Stiffness Is the Cardinal Symptom of Inflammatory Musculoskeletal Diseases, Yet Still Variably Measured: Report from the OMERACT 2016 Stiffness Special Interest Group

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ABSTRACT. ***Objective.*** The objectives of the Outcome Measures in Rheumatology (OMERACT) Stiffness special interest group (SIG) are to characterize stiffness as an outcome in rheumatic disease and to identify and validate a stiffness patient-reported outcome (PRO) in rheumatology.

Methods. At OMERACT 2016, international groups presented and discussed results of several concurrent research projects on stiffness: a literature review of rheumatoid arthritis (RA) stiffness PRO measures, a qualitative investigation into the RA and polymyalgia rheumatica patient perspective of stiffness, data-driven stiffness conceptual model development, development and testing of an RA stiffness PRO measure, and a quantitative work testing stiffness items in patients with RA and psoriatic arthritis.

Results. The literature review identified 52 individual stiffness PRO measures assessing morning or early morning stiffness severity/intensity or duration. Items were heterogeneous, had little or inconsistent psychometric property evidence, and did not appear to have been developed according to the PRO development guidelines. A poor match between current stiffness PRO and the conceptual model identifying the RA patient experience of stiffness was identified, highlighting a major flaw in PRO selection according to the OMERACT filter 2.0.

Conclusion. Discussions within the Stiffness SIG highlighted the importance of further research on stiffness and defined a research agenda. (First Release December 15 2016; J Rheumatol 2017;44:1904–10; doi:10.3899/jrheum.161073)

Key Indexing Terms:
STIFFNESS OUTCOME MEASUREMENT OMERACT

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Stiffness affects 70%–75% of people with rheumatoid arthritis (RA) regardless of treatment status[1] and 44%–80% of patients in low disease activity[2]. Evidence shows that stiffness is important to patients with RA in flare[3] and remission[2] states, and it is an integral part of the RA experience[4,5]. Stiffness adversely affects health-related quality of life[6] and is associated with an earlier initiation of disease-modifying therapy in RA[7].

Further, stiffness is a key symptom recognized by patients and clinicians in many other inflammatory rheumatic diseases including polymyalgia rheumatica (PMR) and psoriatic arthritis (PsA) among others[8,9,10,11,12]. In RA, stiffness assessment is particularly relevant because it likely influences patients' ability to meet remission criteria[13]. A systematic review[2] in RA low disease activity and remission identified and summarized the measurement properties of currently available stiffness patient-reported outcome (PRO) measures. The review identified only 2 articles, which made conflicting recommendations about the most appropriate concept for stiffness assessment (morning stiffness duration or severity), and concluded that there was insufficient scientific data supporting current stiffness measures[2].

The aims of the OMERACT 2016 stiffness special interest group (SIG) were to consolidate the work on stiffness across inflammatory rheumatic conditions to systematize future research on the topic and to work toward identifying and validating an outcome measure for stiffness in rheumatic diseases that would be consistent with the methodology outlined by the OMERACT filter 2.0[14]. In preparation for the Stiffness SIG at OMERACT 2016, the following research projects were conducted: (1) a literature review of stiffness PRO measure in RA, (2) a synthesis of qualitative research conducted in RA, (3) qualitative research with patients with PMR, (4) the development, refinement, and testing of candidate items for an RA stiffness questionnaire[15], and (5) the examination of stiffness items in RA and PsA.

Stiffness Literature Review

A literature review was conducted to identify and assess measurement properties of stiffness PRO in RA. The search was conducted in PubMed using a validated search filter[16] and was consistent with a prior systematic literature review in RA remission[2], including articles identified there. Article screening determined 25 articles suitable for full-text review (Figure 1)[2]. From these, 52 individual stiffness PRO measures were identified. All but 1 assessed morning stiffness or early morning stiffness. Most assessed the concepts of duration (n = 30) or severity/intensity (n = 18), while others assessed improvement (n = 1), importance (n = 1), and 2 were unclear. There was great variation in PRO wording, response options, format, and time frame. For example, PRO item formats included visual analog scale (VAS; n = 14), numeric rating scale (NRS; n = 5), Likert scale (n = 7), and minutes in free text (n = 23); 2 items were unclear. Items were also poorly defined with 22 items unclear regarding some or all item components. Reports of face, content, criterion and construct validity, reliability, and responsiveness were limited and inconsistent. Overall, severity items appeared to perform better than duration items in relation to construct validity and discrimination between disease states, responsiveness, and sensitivity to change, but evidence was limited. No articles reported the face or content validity of stiffness items and no patient involvement in item development was reported. A summary of the literature review findings is outlined in Table 1[17–26,27–36,37,38,39,40,41]. Current RA stiffness assessment is heterogeneous, incompletely reported, and does not appear to have been developed according to the PRO development guidelines recommending incorporating the patient perspective[42].

