

Clinical Quality Management: Putting the Pieces Together

Gerold Stucki and Oliver Sangha

Health care systems are currently undergoing tremendous changes universally. Cost containment, accountability, total quality management, and evidence-based medicine are some among many concepts that are becoming important to the practicing clinician. Managed care has changed the environment where we practice. Although rheumatology as a specialty currently does not seem in jeopardy, it has been questioned whether rheumatologists do better than generalists when caring for arthritis patients. These are by far not only American, but European issues as well.

Health care in the 1990s has taught us to assess what we are doing and to assign accountability (1). Third party payers have become increasingly interested in what outcomes they are getting in terms of money. However, care is not only judged upon outcomes, but also in terms of the process of care. "Doing the right thing to the right person, right the first time" (Donald Berwick: personal communication) may be the best definition of quality of care.

However, what is right? Wide variation in medical practice has questioned the adequacy of the knowledge base that supports clinical decision making. Variation research pioneered by Wennberg more than 20 years ago has continued to demonstrate substantial differences in the way medicine is practiced (2). These ef-

fects remain after adjusting for any explanatory factor one can imagine, and it is evident that such variations fuel concerns about costs and quality of medical care.

The research community has responded with a new focus on effectiveness and outcomes research (3). In rigorously monitored randomized controlled trials we have learned much about the efficacy of rheumatic therapies. In large observational studies we have learned about their effectiveness for unselected patients in practice settings. Now the challenge is to continuously improve the process of care and patient outcomes by applying the insights gained.

Can we do better? The answer should be a unanimous yes. Change should not be difficult since the essential components have been developed:

1. Inclusion of the patient perspective and standardized measurement of patient outcomes using psychometrically sound questionnaires, a development championed in the field of rheumatology (4).

2. Use of standardized, valid, reliable, and efficient measurement of selected clinical and technical parameters relevant to the problem under scrutiny. For example, with the development of the disease activity score (5,6) it is now possible to quantify the rather abstract concept of disease process in rheumatoid arthritis (RA), to adjust treatment based on empirically derived guidelines, and to document and communicate our decisions based on quantitative data.

3. Methodological developments in clinical epidemiology and the cited advances in measuring both impairment and health outcomes have given us the tools to understand the epidemiology of the disabling process and to study the effect of our interference with this process.

4. Computer science and engineering have provided us with the tools to overcome seemingly minor but powerful obstacles to the use of standardized assessments such as scoring of patient questionnaires.

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Table 1. From quality assurance to quality management

	Quality assurance	Quality management
Model	Bureaucratic Professional	New industrial model
Goal	Assurance Avoid "events"	Continuous improvement Move the "crowd"
Means	Education Certification Licensing Equipment Standards, controls, and medical audits (education, equipment, diagnosis, therapy)	Statistics: study of variation (process versus results) Psychology, social, and behavioral science, management science (team, process-analysis)
Focus	Outlier ("bad apple")	Group (distribution, upstream conditions, trends)
Time perspective	Static-retrospective, cross-sectional	Dynamic-prospective
Conceptual orientation	Structure	System-relating process to outcome
Assumption	More is better (education, equipment, standards) Structure translates into quality	What we do is great, what we do can be improved

Yet, though widely used in research, in rheumatology, virtually none of the above developments are used in clinical practice. While cardiologists would not even imagine measuring blood pressure by simply feeling the pulse, and while endocrinologists are anxious about the disastrous consequences of sloppy adjustment of serum glucose levels, rheumatologists still base their decisions on qualitative rather than quantitative data, their experience, and their overall impression of the patient.

It seems that rheumatologists do not see an advantage in measuring patient-oriented parameters. It is often argued that the few studies that have assessed the value of providing physicians in office settings with functional status information were negative (7,8). However, the results of these studies are at best conflicting and the verdict about the value of outcome measures has yet to be reached.

More importantly, we may not expect a great benefit from simply measuring outcomes. Quality management has taught us that we need not construct outcomes measurement systems, but create outcomes measurement-improvement systems useful to patients and clinicians. As we will show for the case of adjusting disease activity in RA, this requires the measurement of all relevant parameters necessary to relate outcomes to the process of care. Also, many of the more practical reasons why physicians do not use standardized measures (9) are potentially addressed with an optimally designed measurement-improvement system.

