Royal National Hospital NHS
for Rheumatic Diseases
NHS Trust

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Dockets Management Branch
(HFA-305)
Food and Drug Administration
5630 Fishers Lane
rm. 1061
Rockville
MD 20852
USA

21st June 2001

Dear Sirs

I am writing in response to the notice published Monday 21st May 2001 regarding the Clinical Development Program for Drugs, Biological Products and Devices for the treatment of Ankylosing Spondylitis (AS) and related disorders (Docket No: 01N-0197).

Specifically, I write in terms of my role of Medical Director of the National Ankylosing Spondylitis Society in Britain, Consultant Rheumatologist at the national referral centre; the Royal National Hospital for Rheumatic Diseases, and member of the international ankylosing spondylitis assessment group.

In conjunction with the National Ankylosing Spondylitis Society of Great Britain, we have at the Royal National Hospital for Rheumatic Diseases some 5,800 patients with ankylosing spondylitis. Over the last 15 years, since I left Stanford University, California, I have headed up a research team focusing on this condition as per the enclosed curriculum vitae. During the last ten years one of the main focuses has been that of ankylosing spondylitis outcomes research, and response to treatment.

We have published a series of studies, defining the important outcome domains. Specifically, in each case we have validated outcome instruments, many of which have been translated into numerous languages. Virtually every study now carried out in ankylosing spondylitis, world-wide, uses these outcome measurements, both in terms of therapeutic studies (e.g non-steroidal anti-inflammatory drugs, use of biologics) and genetic studies relating to the definition of susceptibility and severity gene loci. The self-administered instruments have been translated into many languages and re-validated in their own country.

Specifically, we have focused on the following:

BASDAI - Bath Ankylosing Spondylitis Disease Activity Index.
BASFI - Bath Ankylosing Spondylitis Functional Index
BAS-G - Bath Ankylosing Spondylitis Global Status
BASMI - Bath Ankylosing Spondylitis Metrology Index
BASRI - Bath Ankylosing Spondylitis Radiology Index
BASRI-Hip (J.Rheumatology in Press)

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(all references highlighted in the Original Articles section of my C.V.)

In each case these indices have been explored and re-explored and as intimated now form part of numerous outcomes studies.

In conjunction with the ankylosing spondylitis assessment group, we have used these instruments to assess the relative contribution of the index as a whole, or sub-components of the index, and have further used these instruments in defining both clinically important changes and the definition of partial remission and other relevant issues.

In terms of the key factors raised in your notice, I would tentatively comment as follows:

SCOPE

In large part, ankylosing spondylitis can be studied as a whole, allowing for individuals with ankylosing spondylitis having juvenile onset, psoriatic disease, inflammatory bowel disease and other components. I believe we have something of a consensus that the umbrella term "ankylosing spondylitis" is appropriate. On our own database of 5,800 patients, some 40% have iritis while 14% have psoriatic spondylitis and 7 or 8% have inflammatory bowel disease (i.e. enteropathic spondylitis associated with Crohn's Disease or ulcerative colitis). In large part our studies have included all sub-groups and we believe that this is to our advantage, rather than subsetting at the outset.

CLAIMS

BASRI – the Bath Ankylosing Spondylitis Radiology Index – very simply defines radiological status with four radiographs i.e. pelvis anteroposterior view to include hips and sacroiliac joints, lumbar spine lateral and anteroposterior film, and a single lateral cervical film. As per the enclosed C.V and papers you will see that the BASRI index provides data with a two-year follow up revealing sensitivity to change. Of course, over a shorter period we would anticipate improvement in terms of metrology, function, disease activity and global status, but not radiology.

MEASURES OF DISEASE ACTIVITY

I believe we have a global consensus that BASDAI is a simple, straightforward and carefully validated instrument that, developed in conjunction with patients, physiotherapists and clinicians, addresses all aspects of disease activity (please see publication enclosed).

TRIAL DESIGN

Various different trial designs have been used, and depending on the agent selected a consensus could readily be achieved in terms of the focus on type of statistical analysis in terms of survivors, intention to treat, etc.

INTRINSIC TRIAL DESIGNS

For example, we have shown that BASDAI is better as an outcome instrument than the sub-components making up this self-administered assessment outcome (publication enclosed). Our own perception is that at this stage equal weight can be used for all the self-administered

outcome instruments, although we appreciate that in terms of radiological change, in a study over two or more years, different weighting would be required in terms of structured change.

Naturally, our patients (the 5,800 individuals on our database) are anxious to take part in further evolution of this important approach to defining outcome.

I look forward to have further discussions with you, and would be anxious to play any role that seems appropriate.

Yours sincerely,

Andrei Calin, MD, FRCP
Consultant Rheumatologist.

Encs

PS: The BAS indices have been published extensively as outcome variables for studies in ankylosing spondylitis with:

1) Non-steroidal anti-inflammatory drugs
2) Cox-specific anti-inflammatory drugs
3) Pamidrone, Thalidomide etc
4) α TNF/other biologics

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Mary Jane Walling
Center for Drug Evaluation & Research
(HFD-105)
Food and Drug Administration
5600 Fishers Lane
Rockville MD 20857
USA

21st June 2001

Dear Ms Walling

Re: FDA – Docket No: 01N-0197 – Clinical Development Program for Drugs, Biological Products and Devices for the treatment of Ankylosing Spondylitis (AS) and Related Disorders

I should be most grateful for any additional information regarding this issue. I have prepared written comments for the Dockets Management Branch, but would appreciate any further information that you believe should be incorporated to support this submission.

Yours sincerely,

Andrei Calin, MD, FRCP
Consultant Rheumatologist.

Enc.

CURRICULUM VITAE

ANDREI CALIN MD FRCP

1st May 2001

NAME	Andrei Calin MD FRCP
DATE OF BIRTH	January 7 1944
PLACE OF BIRTH	Andover, England
MARITAL STATUS	Married (August 1973, Jane Weller MB BCh) Three daughters, Tara (born 9.7.79), Sasha and Marisa (born 5.1.83).
IMMEDIATE PAST	Associate Professor of Medicine, Division of Immunology Stanford University School of Medicine, Stanford, California. Chief, Rheumatology Section, Medical Service Veterans Administration Hospital, Palo Alto, California 1976 - 1983.
PRESENT POST	Consultant Rheumatologist Royal National Hospital for Rheumatic Diseases, Bath 1983 - Honorary Senior Lecturer School of Postgratuate Medicine, University of Bath 1995 -

EDUCATION

1957-61	Epsom College Medical Foundation
1962-65	Clare College, Cambridge University (pre-clinical studies)
1965	Qualified BA (Cantab) Class 2:2
1965-68	Guy's Hospital Medical School, London University (clinical studies)
1968	Qualified MA, MB, BChir (Cantab), LRCP, MRCS (London)
1970	MRCP (UK)
1976	Diplomate: American Board of Internal Medicine
1978	MD (Cantab)
1978	Subspeciality Boards: Rheumatology
1986	FRCP (UK)