Qualitative Investigation of Stiffness in RA

A synthesis of qualitative work identifying the RA patient experience of stiffness was performed by an experienced qualitative researcher. The published papers reviewed[4,5] reported 2 independent conceptual models based on inductive thematic analysis[43,44] of international focus groups and semistructured interviews. The synthesis identified 6 common domains (Figure 2). Patients considered stiffness a normal part of RA that was widely variable (in timing, duration, and location) and did not occur exclusively in the mornings. Stiffness was related to other RA symptoms, affected daily life, and was influenced by external or personal factors (e.g., medication, self-management). The key, common concepts that stiffness is not purely a morning symptom and is best evaluated by its effect[45] contrast with current stiffness assessments that focus on morning stiffness severity or duration. This indicates a poor match between the conceptual model and currently used PRO, a major flaw according to the OMERACT filter 2.0 recommendations for selecting PRO[46].

Qualitative Investigation of Stiffness in PMR

Qualitative research was conducted in PMR to investigate the

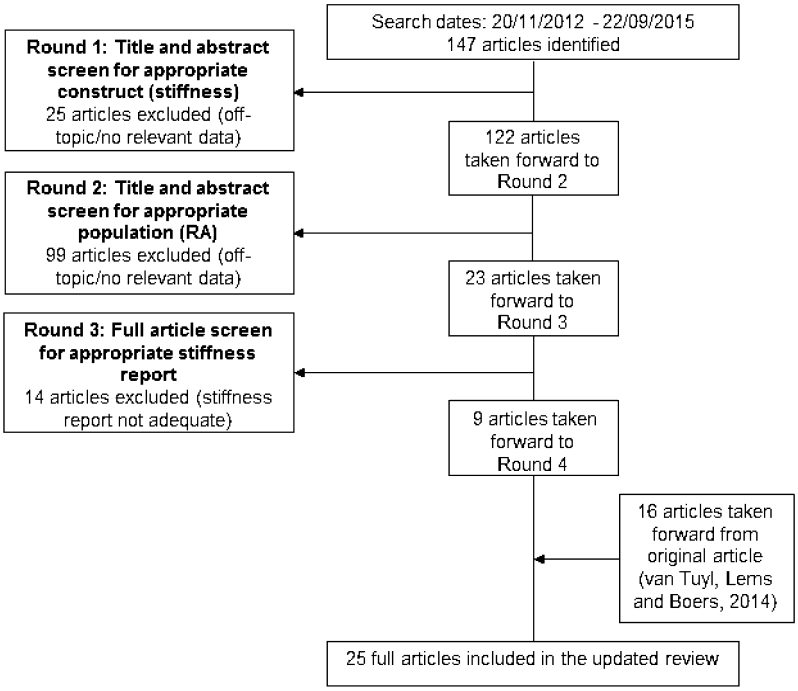

Figure 1. Flow diagram of the article selection process. RA: rheumatoid arthritis.

patient experience of stiffness and its assessment[47] through 8 focus groups. The conceptual model of the PMR patient experience of stiffness had 4 major themes: symptoms, functional effect, influence on daily schedule, and approaches to measurement. Stiffness was an important symptom for patients, distinct from pain, and for some it was over-whelming and imposed restrictions on activities of daily life. For stiffness assessment, patients preferred an NRS or an assessment of stiffness effect on daily life functioning rather than a VAS. Findings in PMR are consistent with qualitative work performed in RA. Assessing functional effect may be a pragmatic approach to difficulties with current stiffness assessments.