Clinical quality management is an attempt to put the

pieces together in order to continuously improve the process of care and health outcomes for each patient and by each caregiver. We will first place clinical quality management into the context of the quality movement. We will then use RA as a case in point to demonstrate the construction and use of a simple measurement-improvement system.

From quality assurance to quality management

In the past, efforts to improve quality have focused on the definition and control of standards (Table 1). These efforts were most important in the creation of the modern health care system. The foundation of medical schools, the introduction of standardized curricula, as well as government regulations for licensing and certification of medical personnel contributed to a level of quality that was steadily improving. On the other hand, the system was punitive; as the name implies, quality assurance assured that certain standards were met, and failure to do so led to investigations and potential punishment. The only "development" this system could take would be to change or implement new standards.

The major drawback of quality assurance is the lack of incentives for continuous improvement. The result is regression to the mean—the lower tail moves up to fulfill the standards whereas the upper tail has little incentive to improve and may be tempted to reduce its efforts. This phenomenon may hold true for different aspects of quality. Most importantly, there is no

"built-in" incentive to improve outcomes or to maximize efficiency. Also, the patients with their individual needs are left out in this system: individual needs are not recognized and meeting these needs is not encouraged. The patient is the beneficiary who should be happy with what is offered by the providers who are fulfilling professional and governmental standards.

Quite different from quality assurance, *quality management* is process-oriented. Its goal is to permanently improve outcomes through a modification of processes and/or potentially modifiable structural variables in an ongoing learning process. Although quality management has been developed in industry, its principles may well be translated into the health care system and eventually into clinical medicine. At the core of quality management is the system perspective. Results are related to processes within a structure. Rather than focusing on the individual failure (bad result), quality management tries to identify conditions that lead to superior results (upstream conditions). Prerequisite is a measurement-improvement system which includes a set of reliable, valid, and sensitive measures on all relevant aspects including health outcomes, processes, and patient and provider characteristics.

Outcomes in terms of quality management may be very different things, e.g., the number of x-rays produced at the first try that are acceptable to the physician. The goal is to limit waste as much as possible. In clinical medicine the goal is to improve health outcomes. Health outcomes represent disease impact, e.g., pain, physical functional disability, psychological distress, social functioning and work disability, and quality of life. Quality management that focuses on improving health outcomes may thus be defined as *clinical quality management*. Clinical quality management may improve health outcomes on 3 levels.

Single patient feedback. The measurement-improvement system is targeted toward the individual patient. The perspective of the analyses is not across patients but longitudinal for individual patients. This is comparable to the $n = 1$ randomized clinical trial which applies the randomized controlled trial concept to individual patients. The goal is to optimize treatment by balancing effect and side effects of treatments. In chronic diseases adjustment of treatment is a continuous improvement process. On the level of the individual patient, sentinel events which may have disastrous consequences are important.

Provider feedback. Caregivers have the opportunity to adjust their practice and thus produce better outcomes in the future based on the results of monitoring and feeding back of processes and health outcomes for

groups of patients to the caregivers. Feedback systems on the group level do not focus on sentinel events but on the result of the group. This approach is increasingly used in improving health outcomes for surgical procedures.

Effectiveness research. Effectiveness research involves analyses of the relationship between health outcomes and processes (treatment) and structure (patient and provider characteristics), resulting in identification of the best settings.

Clinical quality management in RA

Background. RA is the most prevalent inflammatory rheumatic disease. The burden of illness includes suffering from pain and stiffness, physical functional disability, depression, and anxiety often importantly reducing the quality of life (10). Thus, patients are often limited in performing their roles within their families, at work, and during leisure. From society's point of view, the socioeconomic cost is considerable.