PRIZES, SCHOLARSHIPS AND AWARDS

1961	Epsom College Leaving Award
1962	Clare College Scholarship
1963	Scott Polar Travel Award (Atlas Mountains, Morocco)
1964	Medical Research Council Travel Award; Wenner-Gren Anthropological Research Award
	Grant from the Royal Society of London
	(The above three for medico-anthropological investigation and research with the Ainu Tribe, North Japan.)
1965	Cambridge University Travel Scholarship
	Clare College Travel Scholarship (Tropical Medicine, Chagas' Disease - Brazil)
1965	Guy's Hospital Medical School Scholarship
1966	First Prize Cardiology Clinical Examination
1967	Guy's Hospital Medical School Travelling Scholarship
	Lawrence Atwell Travelling Award to Massachusetts General Hospital, Boston, Massachusetts, USA to study Neurology (Professors Raymond Adams and Pierre Dreyfus) and Immunological Aspects of Lymphoma (Professor A Aisenberg)
1974	Fulbright-Hays Travel Scholarship; Guy's Hospital Travel Grant
	Arthritis and Rheumatism Council for Research (Boots) Award
	Back Pain Association Ltd Award: (For year at Stanford University)
1995	Margaret Holroyd Prize, British Society of Rheumatology

SOCIETIES: HONORARY AND SCHOLASTIC

1. American Rheumatism Association
2. British Society for Rheumatology
3. Brompton Association
4. North California Rheumatism Association
5. Diplomate, American Board of Internal Medicine, 1976

6. Diplomate, Rheumatology Board, 1977
7. Fellow of the Royal College of Physicians (United Kingdom)
8. Chairman, National Ankylosing Spondylitis Society (United Kingdom)
9. International Society for Rheumatic Therapy

COMMITTEES AND EDITORIAL BOARDS

1.	American Rheumatism Association: Programme Subcommittee	1979
2.	American Rheumatism Association: Reiter's Syndrome Criteria Subcommittee	1980
3.	Editor, Comprehensive Therapy, Rheumatology Section	1976-82
4.	Co-Editor, Annals of Rheumatic Disease, 38 (Suppl)	1979
5.	Editorial Board, Clinical Rheumatology, Belgium	1981 -
6.	Editorial Board, Advances in Rheumatology, New York	1986 -
7.	Editorial Board, European Journal of Internal Medicine	1988 -
8.	Treasurer, International Society for Rheumatic Therapy	1988 -
9.	Medical and Scientific Committee (Heberden), British Society for Rheumatology	1985-88
10.	Consultant, Steering Committee, RAD-A-R (Risk Assessment of Drugs -Analysis and Response)	1988 -
11.	Chairman, Division of Rheumatology, Royal National Hospital for Rheumatic Diseases, Bath	1987-90
12.	Past Chairman, Therapeutic & Ethical Committee, Stanford University Medical School	1978-83
13.	Past member. Ethics Committee, Royal United Hospital	1984-89
14.	Editorial Board, Rheumatology in Practice	1993 -
15.	Editorial Board, Scand J Rheumatol	1997 –
16.	Editor, Rheumatology 2000	1998 –
17.	Editor, Rheuma 21st (electronic journal of rheumatology/internet	1998 –
18.	Board of Trustees, Community Health UK	1999 –

19.	Executive Board, International Society for Rheumatic Therapy ISRT	2000 –
20.	Editorial Board, la lettre du rheumatologue, France	1995 –
21.	Editorial Board, Reumatismo, Italy	1997 -

TRAINING AND EXPERIENCE

1968 3 months	St Bartholomew's Hospital, London Resident in thoracic surgery
1968 6 months	Guy's Hospital, London House Physician to Dr Charles Baker (cardiologist) and Dr J Houston (Dean of the Medical School) House Surgeon to Mr Sam Wass (gastro-intestinal chief) (Only one resident is invited to stay on to complete a full year's residency at Guy's)
1969-70 6 months	Guy's Hospital, London Senior House Physician to Professor W J Butterfield and Dr K MacLean (general internal medicine)
1970 3 months	Ship's Surgeon Caribbean Line
1970 6 months	Royal Post-Graduate Teaching Hospital (Hammersmith), London Senior House Physician to Department of Medicine (Professor C Booth and Dr C Pallis; Neurology)
1971 3 months	Middlesex Teaching Hospital, London Registrar in general internal medicine
1971 6 months	Brompton Hospital for Diseases of the Chest, London House Physician to Professor J Scadding (Professor of Medicine, London University)
1971-72 1 year	Guy's Hospital, London Registrar (clinical, research and teaching post) to Dr K MacLean (general internal medicine), Dr R Grahame (physician in the Division of Connective Tissue Disorders, Rheumatology and Allied Diseases) and Dr M Abrams (general medicine). First year in clinical rheumatology / immunology
1972-74 2 years	Guy's Hospital, London First two years of a four year rotating Senior Registrarship to Dr R Grahame and Dr H Burry in the Division of Connective Tissue Disorders, Rheumatology and Allied Diseases (clinical, teaching and research post). Third year of rheumatology/immunology at Royal Sussex County. Senior Registrar to Dr C Quinn and B Latham
1974-75	USA Fourth year in clinical rheumatology/immunology at Stanford University Medical Center. Work included teaching, patient care and clinical research. (Epidemiological studies, genetic investigation, drug studies and enquiry into other disease areas.)

1975-76	Fifth year in clinical rheumatology/immunology (as fourth year, with involvement in Fellowship training programme, patient care and clinical research)
1 Oct 1976- Dec 1983	Assistant Professor of Medicine (immunology/rheumatology) Stanford University Medical Center and Chief, Rheumatology Section Medical Service, Veterans Administration Hospital, Palo Alto, California
Dec 1983	Associate Professor of Medicine (immunology/rheumatology) Stanford University Medical Center and Chief, Rheumatology Section Medical Service, Veterans Administration Hospital, Palo Alto, California

ORIGINAL ARTICLES

1. Calin A. Iberic influence on Moorish civilization. Scott Polar Institute Journal, Cambridge University, 10:50-60, 1963.

2. Calin A. The Ainu Tribe - medical and anthropological studies. Guy's Hospital Gazette 12:5-10, 1965.

3. Calin A. Chagas' Disease (Studied in Brazil). Guy's Hospital Gazette, 12:205-212, 1965.

4. Calin A. Immunological factors in Hodgkin's Disease. (Following experience with Professor Aisenberg, Massachusetts General Hospital). Guy's Hospital Gazette, 14:651-655, 1967.

5. Calin A. Bronchorrhoea. BMJ 4:274-275, 1972.

6. Powell-Jackson, Calin A, et al. Excess deoxycorticosterone secretion from adrenocortical carcinoma. BMJ 2:32-33, 1974.