Development of New RA Stiffness Questionnaire

A new PRO for stiffness in RA has been developed based on qualitative research findings[4], a qualitative investigation into the patient perspective of stiffness assessment, and an iterative process of item development involving clinicians, researchers, and patients. Cognitive interviews with patients with RA refined draft items into a set of 45 preliminary stiffness items. These were administered by a postal survey with additional PRO [patient's global assessment (PtGA) VAS[48], pain NRS[49], Bristol Rheumatoid Arthritis Fatigue Severity NRS[50,51], flare question from the Preliminary Flare Questionnaire[52], modified Health Assessment Questionnaire (mHAQ)[53], patient-based disease activity score[54,55]] and demographic questions to a new sample of patients with RA [n = 277; 32.9% men; mean (SD) age 63.9 (12.4) yrs, range 23–97; median disease duration (interquartile range) 6 (3–15) yrs, range 1–45]. Successive rounds of analytical refinement were performed using principal component analysis and Cronbach's alpha coefficient for internal consistency to identify the smallest number of informative items. This resulted in the development of a new RA stiffness PRO measure (RAST) with 21 items and 3 components identifying stiffness severity, physical effect, and psychosocial effect[15]. The RAST PRO measure can now be tested in independent longitudinal studies to accumulate evidence on psychometric properties in RA and other rheumatic diseases.

Quantitative Testing of Stiffness Items in RA and PsA

Stiffness items (severity, duration, and effect) were assessed in a cross-sectional study of patients with PsA and age- and sex-matched RA controls in the Australian Rheumatology Association Database[56], a voluntary national registry for patients with inflammatory arthritis. Stiffness items and additional PRO (mHAQ[53], pain, PtGA) were completed electronically by 103/158 patients with PsA and 111/158 with RA. Ratings of stiffness severity, duration, and effect were comparable in RA and PsA. There was a high degree of correlation between different dimensions of stiffness (r = 0.71–0.89) and stiffness item formats (r = 0.58–0.90). Stiffness was independently associated with physical function in the multiple regression model. Stiffness severity and effect were most strongly associated with physical function (adjusted $R^2 = 0.60$).

Table 1. Individual stiffness PRO measures identified in literature review.