Among the greatest achievements in rheumatology during the past 15 years has been the inclusion and formal measurement of the patient's perspective using questionnaires of sound metric properties (4). Systematic assessment of symptoms (11), physical functional disability (10), and overall health status (12) complements the data on impairment. The initial skepticism of these "soft data" has made way for the insight that these measures are valid and reliable endpoints in clinical trials, epidemiology, and health services research.

There have also been important developments with respect to the measurement of impairment. While there has been little agreement among physicians about which measures to use, there have been recent, successful attempts to establish guidelines on "core sets" of measures (13). It has been possible to simplify clinical measures. The use of simplified joint counts such as the 28-joint count allows for a more efficient assessment of disease activity.

Although concepts such as "disease activity" and "damage" have been used in rheumatology since the beginning, only recently have these concepts been defined and studied empirically. The concept of disease activity has been operationalized by the Nijmegen group (5,6,13). They clearly showed that what physicians describe as disease activity and use in their decision making regarding disease-modifying antirheumatic drug (DMARD) treatment can be measured with few, weighted variables. With their algorithm called Disease Activity Score (DAS), which integrates the number of swollen, tender joints and erythrocyte sedimentation rate (ESR), disease activity can be quanti-

fied. The index is further advantageous because it provides a more reliable estimate than each individual measure (5,6). With a definition of empirically derived response criteria it is now possible to make decisions based on quantitative, objective data rather than solely on "personal experience" and an overall impression (6). As a consequence, disease activity, the prime target of our medical therapy, can be adjusted similarly to blood glucose in diabetics or blood pressure in hypertensives.

The importance of optimal adjustment of disease activity can not be overemphasized. Because untreated or insufficiently treated disease activity is associated with joint destruction and worse health outcomes, it is critical to sufficiently dose DMARD therapy. Because disease activity is suppressed with potentially toxic drugs, it is critical to find the most precise, minimally efficacious dose possible. As there are only a few drugs available, and DMARD therapy may take up to 6 months before being effective, much is lost if an efficacious but overdosed DMARD causes intolerable side effects and needs to be stopped.

Model of disease and measures. Models of disease differentiate between the disease process, impairment (morphologic and functional organ pathology), and outcomes (disease impact to the patient) (10,13).

In RA, the disease process has been operationalized as disease activity. Disease activity can be measured reliably with the DAS (5,6). Based on an empirically derived algorithm, the DAS integrates the number of swollen joints, the number of tender joints, and the ESR.

Impairment may be either morphologic (joint destruction) or functional (e.g., range of motion, strength). Joint destruction or damage can be measured radiologically using, for example, a quantitative scoring system such as the Larsen or Sharp indices. Several modifications have been developed for simplified use in clinical practice. A recently proposed system grades the amount of damage of the radiologic joint surface in percentage (14) and may be useful for clinical practice. Functional impairment can be quantified using standardized measurements of joint mobility (Escola Paulista di Medicina-Range Of Motion Scale) (15) and muscle strength (Muscle Strength Index) (16).

While the physician is the expert for the assessment of the disease process and morphologic and functional impairments, the patient is the expert in assessing disease outcomes by responding to structured interviews or questionnaires. In RA, symptoms can be measured with the Rheumatoid Arthritis Disease Activity Index (RADAI) (5). A standard measure for physical functional disability is the Health Assessment Questionnaire (HAQ), which has been used in a variety of set-

tings and has been adapted cross-culturally into many languages (4,10). Global health may be measured with a generic health status instrument, e.g., the Short-Form 36 (12). It is apparent that long questionnaires are burdensome to the patient and jeopardize compliance: recent developments allow for an overall assessment of general physical and mental health with 12 items (SF-12) (17).

Measurement-improvement system. The fundamental problem in patients with RA is systemic inflammation. The assumptions of our current therapeutic approach are that 1) control of systemic inflammation reduces disease impact to the patient in the short-term, and 2) control of inflammation reduces damage and consequently disability in the long-term. This assumption is at the core of the definition of the measurement-improvement system.

Disease activity and damage are intermediate clinical outcomes, while pain and disability are primary patient-oriented health outcomes. The planning, selection, and execution of the treatment represents the process. Patient characteristics (e.g., age, sex, immunogenetic and socioeconomic status, disease severity, comorbidity) and provider characteristics (e.g., education, experience of the caregiver, availability of technical resources) represent the structure. They are prognostic factors that interact with processes and health outcomes.