7. Calin A, Grahame R. Double blind cross-over trial of flurbiprofen and phenylbutazone in ankylosing spondylitis. BMJ 4:496-499, 1974.

8. Grahame R, Calin A, et al. Ankylosing rheumatoid arthritis. Brit J Rheum and Rehab 14:24-30, 1975.

9. Calin A. Renal glomerular function in ankylosing spondylitis. Scand J Rheumatol 4:241-242, 1975.

10. Calin A. Raised serum creatinine phosphokinase activity in ankylosing spondylitis. Ann Rheum Dis 34:244-248, 1975.

11. Calin A, Fries JF. Striking prevalence of ankylosing spondylitis in W27 Positive Males and Females: A Controlled Study. New Engl J Med 293:835-839, 1975.

12. Calin A, Fries JF. An 'experimental' epidemic of Reiter's Syndrome revisited. Ann Int Med 84:564-566, 1976.

13. Calin A, Porta J, Fries JF, et al. The clinical history as a screening test in ankylosing spondylitis. JAMA 237:2613-2614, 1977.

14. Calin A, Bennett PH, Jupiter J, et al. HLA B27 and sacroiliitis in Pima Indians - association in males only. J Rheumatol 4:44-48, 1977.

15. Calin A, Bennett RM, Sukhupunyaraksa S, et al. Double-blind multi-center parallel trial of ketoprofen and ibuprofen in the treatment of rheumatoid arthritis. J Rheumatol 4:153-157, 1977.

16. Calin A, Fries JF, Schurman D, et al. The close correlation between symptoms and disease expression in HLA B27 positive individuals. J Rheumatol 4:277-281, 1977.

17. Hirshman HP, Schurman DJ, Calin A. Neutropenia and rheumatoid arthritis. West J Med 129:235-236, 1978.

18. Calin A. MD Thesis: The relative contribution of the environment and genetics in the pathogenesis of HLA B27 related rheumatological disorders. Cambridge University, 1978.

19. Rosenthal AR, Egbert PR, Calin A, et al. Association of HLA B27, ankylosing spondylitis and uveitis. International Congress Series N. 450 XXIII Concilium Ophthalmologicum, Kyoto, 1978, Ed K Shimizu - Co-Ed JA Oosterhuis, Excerpta Medica, Amsterdam - Oxford, Elsevier North-Holland, 940-943.

20. Calin A, McShane D, Powers R. Objective measurements in evaluating drug therapy in ankylosing spondylitis. Current Therapeutic Research 24:838- 842, 1978.

21. Calin A. Ankylosing spondylitis sine sacroiliitis. Arthritis Rheum 22:303-304, 1979.

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23. Calin A. Keratodermia blennorrhagica and mucocutaneous manifestations of Reiter's Syndrome. Ann Rheum Dis 38 S:68-72, 1979.

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25. Calin A. The management of Reiter's Syndrome. Ann Rheum Dis 38 S:96-97, 1979.

26. Wilkens RF, Arnett FC, Bitter T, Calin A, et al. Reiter's Syndrome: evaluation of proposed criteria. Ann Rheum Dis 38 S:8-11, 1979.

27. Kaslow RA, Ryder RW, Calin A. Search for Reiter's Syndrome following an outbreak of Shigella sonnei dysentery. J Rheumatol 6:562-566, 1979.

28. Gottlieb M, Hoppe RT, Calin A, et al. Arthritis in a patient with mycosis fungoides - complete remission after radio-therapy. Arthritis Rheum 22:424-425, 1979.

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44. Tucker CR, Fowles RE, Calin A, et al. Aortitis in ankylosing spondylitis: early detection of aortic root abnormalities with two-dimensional echocardiography. Am J Cardiol 9:680-686, 1982.

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59. Field EH, Strober S, Hoppe R, Calin A, et al Sustained improvement of intractable rheumatoid arthritis after total lymphoid irradiation. Arthritis Rheum 26:937-946, 1983.

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62. Calin A, Marder A, Marks S, Burns T. Familial aggregation of Reiter's syndrome and ankylosing spondylitis: a comparative study. J Rheumatol 11:672-677, 1984.

63. Calin A. Pain and inflammation. Am J Med 77(3A):9-16, 1984.

64. Calin A. Classification of seronegative arthritis: recent developments. In: Proceedings of the Finnish-Soviet symposium on seronegative arthritis. Eds HA Isomaki and R von Essen. Scand J Rheumatol Suppl 52:5- 8, 1984.

65. Grumet FC, Calin A, Engleman EG, Fish L, Foung SKH. Studies of HLA-B27 using monoclonal antibodies: ethnic and disease associated variants. Advances in Inflam Res 9:41-53. In: The Spondylathropathies, ed. M Ziff and SB Cohen. Raven Press, New York, 1985.

66. Strober S, Tanay A, Field E, Hoppe RT, Calin A, Engleman EG, Kotzin B, Brown BW, Kaplan HS. Efficacy of total lymphoid irradiation in intractable rheumatoid arthritis. Ann Intern Med 102:441-449, 1985.

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68. Calin A. Patterns of the Spondyloarthropathies. Advances in Inflam Res 9:231-248. In: The Spondyloarthropathies. ed. M Ziff and SB Cohen. Raven Press, New York, 1985.

69. Calin A. When - and Why - to order x-ray films for RA patients. J Musculoskel Med. 2(7):14-20, 1985.

70. Calin A. Osteoarthritis - more questions than answers. Geriatric Medicine. June:8, 1985.

71. Calin A. A placebo-controlled cross-over study of azathioprine in Reiter's syndrome. Ann Rheum Dis 45: 653-655, 1986.

72. Calin A. Treatment of ankylosing spondylitis with oxaprozin: A comparison with indomethacin. Seminars Arthritis Rheum (suppl). 15:95-100, 1986.

73. Calin A. Drug Trials by Fleet Street. (Editorial). Brit J Hosp Med. 35(6):427-428, 1986.

74. Calin A. NSAIDs, Misinformation and the Media. (Editorial). MIMS Magazine 15 Sept;16, 1986.

75. Calin A. Bowel flora in ankylosing spondylitis. (Editorial). Lancet. ii, 1259, 1986.

76. Calin A. Focus on physician - patient communication. Am J Med. 80(6A):1-2, 1986.

77. Calin A. The epidemiology of rheumatoid disease: past and present. Disease Markers. 4:1-6, 1986.

78. Calin A. Do NSAIDs need built-in protection? MIMS Magazine. Dec 11, 1986.

De Souza Meirelles E, Calin A. Sindrome de Reiter nos Sexos Masculino e Feminino: Um Estudo de Caso Controle. Rev Hosp Clin Fac Med S Paulo 43; 3: 117-120, I986.

79. Calin A, Goulding N, Brewerton D. Post salmonella vaccination reactive arthropathy. Arthritis Rheum 30:1197, 1987.

80. Calin A. Drugs and the relationship between university, industry and legislation. Drugs under exp and clin research, 13(11):685-687, 1987.