Study	Instrument Concept	Stem Wording	Response Options/anchors
Rhind, *et al*[17]	(1) Severity of MS	(1) EWU	(1) 10-cm VAS, no to very severe
	(2) Severity of MS	(2) EWU	(2) 11-point NRS, no to very severe
	(3) Severity of MS	(3) EWU	(3) 5-point VS, no, mild, moderate,
	(4) Duration of MS	(4) How long did it take for your stiffness to begin to ease after you got out of bed this morning?	severe, very severe (4) Mins
Hazes, *et al*[18]	(1) Severity of MS	(1) EWU	(1) 10-cm VAS, no to very severe
	(2) Severity of MS	(2) EWU	(2) 11-point NRS, no to very severe
	(3) Duration of MS	(3) How long does your MS last until it begins to improve?	(3) Mins
	(4) Duration of MS	(4) How long does your MS last until maximum improvement	(4) Mins
	(5) Duration of MS	occurs?	(5) Mins
		(5) How long does it take you to get going properly?	
Hazes, *et al*[19]	(1) Duration of MS	(1) Waking to first improvement	(1) Mins
	(2) Duration of MS	(2) Getting up to first improvement	(2) Mins
	(3) Duration of MS	(3) Waking to maximum improvement	(3) Mins
	(4) Duration of MS	(4) Getting up to maximum improvement	(4) Mins
	(5) Duration of MS	(5) Waking to complete disappearance	(5) Mins
	(6) Duration of MS	(6) Getting up to complete disappearance	(6) Mins
Ward[20]	(1) Duration of MS	(1) EWU	(1) Mins
Buchbinder, *et al*[21]	(1) Duration of MS	(1) Time from awakening, EWU	(1) Mins, as time from awakening
Borstlap, *et al*[22]	(1) No mention of severity or duration	(1) EWU	(1) 10-cm VAS, anchors unclear
Vliet Vlieland, *et al*[23]	(1) Severity of MS	(1) EWU	
	(2) Duration of MS	(2) How long does your morning stiffness last from waking until maximum improvement occurs?	(1) 10-cm VAS, none to very severe (2) Mins, cutoff at 240
Houssien, *et al*[24]	(1) Duration of EMS	(1) EWU	(1) Mins
Wolfe[25]	(1) Severity of MS	(1) How severe has your stiffness been after you first woke up	(1) 100-mm VAS, none to extreme
	(2) Severity after immobility	in the morning?	(2) 100-mm VAS, none to extreme
		(2) How severe has your stiffness been after sitting or lying down or while resting later in the day?	
Fransen, *et al*[26]	(1) Duration of MS	(1) Were your joints stiff when you woke up today? If yes, how long did this extra stiffness last?	(1) 0 min, < 30 mins, 30 min to 1 h, 1–2 h, 2–4 h, > 4 h < all day, all day
Sarzi-Puttini, *et al*[27]	(1) Duration of MS	(1) EWU	(1) Mins on a VAS? Anchors unclear
Leeb, *et al*[28]	(1) Daily MS severity	(1) EWU	(1) 100-mm VAS, no to unbearable
	(2) Starting stiffness after a time of rest	(2) Starting stiffness after a time of rest, EWU	(2) 100-mm VAS, no to unbearable
	(3) Duration of MS	(3) EWU	(3) Mins
Yazici, *et al*[29]	(1) Duration of MS	(1) EWU	(1) 0 min, 1–15 mins, 16–59mins, ≥ 60 mins
Westhoff, *et al*[30]	(1) Severity of MS	(1) EWU	(1) 11-point NRS, no to extremely severe