Based on the two time horizons, use of the measures in the following way is suggested: short-term (6-month intervals)—DAS and/or RADAI; long-term (12-month intervals) DAS, RADAI, HAQ, x-ray score (Figure 1).

In early RA, shorter intervals would be appropriate, while in stable RA longer intervals are possible. Ideally, the DAS and RADAI are completed with every relevant treatment change.

In the short-term, the DAS and RADAI allow for best possible adjustment of anti-inflammatory and immunosuppressive treatment. The goal is to reduce the DAS to values <2.4, which makes the development of destructive changes unlikely (6). With limited effort (counting the number of tender and swollen out of 28 joints) the physician gets all the information relevant to the adjustment of disease activity.

While the DAS provides an estimate about disease activity based on clinical expression, the RADAI provides an estimate of disease activity based on pain, stiffness, and patients' perception of disease activity. It is envisioned that for intermediate controls the RADAI provides sufficient information to monitor disease activity in stable patients. As a substitute for a systematic clinical examination (which is impossible in routine

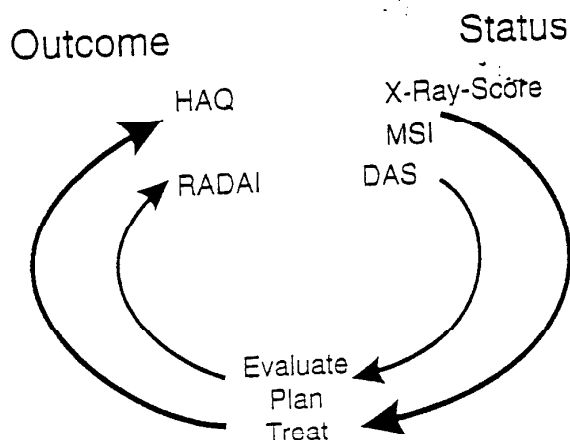


Figure 1. Measurement-improvement system for rheumatoid arthritis. The inner circle reflects the short-term perspective (weeks to months), the outer circle the long-term perspective (months to years). HAQ = Health Assessment Questionnaire; RADAI = Rheumatoid Arthritis Disease Activity Index; MSI = Muscle Strength Index; DAS = Disease Activity Score.

daily practice) the joint list question of the RADAI provides a systematic overview on pain for all joints or joint groups by body side. This is of particular usefulness because the 28-joint count version of the DAS does not include the feet, which cause local problems in many patients.

While the DAS and/or RADAI provide the information necessary for adjustment of disease activity, x-rays and functional disability allow judgement of the quality of adjustment of disease activity in the long-term. This is similar to the diabetic patient in whom the quality of control of serum glucose can be assessed using HbA_{1c}. Destructive changes shown by the x-ray despite optimal adjustment of disease activity may help to identify patients with little systemic inflammation but tumor-like destruction requiring a different treatment approach. Regular use of the HAQ helps to recognize slowly developing functional deficits unrecognized by both the physician and the patient. Demonstration of a new functional deficit in the HAQ may be useful when documenting the need for rehabilitation services to third parties. At the same time, the effect of rehabilitation services may be documented.

While it is possible to use and interpret the RADAI and HAQ in a qualitative way, it is virtually impossible to score these questionnaires and to assess the DAS (an awkward algorithm with square roots and logarithm) in clinical practice. The practical use of the measurement-improvement system thus requires an organization similar to that of a laboratory.

In our setting, the participating physicians are pro-

vided with a single-page doctor's record sheet and two types of questionnaires in different colors (HAQ and RADAI). The physician's record sheet shows two mannequins on which to mark swollen and tender joints, and space to fill in the ESK and medication (DMARDs, nonsteroidal anti-inflammatory drugs, corticosteroids, and analgesics).