81. Calin A. The origins of bone pain. (Editorial) MIMS Magazine. 1st May: 41, 1987.

82. Calin A. Assessing disease activity in ankylosing spondylitis. (Editorial). Lancet, 1:1072,1987.

83. Elswood J, Calin A, Berg C, Rogers F. Ankylosing spondylitis: comparative analysis of Swedish (n = 780) and British (n = 1500) experience - the national ankylosing spondylitis societies. Scand J Rheum 16:437-440, 1987.

84. Calin A. Diagnostic criteria (new and old) for the spondylarthropathies. (Editorial). Clin exp Rheum. 5(2):101-102, 1987.

85. Calin A. Pathogenesis of ankylosing spondylitis: the state of the art. Brit J Rheum, 27 (supp II): 106-109, 1988.

86. Reilly PA, Elswood J, Calin A. Therapeutic intervention in rheumatoid arthritis: a case controlled comparison of seronegative and seropositive disease. Brit J Rheum 27:102-105, 1988.

87. Calin A, Cawley MID, Pal B, Rosenberg JN, Silas AM, Williams PI. Multicentre double-blind comparison of sustained action formulations of tiaprofenic acid and indomethacin in osteoarthrits. Drugs 35(S1):57-63, 1988.

88. Calin A, Elswood J. The relationship between pelvic, spinal and hip involvement in ankylosing spondylitis - one disease process or several? Brit J Rheum 27:393-395, 1988.

89. Calin A. Seronegative (reactive) arthropathy. The precipitating factors. (Editorial) Lancet ii, 200-201, 1988.

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95. Calin A, Elswood J, Rigg S, Skevington SM. Ankylosing Spondylitis - an analytical review of 1,500 patients: the changing pattern of disease. J Rheumatol, 15:1234-1238, 1988.

96. Calin A, Elswood J. The natural history of juvenile onset ankylosing spondylitis: a 24 year retrospective case control study. Brit J Rheum 27:91-93, 1988.

97. Calin A. The dilemma of the elderly rheumatic patient. Proceedings of the satellite Symposium of the 11th European Congress of Rheumatology. Gerontology 34(I)1:42-44,1988.

98. Carette S, Calin A, McCafferty JP, Wallin BA. The Auranofin Cooperating Group: A double-blind placebo-controlled study of auranofin in patients with psoriatic arthritis. Arthritis Rheum 32:158-165, 1989.

99. Calin A, Elswood J. The outcome of 138 total hip replacements and 12 revisions in ankylosing spondylitis: high success rate after a mean follow-up of 7.5 years. J Rheumatol 16:955-958, 1989.

100. Calin A, Elswood J. Relative role of genetic and environmental factors in disease expression: sib-pair analysis in ankylosing spondylitis. Arthritis Rheum 32:77-81, 1989.

101. Calin A, Elswood J, Klouda P. Destructive arthritis, rheumatoid factor HLA DR4: susceptibility versus severity:- a case-control study. Arthritis Rheum 32:1221-1225, 1989.

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A New Approach to Defining Functional Ability in Ankylosing Spondylitis: The Development of the Bath Ankylosing Spondylitis Functional Index

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ABSTRACT. Objective. After pain and stiffness, one of the most important complaints of patients with ankylosing spondylitis (AS) is disability. The main aims of treatment are to control pain but also to improve function. Various methods of assessing function exist but are either not specific for the disease or have not been adequately validated. As a result of this deficiency we developed the Bath Ankylosing Spondylitis Functional Index (BASFI) as a new approach to defining and monitoring functional ability in patients with AS.

Methods. This self-assessment instrument was designed by a team of medical professionals in conjunction with patients, and consists of 8 specific questions regarding function in AS and 2 questions reflecting the patient's ability to cope with everyday life. Each question is answered on a 10 cm horizontal visual analog scale, the mean of which gives the BASFI score (0–10). The questionnaire was completed 257 times in total: once by 116 outpatients and by 47 inpatients on 3 occasions over a 3-week intensive physiotherapy course. In addition, the instrument was compared with the Dougados functional index.

Results. Patient scores covered 95% of the BASFI range, giving a normal distribution of results. In contrast only 65% of the Dougados functional index scale was used. Furthermore, over the 3 week period of inpatient treatment, the BASFI revealed a significant improvement in function (20%, $p = 0.004$) while there was a less impressive change in the Dougados functional index (6%, $p = 0.03$). This demonstrates the superior sensitivity of the BASFI. Consistency was good for both indices ($p < 0.001$), as was the relationship between patient perception of function and function as assessed by an external observer ($p < 0.001$).

Conclusion. The BASFI satisfies the criteria required of a functional index: it is quick and easy to complete, is reliable and is sensitive to change across the whole spectrum of disease. (*J Rheumatol 1994;21:2281–5*)

Key Indexing Terms:
ANKYLOSING SPONDYLITIS
FUNCTIONAL INDEX
FUNCTIONAL ABILITY
VALIDITY

The control of pain and the preservation of function remain the goals of treatment in ankylosing spondylitis (AS)[1]. Nonsteroidal antiinflammatory drugs (NSAID) and physiotherapy, in the form of specific exercises, are the main methods of therapy[2]. However the relationship between disease activity, disease progression and its functional consequences is tenuous[3]. Clinical and laboratory indicators of disease activity are poor predictors of radiological damage[4]. The maintenance of optimal function is of paramount importance to the patient, thus any method of assessing function must be clinically relevant and reflect the patient's point of view[5].

The ideal self-administered instrument should satisfy validity criteria: content [the choice and relative importance of each component is appropriate for the purpose of the index]; face [the methods of weighting and aggregating components into an index are sensible]; criterion [the index produces consistent results that reflect the true clinical state of the patient]; discriminant [the index detects the smallest clinically significant differences between and within patients]; construct [the index agrees with expected results based on the hypothesis of the investigator][6]. The index should be reliable, reproducible and reflect the entire spectrum of the disease, in addition to being quick and simple. A number of self-assessment instruments for measuring function already exist, including the functional index produced by Dougados, *et al* which is widely used[7]. However, although validated, the index has a number of weaknesses such as its scoring system, which affects both sensitivity and score distribution.

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In addition, many of the questions are not sufficiently specific in their instruction. We have therefore developed the Bath AS Functional Index (BASFI) as a new approach to defining and monitoring functional ability in patients with AS.