	(2) Duration of MS	(2) EWU	(2) Mins
Khan, *et al*[31]	(1) Duration of MS	(1) From time of waking to time of max improvement	(1) 0 min, 1–30 mins, 31–60 mins, > 60 mins
El Miedany, *et al*[32]	(1) Duration of MS	(1) Over the last week when you awoke in the morning, did you feel stiff? Please indicate the number of minutes, or hours until you are as limber as you will be for the day.	(1) Mins
Wiesinger, *et al*[33]	(1) No mention of severity or duration	(1) EWU	(1) Anchors unclear
Jastrząbek, *et al*[34]	(1) Duration of MS	(1) EWU	(1) Mins
Lie, *et al*[35]	(1) Severity of MS	(1) How would you describe the overall level of morning	(1) 10-cm VAS, none to very severe
	(2) Duration of MS	stiffness you have had from the time you wake up?	(2) 10-cm VAS, 0 = 0 h to 10 = > 2 h
		(2) How long does your morning stiffness last from the time you wake up?	
Bykerk, *et al*[36]	(1) Severity of MS	(1) EWU	(1) Response options unclear
	(2) Duration of MS	(2) EWU	(2) Response options unclear
	(3) Stiffness severity	(3) EWU	(3) 11-point NRS, anchors unclear
Hamad, *et al*[37]	(1) Duration of MS	(1) How long does your MS last until maximum improvement occurs?	(1) Mins
Bartlett, *et al*[38]	(1) Stiffness	(1) Stiffness, EWU	
	(2) Duration of MS	(2) Were your joints stiff when you woke up today? If yes, how long did this extra stiffness last?	(1) 11-point NRS, anchors unclear (2) 0 min, < 30 mins, 30 mins to 1 h, 1–2 h, 2–4 h, > 4 h to < all day, all day

Table 1. Continued.

Study	Instrument Concept	Stem Wording	Response Options/anchors
van Nies, *et al*[39]*	(1) Duration of MS (2) Duration of MS (3) Duration of MS (4) Severity of MS	(1) Do you experience stiffness when you get up in the morning? If so, for how many minutes? (2) Do you experience morning stiffness? If yes, for how long? (3) Do you experience stiffness in your joints in the morning? And if so, how long does this stiffness endure? (4) EWU	(1) Mins, < 60 or ≥ 60 and ≥ 30 or ≥ 90 (2) Mins, < 60 or ≥ 60 and ≥ 30 or ≥ 90 (3) Mins, < 60 or ≥ 60 and ≥ 30 or ≥ 90 (4) 100-mm VAS, mild 0–33, moderate 34–67, severe 68–100
Ward, *et al*[40]	(1) Severity of MS (2) MS transition (3) MS transition importance	(1) EWU (2) Since the start of the study, my stiffness in the morning has… (3) MS transition importance, EWU	(1) 100-mm VAS, none to very severe (2) 3-point VS, improved, stayed the same, worsened (3) 7-point VS, hardly important at all to extremely important
Ward, *et al*[41]	(1) Severity of MS (2) Duration of MS	(1) EWU (2) How long does your MS last until maximum improvement occurs?	(1) 100-mm VAS, none to severe (2) Mins

* Different cohorts used different questions. PRO: patient-reported outcome; MS: morning stiffness; EMS: early morning stiffness; EWU: exact wording unclear; VAS: visual analog scale; NRS: numerical rating scale; VS: verbal scale.