While the physician fills in this record sheet the patient completes the self-administered questionnaires. Both the doctor's record sheet and the patient questionnaires, and at regular intervals x-rays of the hand and feet, are sent to our center in preaddressed envelopes where the data are entered and scored and a feedback report, including graphic displays and tables, is generated and sent back to the physician. Physicians are given written instructions on how to interpret the measures. Experience between physicians may be exchanged within quality improvement circles.

This organization similar to a laboratory limits the burden to both the physician and the patient. The burden to the physician is to count the number of tender and swollen joints out of 28, to fill in the ESR and the relevant medications, and to order hand and foot x-rays at regular intervals (every 12 months). The burden to the patient is to regularly fill in the RADAI and to fill in the HAQ yearly (Table 2).

On a group level, participating physicians are provided regularly with anonymous feedback reports on groups of patients. Emphasis is given to longitudinal trends by the caregiver. No benchmarking of outcomes across physicians is provided because adjustment for differences in patient characteristics seems most difficult.

However, physicians are provided with the data on all patients and may individually compare their use of medications and the outcome profiles of their patients to the whole cohort. Also, it is envisioned to regularly provide physicians with reports on upstream and downstream conditions.

Comments. A measurement-improvement system in RA is not a substitute for the problem-oriented approach to the patient. Indeed, standardized assessment of disease activity and patients' outcomes may free time and energy which the caregiver can spend on discussing and resolving specific problems. Standardized and problem-oriented assessment are complementary.

The suggested measurement system directed towards the titration of disease activity and its short- and long-term consequences is a compromise between what is desirable and what is feasible. To limit the burden to the patient, at this stage we did not include measures of depression, fatigue, global health, or patient preference measures. However, we feel that the

Table 2. Practical use and interpretation of measures*

Measure	DAS	Radiologic damage score	RADAI Symptom Questionnaire	HAQ Physical Functional Disability
Practicability				
Time physician	3 min.	3 min.	-	-
Time patient	-	-	~3 min.	~5 min.
Administration†	Short cycle	Long cycle	Short cycle	Long cycle
Interpretation				
Variable type	Continuous	Continuous	Ordinal	Ordinal
Range‡	0-10	0-100%	0-10	0-3
Median (25%; 75% quartiles)§	3.1 (1.6; 4.9)	ND	4.0 (2.0; 5.4)	1.31 (0.36; 1.75)
Minimal clinically relevant difference	0.6	ND	ND	0.17

* DAS = Disease Activity Score; RADAI = Rheumatoid Arthritis Disease Activity Index; HAQ = Health Assessment Questionnaire; ND = not defined.
 † Short cycle = every 6 months; long cycle = every 12 months.
 ‡ 0 reflects a normal value.
 § In the reference population, University Hospital of Zurich.

inclusion of these dimensions could add important information.

While there is little additional benefit to including standardized measures of range of motion and strength when adjusting disease activity, these measures may be of value in the rehabilitation of patients with RA. They are simple to use, do not require expensive equipment, and allow for documentation of treatment results.

Discussion

While one of the main questions of the efficacy and outcomes research movement in the past 10-15 years has been the question, "What works in medicine?" the next question is "How can we apply this knowledge to improve the process of care and patient outcomes?" Only if we succeed in putting theory into practice may we expect a demonstrable impact on quality, cost, or both. It is thus important not only to study, review, and summarize what works, but to implement the gathered knowledge into clinical practice.

At the same time, we need to open clinical practice as a most important source of information. From a clinical quality management perspective, clinical practice may be considered a challenging laboratory for the study of the variation of medical practices within defined structures in relation to health outcomes. Because clinical quality management does not use randomization or blinded assessment, analyses are exploratory in nature. Compared to efficacy research, the conclusions reached thus have less internal validity and need to be considered with caution. However, because of the wide variation of alternative processes and patient charac-

teristics with respect to disease severity, comorbidity, and other variables that affect prognosis, clinical quality management may generate data of greater clinical relevance and external validity (generalizability).

Standardization of measurement-improvement systems across centers and countries offers the unique opportunity of gathering and examining data on large numbers of patients. Feedback on individual and groups of patients could be an invaluable basis for discussions regarding medical practice among physicians and centers, offering outstanding opportunities and stimulus for improvement.