MATERIALS AND METHODS

The BASFI was designed, through extensive discussion, by a team of rheumatologists, physiotherapists and research associates with a major input from patients with AS. Initially, over 20 questions were considered, encompassing a wide range of activities. Questions which were either repetitive in terms of requiring the same movement, or which were ambiguous/not entirely clear to patients were excluded. The final version consists of 8 questions on activities relating to the functional anatomy of patients, and 2 additional questions that assess the patient's ability to cope with everyday life. The questions reflect activities of daily living and include: "putting on socks or tights without help or aids"; "bending forward from the waist to pick up a pen from the floor without an aid"; "reaching up to a high shelf"; "getting out of an armless dining-room chair without using your hands"; "getting up off the floor without help from lying on your back"; "standing unsupported for 10 minutes without discomfort"; "climbing 12-15 steps without using a handrail or walking aid"; "looking over your shoulder without turning your body"; "doing physically demanding activities (e.g., physiotherapy exercises, sports and gardening)"; and "doing a full day's activities whether at home or at work" (Figure 1). The questions are simple to understand, specific in relation to a particular action and relevant to assessment of function in AS.

Each question is answered on a 10 cm visual analog scale (VAS), as this improves both the sensitivity of the index to change and its capacity to elicit a range of responses across the entire scale. The VAS have no distinguishing marks, in accordance with previous work[8], the only guidelines being the words "Easy" and "Impossible" at either end of the line to indicate the direction of severity (Figure 1). The mean of the 10 scales gives the BASFI score (0-10).

A total of 163 patients took part in the study (47 consecutive inpatients on an intensive 3-week physiotherapy course and 116 randomly selected outpatients). The patients included in the study reflect the whole range of disease from early AS to established late disease. The BASFI was analyzed in terms of all validity criteria and was compared with a published functional index (Dougados)[7]. The 0-40 scoring system of the latter was converted to a 0-10 scale for ease of comparison. All 163 patients were given both indices and a direct comparison was made, using the 149 patients who fully completed the questionnaires. Both the BASFI and Dougados functional index were completed by 30 inpatients at the start, 2nd day and end of the 3-week period of physiotherapy. To assess reproducibility of the 2 indices, inpatient scores taken 24 hours apart (Day 0 and Day 1 of treatment), at about the same time of day, were compared. An external validation of both indices was performed on 20 of the inpatients. On completion of 8 specific tasks by each of the patients, 2 physiotherapists independently scored the relevant questions of the BASFI and the Dougados functional index. The patients completed the questionnaires separately. Finally, sensitivity to change over the 3 weeks of intensive physiotherapy was analyzed for both indices by comparing the inpatient scores on Day 0 and Day 18 of treatment.

The analyses were carried out using the UNISTAT statistical software on an IBM compatible PC. Correlations were performed using the Pearson correlation coefficient and analyses of difference using the Kruskal-Wallis one-way ANOVA and the Wilcoxon ranked sign test.

RESULTS

The mean age of the 163 patients (123 men : 40 women - a 3.1:1 ratio) who completed the BASFI and Dougados functional index was 47.7 (SD 11.13; inpatients: 47.12, outpatients: 47.32), with a mean age at disease onset of 23.0 (SD 8.07; inpatients: 23.8, outpatients: 22.7), and a mean disease duration of 24.7 years (inpatients: 23.2, outpatients: 24.6).

The BASFI and Dougados functional index took an equivalent amount of time to complete (100 s maximum) and no preference was expressed for either instrument by the patients. However, the distribution of the BASFI scores was superior to that of the Dougados functional index: range 0–9.5 (mean 4.03, SD 2.16) compared to 0–6.5 (mean 2.58, SD 1.68), respectively (Figures 2 and 3).

In a comparison between the BASFI scores of hospital inpatients and those of the outpatients, the mean BASFI score of the former was significantly higher than that of the latter [hospital patients: mean score = 5.06 (SD 2.0) vs outpatients: mean score = 3.55 (SD 2.0); $p < 0.001$]. The mean score for the Dougados functional index was also higher among the inpatients than the outpatients [mean score = 3.36 (SD 1.56) vs mean score = 2.29 (SD 1.62); $p = 0.001$].

The reproducibility of both instruments was good in terms of consistency of inpatient scores taken 24 h apart at the same time of the day (BASFI: mean at time zero = 5.19 (SD 2.05) vs mean at +24 h = 5.26 (SD 1.93); $r = 0.89$, $p < 0.001$. Dougados FI: mean time at zero = 3.46 (SD 1.52) vs mean at +24 h = 3.46 (SD 1.55); $r = 0.96$, $p < 0.001$).

An external validation of the BASFI demonstrated patient and observer scores to be reliably consistent (mean Patient score = 2.76 vs mean Observer A score = 2.33 vs mean Observer B score = 2.65; $r = 0.87$–0.89, $p < 0.001$). The same interobserver consistency was found in the Dougados FI (mean Patient score = 1.93 vs mean Observer A score = 2.29; $r = 0.9$, $p < 0.001$).

Over an intensive 3 week treatment period the BASFI scores improved significantly from a mean of 4.82 (SD 2.04) on Day 0 to 3.75 (SD 2.11) on Day 18 ($p = 0.004$; mean score change = −1.07 [19.6% improvement]; range = −5.15 to +3.23). The Dougados FI however, showed no significant change over the same period of time (Day 0: mean = 3.09 (SD 1.43) vs Day 18: mean = 2.77 (SD 1.64); $p = 0.19$, mean score change = −0.32 [5.9% improvement]; range = −4.0 to +3.0).

DISCUSSION

The aims of treatment in AS are to control pain and to maintain or improve function, and thus quality of life. Mobility and function are improved by physiotherapy and specific exercise programmes[9,10]. Function is an important outcome measure in AS. Most of the previous functional assessments have been directed towards patients with peripheral joint disease, primarily assessing the function of hands and feet, e.g., Steinbroker[11] and the Stanford Health Assessment Questionnaire (HAQ)[12]. Since AS predominantly affects the spine, these assessments have only limited value. Generic measures of health status such as the Sickness Impact Profile[13], Arthritis Impact Measurement Scale[14] and the more specific

PLEASE DRAW A MARK ON EACH LINE BELOW TO INDICATE YOUR LEVEL OF ABILITY WITH EACH OF THE FOLLOWING ACTIVITIES. DURING THE LAST WEEK:

N.B An aid is a piece of equipment which helps you to perform an action or movement

EXAMPLE:

EASY ——|—— IMPOSSIBLE

1) Putting on your socks or tights without help or aids (e.g sock aid)

EASY _____ IMPOSSIBLE

2) Bending forward from the waist to pick up a pen from the floor without an aid

EASY _____ IMPOSSIBLE

3) Reaching up to a high shelf without help or aids (e.g helping hand)

EASY _____ IMPOSSIBLE

4) Getting up out of an armless dining room chair without using your hands or any other help

EASY _____ IMPOSSIBLE

5) Getting up off the floor without help from lying in your back

EASY _____ IMPOSSIBLE

6) Standing unsupported for 10 minutes without discomfort

EASY _____ IMPOSSIBLE

7) Climbing 12 - 15 steps without using a handrail or walking aid One foot on each step

EASY _____ IMPOSSIBLE

8) Looking over your shoulder without turning your body

EASY _____ IMPOSSIBLE

9) Doing physically demanding activities (e.g physiotherapy exercises, gardening or sports)

EASY _____ IMPOSSIBLE

10) Doing a full days activities whether it be at home or at work

EASY _____ IMPOSSIBLE

Fig. 1. A copy of the BASFI.

indices such as the HAQ-S[15] may not be sensitive enough to detect change in patients with AS. Indeed the value of such functional outcome measures in AS has been questioned by some[16]. However, most physicians are aware of the importance of function and realize that the main problem of measurement relates to the fact that the present indices are either inappropriate or insensitive[17].

