01(1.00, 1.01)	1.00(1.00,1.01)	1.01(1.00,1.01)	1.01(1.00,1.01)	1.01(1.00,1.01)	1.01 (1.00,1.01)
Glucose	1.08(1.06, 1.09)	1.07 (1.06,1.09)	1.07(1.05, 1.09)	1.06(1.05,1.08)	1.08(1.06,1.09)	1.08(1.06,1.09)	1.07(1.06,1.09)	1.07 (1.05,1.09)
Time to treatment	1.18(1.16, 1.21)	1.28 (1.13,1.44)	1.18(1.15, 1.21)	1.16(1.13,1.19)	1.17(1.14,1.20)	1.16(1.14,1.19)	1.16(1.13,1.19)	1.24 (1.09,1.41)
Sex (Female=1)	1.45(1.34, 1.56)	1.41 (1.31,1.52)	1.59(1.47, 1.72)	1.37(1.26,1.48)	1.54(1.43,1.66)	1.53(1.41,1.65)	1.47(1.36,1.59)	1.59 (1.47,1.72)
Stroke type (ICH=1)	1.40(1.24, 1.58)	1.28 (1.13,1.44)	1.24(1.10, 1.41)	1.14(1.01,1.30)	1.32(1.17,1.50)	1.30(1.15,1.47)	1.22(1.08,1.38)	1.24 (1.09,1.41)
Thrombolysis (YES=1)	0.72(0.66, 0.78)	0.73 (0.67,0.79)	0.73(0.66, 0.80)	0.78(0.71,0.86)	0.69(0.63,0.76)	0.69(0.63,0.75)	0.70(0.64,0.80)	0.73 (0.66,0.80)
AFIB (YES=1)	1.80(1.65, 1.97)	1.77 (1.61,1.94)	1.89(1.72, 2.08)	1.80(1.64,1.98)	1.87(1.70,2.05)	1.88(1.72,2.06)	1.91(1.74,2.10)	1.90 (1.73,2.09)
Hypertension (YES=1)	1.35(1.24, 1.47)	1.31 (1.20,1.43)	1.41(1.29, 1.54)	1.31(1.20,1.44)	1.36(1.24,1.48)	1.34(1.23,1.46)	1.31(1.20,1.43)	1.41 (1.28,1.54)
Diabetes (YES=1)	1.47(1.34, 1.61)	1.39 (1.26,1.53)	1.45(1.32, 1.60)	1.42(1.29,1.57)	1.40(1.27,1.53)	1.39(1.26,1.52)	1.38(1.25,1.51)	1.45 (1.32,1.60)
CHF (YES=1	1.33(1.10, 1.61)	1.24 (1.02,1.51)	1.34(1.10, 1.64)	1.25(1.02,1.53)	1.34(1.10,1.63)	1.33(1.09,1.62)	1.29(1.06,1.58)	1.33 (1.09,1.63)
Prior stroke (YES=1)	1.48(1.36, 1.62)	1.34 (1.23,1.47)	1.40(1.28, 1.53)	1.32(1.20,1.44)	1.40(1.28,1.53)	1.39(1.27,1.52)	1.36(1.24,1.49)	1.40 (1.27,1.53)

Base NIHSS, Baseline National Institute of Health Stroke Scale; SBP, Systolic Blood Pressure; ICH, Intracerebral haemorrhage; AFIB, Atrial Fibrillation; CHF, Chronic Heart Failure.

SVII) Univariate ordinal regressions showing the relationships between each SF-BI and each primary outcome measure.

Data are presented as odds of better outcome on mRS and NIHSS.

Variable	OR for SF BI and higher score on outcome measure	
	mRS90	NIHSS90
BI day 90	1.16(1.15, 1.16)	1.08(1.07, 1.08)
Cho 3-item	1.51 (1.49, 1.52)	1.26 (1.25, 1.27)
BI Ellul 3-item	1.18(1.17, 1.18)	1.07(1.07, 1.07)
Granger 4-item	1.36(1.34,1.37)	1.21(1.20,1.21)
Hobart 5-item	1.34(1.33,1.36)	1.12(1.12,1.13)
Hobart 4-item	1.41(1.39,1.42)	1.17(1.17,1.18)
Hobart 3-item	1.53(1.51,1.55)	1.24(1.23,1.25)
VISTA 3 Item	1.46(1.44,1.48)	1.18(1.17,1.18)

SVIII) Results from Exploratory Factor analysis

Rotated factor patter (standardised regression coefficients) of all 10 items of the BI day 90 using traditional factor analysis performed on full data. Those highlighted in yellow are significantly loaded to one factor and those highlighted in red are cross loaded.

BI day 90 attribute	F1	F2
1. Feeding	0.64724	0.50522
2. Bathing	0.77588	0.24517
3. Grooming	0.62941	0.46256
4. Dressing	0.79295	0.44661
5. Bowel Control	0.34105	0.80712
6. Bladder Control	0.37947	0.78764
7. Toilet Use	0.75150	0.55110
8. Transfer	0.71845	0.57813
9. Mobility	0.74211	0.54284
10. Stairs	0.82221	0.37295

SIX) Steering group members of the Virtual International Stroke Trials Archive (VISTA) VISTA-Acute

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