Clinical quality management allows examination of the effectiveness and side effects in a "real life" situation for patients who have little or nothing in common with the typical trial patient, but who are the most likely to be treated based on efficacy data from such trials. The most important hypotheses generated from clinical quality management data may be rigorously tested in efficacy studies. This may help to focus research energy and to study the most relevant questions.

Clinical quality management also allows the identification of problem areas that show an unacceptably high degree of variation. This may help professional societies focus on the development of practice guidelines where most benefit can be expected. Also, the implementation of practice guidelines can be monitored. It can be studied whether practice patterns change and whether and for whom this results in hypothesized gains in health outcomes. If data are available from a wide spectrum of patients, practice guidelines can be developed that differentiate between patients with a variety of characteristics. With the inclu-

sion of simple measures for health preferences it may be possible to include individual preferences into a decision-making algorithm.

Clinical quality management may provide answers to some criticism of outcomes as tools to gauge medical practice because it offers both the perspective of outcomes as well as process. The use of health outcomes to gauge the effect of adjusting therapy for an individual patient longitudinally does not seem problematic. However, when comparing health outcomes across patients and caregivers, one faces the difficult problem of adjusting for confounding. In clinical quality management, health outcomes are measured within a comprehensive measurement-improvement system and can be linked to processes and patient and provider characteristics. Thus, best possible adjustment for confounding seems possible. Nevertheless, when taking the perspective across patients and caregivers, it may be preferable to focus on the process rather than outcomes. This is in accordance to the goal to "do the right thing to the right person, right the first time."

Whether clinical quality management will be successful depends on many factors. System thinking and continuous improvement, e.g., the continuous adjustment of blood pressure or glucose in patients with hypertension or diabetes, are common in clinical practice. Physicians should thus be able to easily understand and make increasing use of measurement-improvement systems. Also, there is increasing pressure from society, patients, and insurers to document practice effectiveness and efficiency.

However, there are many obstacles to be overcome if clinical quality management methods should become common practice. First, closing the loop of practice and research will require unprecedented cooperation between clinicians and investigators. Second, implementation of quality management into clinical practice will only work if an overall benefit for the participating physicians results.

On the negative side, one needs to reduce the burden in terms of time and resources to a minimum. Inclusion of the patient as an important source of information for the assessment of symptoms, disability, and global health is an important step. The use of few, but reliable and valid indices such as the DAS, which comprehensively measures a disease dimension, e.g., disease activity, is important because it allows the reduction of assessment without loss of information. In hospital settings, dedicated nonmedical personnel helping patients with the completion of questionnaires may be of great help.

On the positive side, the building in of benefits (Table 3) and incentives is critical. Most importantly, the additional information for individual patients

Table 3. Potential benefits of clinical quality management in rheumatoid arthritis for patients, physicians, and health care professionals

Patient	Understanding of the disease and disease impact, indication, and course of treatment Better motivation and compliance with treatment Improved patient-doctor communication
Physician, health care professional	Comprehensive but easily interpretable assessment of disease and disease impact Adjustment of treatment over time according to quantitatively measured, valid, and sensitive parameters Better outcomes in terms of disease activity, damage, health outcomes, side effects, and treatment withdrawals Possibility to document indication, course, and outcomes to third parties Communication of comprehensive and quantitative information between health care professionals and over time Basis for better communication: specialist-generalist, physician-health care professional Quantitative feedback for individual patients and groups of patients as basis for professional discussions and research Confidential gauging of its own praxis versus others Continuous, conscious learning process

needs to be fed back in a timely, reliable, and easily understandable form, such as graphic displays. Results from group data need to be fed back to the medical community on a regular basis. Feeding back information (e.g., on disease activity) is insufficient and needs to be complemented with guidelines on how to interpret the figures, e.g., guidelines on the target DAS to be achieved. From a financial perspective, there need to be incentives to ensure high compliance from health care providers and patients.