As a result, recent efforts, such as the Dougados FI[7], have focussed on more specific measures of function regarding AS. This functional index is a valid measure of disabili-

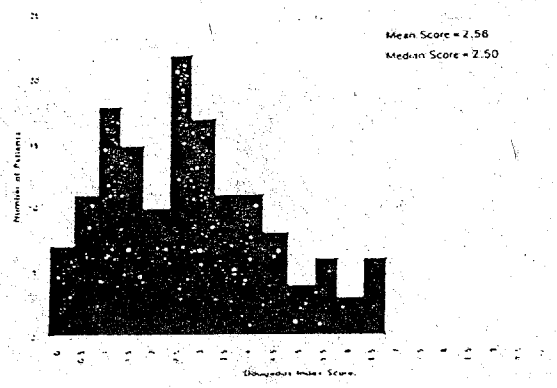


Fig. 2. Title: Dougados functional index: score distribution, showing the distribution of the Dougados Functional Index scores among 149 patients (mean score = 2.58, 65% of scale used).

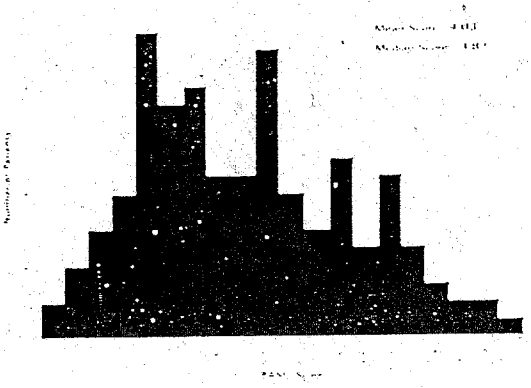
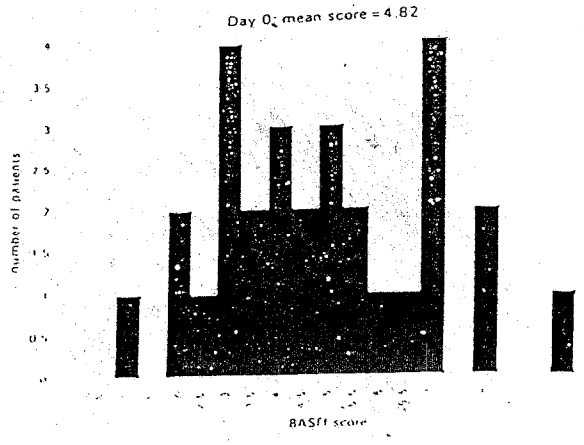


Fig. 3. Title: BASFI score distribution: showing the distribution of BASFI scores among 149 patients (mean score = 4.03, 95% of scale used).



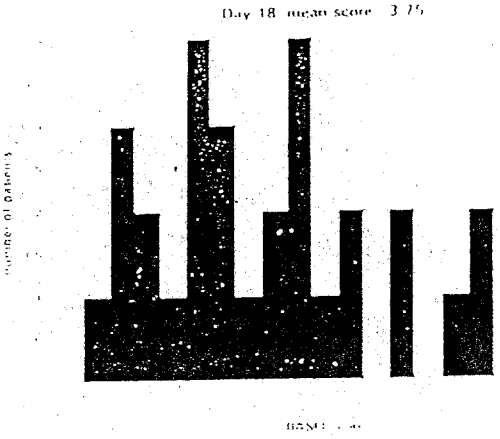


Fig. 4. Title: BASFI sensitivity to change over 3 weeks of intensive (up to physiotherapy treatment: showing the pre and post-treatment (at Day 0 and Day 18) BASFI score-distributions of 30 inpatients.

ty and consists of 20 questions corresponding to activities of daily living. A score of 0 is given if the task can be accomplished without difficulty, 1 if it is possible but difficult and 2 if it is impossible. The answers are added to give a total score of dysfunction. The Dougados FI was designed by physicians with a specialist interest in AS. Apparently there was no input from physiotherapists, who are closely involved with the monitoring of patient function, or from the patients themselves. The importance of the patient's point of view has recently been stressed[12]. Other problems encountered with this particular functional index include the fact that patients often find the questions difficult to answer without qualification. Many of the questions are not specific enough in terms of the exact movement or task required and, in addition, the index does not account for the possible use of help or aids by the patients when carrying out the activities listed. Furthermore, movements are seldom impossible and patients can often perform a task by "getting round" the difficulty — for example, flexing hips and knees in order to bend over and pick up an object. These weaknesses tend to restrict the sensitivity and its capacity to elicit a range of responses across the scale of this particular functional index. Confusion also occurs because of designated clothing such as trousers or pullover, with patients often substituting items of clothing without the action performed being similar. In addition, some of the questions appear to be assessing roughly the same function (e.g., "putting on shoes" and "putting on trousers", "lie down" and "sleep on your back", "sit down" and "crouch", and "run" and "climb a flight of stairs," suggesting an element of redundancy.

A further problem with the instrument lies in its scoring system. Patients are given only 3 choices of answer to the question "can you?" for each of the 20 activities listed. The possibilities available are "yes with no difficulty", "yes but with difficulty" and "no". The middle option covers a broad range of possible responses and cannot distinguish between patients able to fulfill a task with minimal difficulty and those who can only just manage an activity. Such a scoring method also makes the index relatively insensitive to change, since ability with a particular task would have to

alter dramatically in order for a response to change.

It was as a result of these apparent inadequacies in the current methods of assessing function in AS that a team of physiotherapists, physicians, research associates and patients designed a new functional index: the BASFI. This instrument consists of 10 questions, specific in their instruction, considered to be clinically relevant and to encompass the appropriate anatomy and reflect the overall level of function of the patient. The questions were answered on a 10 cm VAS in order to improve both the sensitivity of the index and its capacity to make use of the entire scale of the index. The questions relating to specific movements are concise and do not require further explanation. They specifically exclude the use of help or aids.

The BASFI scores produced a normal distribution which covered 95% of the total scale whereas the Dougados functional index used only 65% of the total range. This skew was highlighted by the low mean of the patient scores on the Dougados FI: (2.58), compared to that of the BASFI: (4.03). As the inpatients assessed covered a broad spectrum of disease severity, a full range of scores for both indices would be expected, with a mean score near the middle of the scale. The superior score distribution of the BASFI was demonstrated in almost 50 consecutive inpatients as well as over 100 randomly selected outpatients and gives it a distinct advantage over the existing functional index.