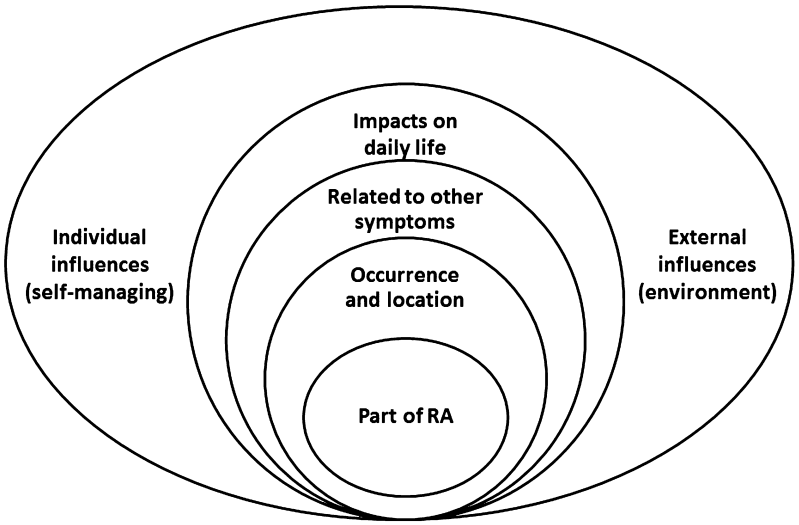

Figure 2. Synthesis of patient-derived conceptual models of stiffness in RA. RA: rheumatoid arthritis.

DISCUSSION

Stiffness is an important symptom for patients across rheumatic conditions. It has been included in the RA Flare core domain set since 2014, and its inclusion in the PMR core domain set and the research agenda for PsA was endorsed at OMERACT 2016. Qualitative research and literature reviews demonstrate that current stiffness PRO may not adequately reflect stiffness dimensions that matter most to patients[2,4,5,8]. Hence, current stiffness items do not meet the OMERACT filter 2.0 "eyeball test" of being a good match with the domain of interest[46]. Discussions within the SIG suggested that while stiffness is a generalizable domain across several rheumatic conditions, notable differences exist in the patient experience. For example, patients within the SIG highlighted that the location of stiffness would differ between PMR and RA and this should be reflected in the wording of items. This is also relevant in ankylosing spondylitis or PsA with axial spondyloarthritis. Possible solutions could include further qualitative investigations with different patient groups to tailor assessments to specific populations, or design a comprehensive databank of stiffness items that can be administered using an interactive approach such as computer-adaptive testing. Meanwhile, research to develop and validate a comprehensive RA stiffness PRO measure is currently ongoing in the United Kingdom, United States, and Australia. This work has been grounded on qualitative research with patients and followed by item testing and refinement. Further testing and refinement in independent RA cohorts and additional rheumatic diseases is ongoing.

Research Agenda

The OMERACT 2016 Stiffness SIG defined the following items on its research agenda: (1) investigation of contextual factors and adverse events that can be achieved through secondary data analysis of 2 qualitative datasets we collected in RA, a PMR qualitative dataset, as well as additional qualitative datasets (PsA), (2) a qualitative investigation into the patient perspective of stiffness assessment in rheumatic diseases other than RA and PMR, (3) development and validation of stiffness assessment tools in RA, which may include further psychometric evaluations of the RAST and testing using item response theory, (4) an investigation into stiffness pathophysiology across rheumatic conditions, and (5) a review of stiffness assessment in osteoarthritis and nonrheumatic conditions to assess potential for integration with rheumatic disease stiffness.