It seems critical that clinical quality management stay within the medical community, and that all measures are undertaken to keep data confidential. Only if it is not imposed from the top down and if physicians may be sure that their practice will not be scrutinized may it be successful. Otherwise it is likely to produce fear and a desire to protect one's own position and to discredit the information and its source.

Finally, it needs to be demonstrated that the use of clinical quality management improves health outcomes. While a quasi-experimental design may offer some insight, a randomized controlled trial is necessary to show proof of the concept.

In conclusion, clinical quality management is a po-

tentially useful tool for continuous improvement of patient care. Clinical quality management makes best use of evidence provided by effectiveness and outcomes research by adding the dimension of technology transfer. It offers a unique opportunity to bidirectionally link practice to research and to expand our understanding of outcomes as a result of alternative processes for a large spectrum of patients in a variety of settings.

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REFERENCES

1. Reiman AS: Assessment and accountability: the third revolution in health care. *N Engl J Med* 319:1220-1222, 1988
2. Welch WP, Miller ME, Welch HG, Fisher ES, Wennberg JE: Geographic variation in expenditures for physicians' services in the United States. *N Engl J Med* 328:621-627, 1993
3. Heithoff KA, Lohr KN: Effectiveness and outcomes in health care. Invitational conference of the Institute of Medicine Division of Health Care Services. National Academy Press, Washington DC, 1990
4. Liang MH, Katz JN: Measurements of outcome in rheumatoid arthritis. *Baillieres Clin Rheumatol* 6:23-37, 1992
5. Van der Heijde DMFM, van't Hof MA, van Riel PLCM, van Leeuwen MA, van Rijswijk MH, van de Putte LBA: Validity of single variables and composite indices for measuring disease activity in rheumatoid arthritis. *Ann Rheum Dis* 51:177-181, 1992
6. Van Gestel AM, Prevoo MLL, van't Hof MA, van Rijswijk MH, van de Putte LBA, van Riel PLM: Development and validation of the European League Against Rheumatism response criteria for rheumatoid arthritis: comparison with the preliminary American College of Rheumatology and the World Health Organization/International League Against Rheumatism criteria. *Arthritis Rheum* 39:34-40, 1996
7. Rubenstein IV, Calkins DR, Young RT: Improving patient function: a randomized trial of functional disability screening. *Ann Intern Med* 111:836-842, 1989
8. Kazis LE, Callahan LF, Meenan RF, Pincus T: Health status reports in the care of patients with rheumatoid arthritis. *J Clin Epidemiol* 43:1243-1253, 1990
9. Deyo RA, Carter WB: Strategies for improving and expanding the application of health status measures in clinical settings: a researcher-developer viewpoint. *Med Care* 30 (suppl):MS176-MS186, 1992
10. Fries JF, Spitz P, Kraines RG, Holman HR: Measurement of patient outcome in arthritis. *Arthritis Rheum* 23:137-145, 1980
11. Stucki G, Liang MH, Stucki S, Brühlmann P, Michel BA: A self-administered Rheumatoid Arthritis Disease Activity Index (RADAI) for epidemiologic research: psychometric properties and correlation with parameters of disease activity. *Arthritis Rheum* 38:795-798, 1995
12. Ware JE, Sherbourne CD: The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 30:473-483, 1992
13. Van Riel PLCM: Provisional guidelines for measuring disease activity in clinical trials on rheumatoid arthritis. *Br J Rheumatol* 31:793-794, 1992
14. Rau R: Validation of a modified version of Larsen's radiological scoring method in patients with early erosive RA (abstract). *Rheumatol Europe* 24:C191, 1995
15. Ferraz BM, Magalhaes Oliveira L, Araujo PMP, Atra E, Walter SD: EPM-ROM scale: an evaluation instrument to be used in rheumatoid arthritis trials. *Clin Exp Rheumatol* 8:491-494, 1990
16. Stucki G, Schönbacher J, Brühlmann P, Mariacher S, Stoll T, Michel BA: Does a muscle strength index provide complementary information to traditional disease activity variables in patients with rheumatoid arthritis? *J Rheumatol* 21:2200-2205, 1994
17. Ware JE, Kosinski M, Keller SD: A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med Care* 34:220-233, 1996