Patients did not express a preference for either the BASFI or Dougados FI, in terms of time taken to complete them or overall user friendliness, but as explained above, some of the questions in the Dougados FI needed qualification in order to be answered accurately. The reproducibility of the BASFI is highly significant and, in addition, the patients' perception of their level of function accurately mirrored that of external observers.

Any index which is to be used in the analysis of function needs not only to be accurate but also sensitive to change. The BASFI was shown to be sufficiently sensitive to demonstrate an improvement in the functional ability of patients over a 3 week period of inpatient therapy. This was not reflected by the Dougados FI. There is an inevitable trade-off between sensitivity to change and reproducibility: by increasing one, the other is usually decreased. This is reflected in the BASFI where its superior sensitivity is balanced against a lower degree of reproducibility compared to the Dougados index. However, the high degree of reproducibility shown by the Dougados is primarily a function of its low sensitivity, whereas the greatly increased sensitivity of the BASFI does not result in a comparable decrease in its reproducibility.

In conclusion, the BASFI satisfies the criteria considered necessary in the design of a functional index. Specifically, it is quick and easy to complete, is reliable and is sensitive to change across the whole spectrum of disease. Moreover, not only does the BASFI satisfy the needs of medical practitioners and their physiotherapy colleagues, but its clinical relevance is also heightened by the inclusion of advice given by patients with AS during its design and subsequent assessment.

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THE BATH ANKYLOSING SPONDYLITIS RADIOLOGY INDEX (BASRI)

A New, Validated Approach to Disease Assessment

KIRSTEN MACKAY, CHRISTOPHER MACK, SINEAD BROPHY, and ANDREI CALIN

Objective. To develop a reproducible and simple radiologic scoring system for the spine in patients with ankylosing spondylitis (AS): the Bath Ankylosing Spondylitis Radiology Index for the spine (BASRI-s).

Methods. Radiographs of 470 patients with AS were scored using the New York criteria for the sacroiliac joints and, similarly, grading the lumbar and cervical spine on a scale of 0–4 (for normal, suspicious, mild, moderate, and severe). These 3 scores were added together to produce the BASRI-s score (scored 2–12). Radiographs of 188 patients were used to test reproducibility. Blinded radiographs of 89 non-AS patients were included, randomly, to assess disease specificity. Sensitivity to change was assessed using 177 radiographs from 58 AS patients.

Results. Intra- and interobserver variation showed 75–86% and 73–79% complete agreement at all sites, respectively. Specificities of 0.83–0.89 suggested that the lumbar and cervical spine BASRI scores were disease specific. Sensitivity to change became apparent at 2 years ($P < 0.001$). Using a lateral view *and* an anteroposterior view of the lumbar spine was more sensitive than using a lateral view alone. Grading a set of radiographs (sacroiliac joints, lumbar spine, and cervical spine) took 30 seconds.

Conclusion. BASRI is a reliable method for grading radiographic changes in patients with AS. It is disease specific, sensitive to change, valid, simple, and rapid to perform.

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Ankylosing spondylitis (AS) is a chronic, progressive condition with fluctuating disease activity. A number of measures are used simultaneously to monitor outcome (1–10), and these are fundamental in assessing the natural history of AS and the effectiveness of specific management strategies in terms of outcomes research (11). Characteristic radiologic change is essential for the diagnosis of AS and is considered the "gold standard" for disease status, but little work has been done to assess disease progression in radiologic terms. Radiographs have the advantage over other measures of being objective and uncomplicated by diurnal variation (12).

No classification defining global radiologic change in AS exists. The New York (NY) criteria for AS include the only widely accepted radiology measure specific for the disease, but this refers purely to the sacroiliac (SI) joints (13–15). The Rome criteria use the presence of radiologic sacroiliitis to diagnosis AS but ignore the rest of the spine (16). End-stage cervical and lumbar spine disease may be readily recognizable in terms of a "bamboo spine," but less severe changes have not been adequately described. A number of systems for scoring some part of the spine in AS have been published (12,17–20), but these are not used widely. None of them score the whole spine. Some have poor reproducibility, are insensitive to disease progression, and are slow to use (21). All ignore the posterior structures of the spine, classifying those who have only posterior element fusion as normal or as having "mild" radiographic changes when in fact the spine may be completely fused (see Figures 1A and B and Figure 2).

The Bath Ankylosing Spondylitis Radiology Index for the spine (BASRI-s), a new radiologic scoring system, was designed to address these problems. This report describes the BASRI-s, its inception, and its uses. Radiologic changes in the hip have specifically been excluded from this study, since those AS patients who develop hip disease represent a small, distinct subset of

Table 1. Bath Ankylosing Spondylitis Radiology Index (BASRI) for the spine*

Score	Grade	System applies to both the lumbar and the cervical spine (grade each as 0–4)
0	Normal	No change
1	Suspicious	No definite change
2	Mild	Any number of erosions, squaring, or sclerosis, with or without syndesmophytes, on ≤2 vertebrae
3	Moderate	Syndesmophytes on ≥3 vertebrae, with or without fusion involving 2 vertebrae
4	Severe	Fusion involving ≥3 vertebrae

* For the lumbar spine, examine both the anteroposterior and lateral radiographs together. The score for the lumbar spine is a composite of the 2 views. If, as in Figures 1A and B, one view shows syndesmophytes and fusion but the other view shows lesser changes, the overall score will relate to the view showing the more significant change. This system applies equally to the cervical spine, but only to the lateral radiograph. See Figures 1 and 2.

patients whose disease occurs at a younger age (22–26). An index documenting radiologic hip change is being developed.

PATIENTS AND METHODS

A consensus approach (27) was used to determine a suitable scoring system for radiographs of patients with AS. Radiographs of 470 patients who had been diagnosed according to the NY criteria were scored openly and assigned to 1 of 5 severity grades based on the NY grading of SI joint disease (0 = no disease, 1 = suspicious for disease, 2 = minimal disease, 3 = moderate disease, and 4 = severe disease). The radiographs used were an anteroposterior (AP) pelvis film, AP and lateral lumbar spine films, and a lateral cervical spine film. The SI joints, lumbar spine, and cervical spine were each assessed separately. The lumbar spine was defined as extending from the lower border of T12 to the upper border of S1, and the cervical spine as extending from the lower border of C1 to the upper border of C7.

The discriminating features of each radiologic severity group were defined and used as the basis to describe a method of assessing the severity of radiologic change in AS. The system was then repeatedly tested in a blinded manner by 3 experienced readers (KM, CM, and AC) and modified openly on several occasions before the final format was determined. Rules for scoring the lumbar and cervical spine are shown in Table 1. The NY criteria were used to score the SI joints (15).