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REFERENCES

1. Strand V, Holt RJ, Saunders KC, Kent JD, Xu P, Grahn AY, et al. Prevalence of morning stiffness in a US registry population of rheumatoid arthritis patients [abstract]. Arthritis Rheum 2014;66 Suppl 10:S178.
2. van Tuyl LH, Lems WF, Boers M. Measurement of stiffness in patients with rheumatoid arthritis in low disease activity or remission: a systematic review. BMC Musculoskelet Disord 2014;15:28.
3. Bartlett SJ, Hewlett S, Bingham CO 3rd, Woodworth TG, Alten R, Pohl C, et al; OMERACT RA Flare Working Group. Identifying core domains to assess flare in rheumatoid arthritis: an OMERACT international patient and provider combined Delphi consensus. Ann Rheum Dis 2012;71:1855-60.
4. Halls S, Dures E, Kirwan J, Pollock J, Baker G, Edmunds A, et al. Stiffness is more than just duration and severity: a qualitative exploration in people with rheumatoid arthritis. Rheumatology 2015;54:615-22.
5. Orbai AM, Smith KC, Bartlett SJ, De Leon E, Bingham CO 3rd. "Stiffness has different meanings, I think, to everyone": examining stiffness from the perspective of people living with rheumatoid arthritis. Arthritis Care Res 2014;66:1662-72.
6. Iqbal I, Dasgupta B, Taylor P, Heron L, Pilling C. Elicitation of health state utilities associated with differing durations of morning stiffness in rheumatoid arthritis. J Med Econ 2012;15:1192-200.
7. Pappas DA, Kent JD, Greenberg JD, Mason MA, Kremer JM, Holt RJ. Delays in initiation of disease-modifying therapy in rheumatoid arthritis patients: data from a US-based registry. Rheumatol Ther 2015;2:153-64.
8. Mackie SL, Arat S, da Silva J, Duarte C, Halliday S, Hughes R, et al. Polymyalgia Rheumatica (PMR) Special Interest Group at OMERACT 11: outcomes of importance for patients with PMR. J Rheumatol 2014;41:819-23.
9. Hewlett S, Sanderson T, May J, Alten R, Bingham CO 3rd, Cross M, et al. 'I'm hurting, I want to kill myself': rheumatoid arthritis flare is more than a high joint count—an international patient perspective on flare where medical help is sought. Rheumatology 2012;51:69-76.
10. Calin A. The individual with ankylosing spondylitis: defining disease status and the impact of the illness. Rheumatology 1995;34:663-72.
11. Garg N, Truong B, Ku JH, Devere TS, Ehst BD, Blauvelt A, et al. A novel, short, and simple screening questionnaire can suggest presence of psoriatic arthritis in psoriasis patients in a dermatology clinic. Clin Rheumatol 2015;34:1745-51.
12. Lapane KL, Yang S, Driban JB, Liu SH, Dubé CE, McAlindon TE, et al. Effects of prescription nonsteroidal antiinflammatory drugs on symptoms and disease progression among patients with knee osteoarthritis. Arthritis Rheumatol 2015;67:724-32.
13. Pappas DA, Holt RJ, Shan Y, Kent JD, Nguyen JT, Kremer JM, et al. The influence of patient reported morning stiffness on patient global assessment in rheumatoid arthritis patients not achieving ACR/EULAR Boolean remission in a large US registry [abstract]. Arthritis Rheum 2015;67 Suppl 10:3202-3.
14. Boers M, Kirwan JR, Wells G, Beaton D, Gossec L, d'Agostino MA, et al. Developing core outcome measurement sets for clinical trials: OMERACT filter 2.0. J Clin Epidemiol 2014;67:745-53.
15. Halls S. Understanding the patient experience of stiffness, and developing a stiffness patient-recorded outcome measure in rheumatoid arthritis [PhD thesis]. [Internet. Accessed November 22, 2016.] Available from: eprints.uwe.ac.uk/29181
16. Terwee CB, Jansma EP, Riphagen II, de Vet HC. Development of a methodological PubMed search filter for finding studies on measurement properties of measurement instruments. Qual Life Res 2009;18:1115-23.
17. Rhind VM, Unsworth A, Haslock I. Assessment of stiffness in rheumatology: the use of rating scales. Br J Rheumatol 1987;26:126-30.
18. Hazes JM, Hayton R, Silman AJ. A reevaluation of the symptom of morning stiffness. J Rheumatol 1993;20:1138-42.
19. Hazes JM, Hayton R, Burt J, Silman AJ. Consistency of morning stiffness: an analysis of diary data. Brit J Rheumatol 1994;33:562-5.
20. Ward MM. Clinical measures in rheumatoid arthritis: which are most useful in assessing patients. J Rheumatol 1994;21:17-27.
21. Buchbinder R, Bombardier C, Yeung M, Tugwell P. Which outcome measures should be used in rheumatoid arthritis clinical trials? Clinical and quality-of-life measures' responsiveness to treatment in a randomized controlled trial. Arthritis Rheum 1995;38:1568-80.
22. Borstlap M, Zant JL, van Soesbergen RM, van der Korst JK. Quality of life assessment: a comparison of four questionnaires: for measuring improvements after total hip replacement. Clin Rheumatol 1995;14:15-20.
23. Vliet Vlieland TP, Zwinderman AH, Breedveld FC, Hazes JM. Measurement of morning stiffness in rheumatoid arthritis clinical trials. J Clin Epidemiol 1997;50:757-63.
24. Houssien DA, McKenna SP, Scott DL. The Nottingham Health Profile as a measure of disease activity and outcome in rheumatoid arthritis. Br J Rheumatol 1997;36:69-73.
25. Wolfe F. Determinants of WOMAC function, pain and stiffness scores: evidence for the role of low back pain, symptom counts, fatigue and depression in osteoarthritis, rheumatoid arthritis and fibromyalgia. Rheumatology 1999;38:355-61.
26. Fransen J, Langenegger T, Michel BA, Stucki G. Feasibility and validity of the RADAI, a self-administered rheumatoid arthritis disease activity index. Rheumatology 2000;39:321-7.
27. Sarzi-Puttini P, Fiorini T, Panni B, Turiel M, Cazzola M, Atzeni F. Correlation of the score for subjective pain with physical disability, clinical and radiographic scores in recent onset rheumatoid arthritis. BMC Musculoskelet Disord 2002;3:18.
28. Leeb BF, Sautner J, Andel I, Rintelen B. SACRAH: a score for assessment and quantification of chronic rheumatic affections of the hands. Rheumatology 2003;42:1173-8.
29. Yazici Y, Pincus T, Kautiainen H, Sokka T. Morning stiffness in patients with early rheumatoid arthritis is associated more strongly with functional disability than with joint swelling and erythrocyte sedimentation rate. J Rheumatol 2004;31:1723-6.

30. Westhoff G, Buttgereit F, Gromnica-Ihle E, Zink A. Morning stiffness and its influence on early retirement in patients with recent onset rheumatoid arthritis. Rheumatology 2008;47:980-4.
31. Khan NA, Yazici Y, Calvo-Alen J, Dadoniene J, Gossec L, Hansen TM, et al; QUEST-RA group. Reevaluation of the role of duration of morning stiffness in the assessment of rheumatoid arthritis activity. J Rheumatol 2009;36:2435-42.
32. El Miedany Y, El Gaafary M, Youssef SS, Palmer D. Incorporating patient reported outcome measures in clinical practice: development and validation of a questionnaire for inflammatory arthritis. Clin Exp Rheumatol 2010;28:734-44.
33. Wiesinger T, Smolen JS, Aletaha D, Stamm T. Compression test (Gaenslen's squeeze test) positivity, joint tenderness, and disease activity in patients with rheumatoid arthritis. Arthritis Care Res 2013;65:653-7.
34. Jastrząbek R, Straburzyńska-Lupa A, Rutkowski R, Romanowski W. Effects of different local cryotherapies on systemic levels of TNF-α, IL-6, and clinical parameters in active rheumatoid arthritis. Rheumatol Int 2013;33:2053-60.
35. Lie E, Woodworth TG, Christensen R, Kvien T, Bykerk V, Furst DE, et al. Validation of OMERACT preliminary rheumatoid arthritis flare domains in the NOR-DMARD study. Ann Rheum Dis 2014;73:1781-7.
36. Bykerk VP, Lie E, Bartlett SJ, Alten R, Boonen A, Christensen R, et al. Establishing a core domain set to measure rheumatoid arthritis flares: report of the OMERACT 11 RA flare Workshop. J Rheumatol 2014;41:799-809.
37. Hamad MB, Marzouk S, Kaddour N, Masmoudi H, Fakhfakh F, Rebai A, et al. Anticyclic citrullinated peptide antibody and rheumatoid factor in South Tunisian patients with rheumatoid arthritis: association with disease activity and severity. J Clin Lab Anal 2014;28:21-6.
38. Bartlett SJ, Bykerk VP, Cooksey R, Choy EH, Alten R, Christensen R, et al. Feasibility and domain validation of rheumatoid arthritis (RA) flare core domain set: report of the OMERACT 2014 RA Flare Group plenary. J Rheumatol 2015;42:2185-9.
39. van Nies JA, Alves C, Radix-Bloemen AL, Gaujoux-Viala C, Huizinga TW, Hazes JM, et al. Reappraisal of the diagnostic and prognostic value of morning stiffness in arthralgia and early arthritis: results from the Groningen EARC, Leiden EARC, ESPOIR, Leiden EAC and REACH. Arthritis Res Ther 2015;17:108.
40. Ward MM, Guthrie LC, Alba MI. Domain-specific transition questions demonstrated higher validity than global transition questions as anchors for clinically important improvement. J Clin Epidemiol 2015;68:655-61.
41. Ward MM, Guthrie LC, Alba MI. Measures of arthritis activity associated with patient-reported improvement in rheumatoid arthritis when assessed prospectively versus retrospectively. Arthritis Care Res 2015;67:776-81.
42. U.S. Department of Health and Human Services Food and Drug Administration. Guidance for industry patient-reported outcome measures: use in medical product development to support labeling claims. [Internet. Accessed November 21, 2016.] Available from: www.fda.gov/downloads/Drugs/GuidanceComplianceRegulatoryInformation/Guidances/UCM193282.pdf
43. Braun V, Clarke V. Using thematic analysis in psychology. Qual Res Psychol 2006;3:77-101.
44. Pope C, Ziebland S, Mays N. Qualitative research in health care. Analysing qualitative data. BMJ 2000;320:114-6.
45. Orbai AM, Halls S, Hewlett S, Bartlett SJ, Leong AL, Bingham CO 3rd; RA Flare Group Steering Committee. More than just minutes of stiffness in the morning: report from the OMERACT Rheumatoid Arthritis Flare Group stiffness breakout sessions. J Rheumatol 2015;42:2182-4.
46. Beaton DE, Terwee CB, Singh JA, Hawker GA, Patrick DL, Burke LB, et al. A call for evidence-based decision making when selecting outcome measurement instruments for summary of findings tables in systematic reviews: results from an OMERACT working group. J Rheumatol 2015;42:1954-61.
47. Mackie SL, Hughes R, Walsh M, Day J, Newton M, Pease C, et al. "An impediment to living life": why and how should we measure stiffness in polymyalgia rheumatica? PLoS One 2015;10:e0126758.
48. van der Heijde DM, van 't Hof M, van Riel PL, van de Putte LB. Development of a disease activity score based on judgment in clinical practice by rheumatologists. J Rheumatol 1993;20:579-81.
49. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. Pain 2001;94:149-58.
50. Nicklin J, Cramp F, Kirwan J, Urban M, Hewlett S. Collaboration with patients in the design of patient-reported outcome measures: capturing the experience of fatigue in rheumatoid arthritis. Arthritis Care Res 2010;62:1552-8.
51. Nicklin J, Cramp F, Kirwan J, Greenwood R, Urban M, Hewlett S. Measuring fatigue in rheumatoid arthritis: a cross-sectional study to evaluate the Bristol Rheumatoid Arthritis Fatigue Multi-Dimensional questionnaire, visual analog scales, and numerical rating scales. Arthritis Care Res 2010;62:1559-68.
52. Bykerk VP, Bartlett SJ, Choy E, Boire G, Hitchon C, Pope J, et al. An evaluation of flare in patients with early rheumatoid arthritis using the OMERACT preliminary flare questionnaire [abstract]. Ann Rheum Dis 2013;71 Suppl 3:180-1.
53. Pincus T, Summey JA, Soraci SA Jr, Wallston KA, Hummon NP. Assessment of patient satisfaction in activities of daily living using a modified Stanford Health Assessment Questionnaire. Arthritis Rheum 1983;26:1346-53.
54. Choy EH, Khoshaba B, Cooper D, MacGregor A, Scott DL. Development and validation of a patient-based disease activity score in rheumatoid arthritis that can be used in clinical trials and routine practice. Arthritis Rheum 2008;59:192-9.
55. Information on funding omitted from the article by Peter, et al (Arthritis Care Res, January 2015). Erratum. Arthritis Care Res 2015;67:1618.
56. Buchbinder R, March L, Lassere M, Briggs AM, Portek I, Reid C, et al. Effect of treatment with biological agents for arthritis in Australia: the Australian Rheumatology Association Database. Intern Med J 2007;37:591-600.