To assess whether an AP or lateral radiographic view was more appropriate for scoring the lumbar spine, 58 sets of lumbar spine radiographs with both AP and lateral views were scored using 1) the AP view alone, 2) the lateral view alone, and 3) the AP and lateral views combined. Sensitivity and specificity for each view was determined and compared with the score obtained with both radiographic views. A similar process was used for assessment of cervical spine radiographs.

Following definition of the scoring system, radiographs of 188 consecutive patients with AS and 89 without AS were scored randomly and blindly by the 3 readers to validate the BASRI. The mean (±SD) age of this AS population was 44.5 ± 10.9 years, and the sex ratio was 3:1 (males:females). Two hundred sixty-three SI joint, 160 lumbar spine, and 145 cervical spine radiographs from the AS cohort were scored, assessing intra- and interobserver variation. Because these data were nonparametrically distributed, tending, with increasing disease duration, to cluster toward a higher score (worse disease), a kappa statistic was used to determine the significance of the intra- and interobserver variability.

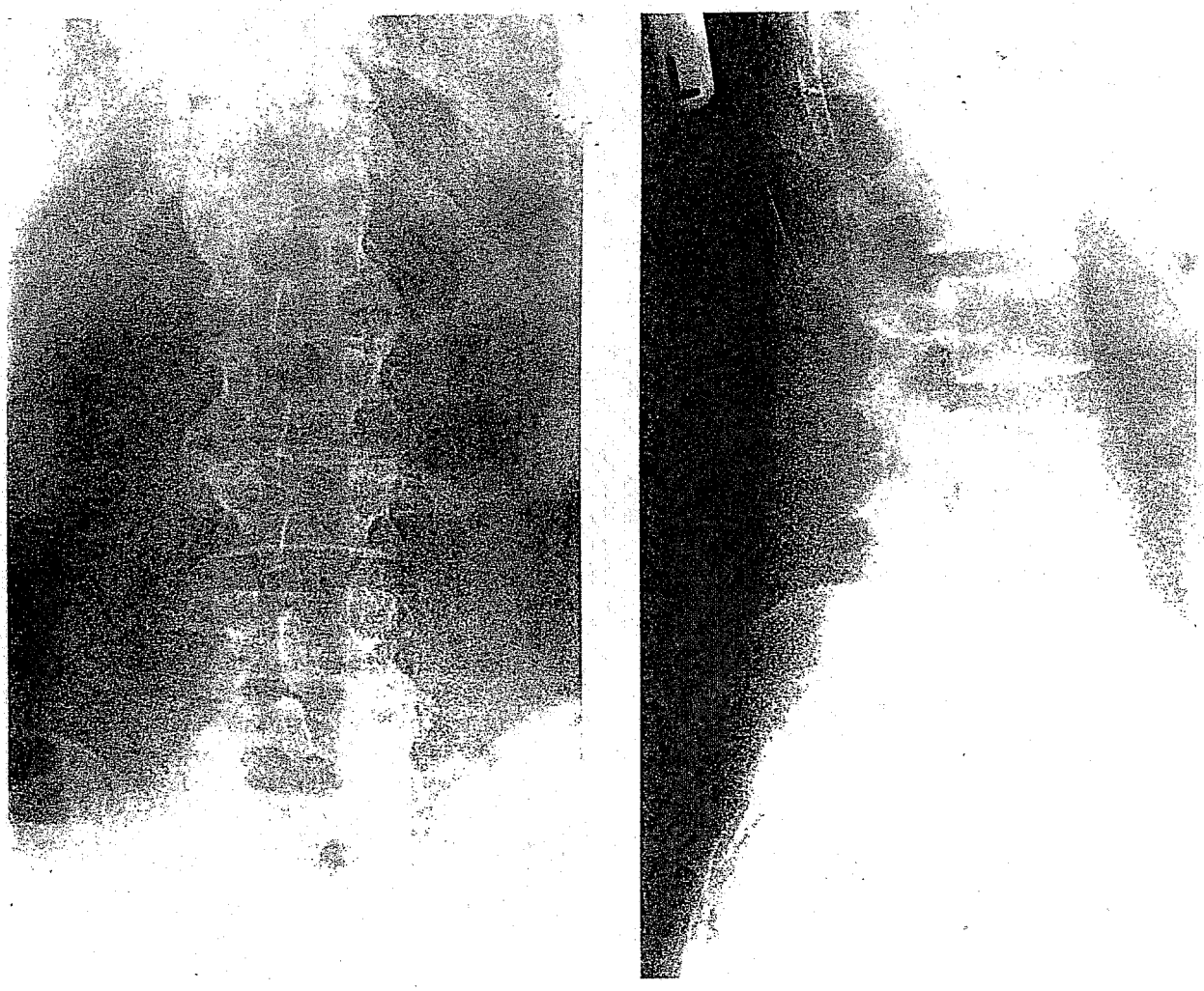
Sensitivity to change over time was determined by scoring serial radiographs of 58 patients, assessing 177 time intervals of 1, 2, 3, and 4 years. Radiographs were obtained on 2 occasions 12, 24, 36, and 48 months apart, and were available in 20, 31, 28, and 23 cases, respectively. The mean time from diagnosis of these 58 patients was 18 years (range 0–44 years). All radiographs were blinded as to the name and date of the radiograph, and a Wilcoxon signed rank test for nonparametric data was used to determine the earliest point at which sensitivity to change became apparent.

The specificity and positive predictive value against other rheumatic conditions was assessed using 305 radiographs from the AS cohort and 78 radiographs from the 89 non-AS patients. Radiographs of non-AS patients were interspersed with the AS patients' films, such that readers were unaware of the diagnosis. A cutoff of grade 2 (definite) disease was used, and all radiographs were then classified into 1 of 2 groups: those with and those without AS changes. The SI joints were not viewed at this point.

The non-AS cohort we studied consisted of consecutive outpatients who were attending the Royal National Hospital for Rheumatic Diseases, a tertiary referral center, and who had had cervical or lumbar spine radiographs obtained for evaluation of symptoms. Their mean (±SD) age was 57.9 ± 16.8 years, and the sex ratio was 1:3 (males:females). This cohort included 41 patients with rheumatoid arthritis, 21 with mechanical back pain, 10 with fibromyalgia, 10 with osteoporosis, and 7 with psoriatic arthritis.

RESULTS

Lumbar and cervical spine: which film should be used? Using 58 sets of AP and lateral lumbar spine radiographs, 3 scores were derived as described above. This third, or combination, score differed from the AP or lateral scores if syndesmophytes or fusion were seen at *different* levels on each projection. This occurred in 3 of the 58 patients. The "combination" score differed from the AP score alone in 9 of the 58 patients (15.5%) and from the lateral score alone in 21 (36%). Overall, the use of 2 projections changed the score 46% of the time. Assuming that the combination view gives the truest assessment, the sensitivity for the AP view alone is 0.83 and that for the lateral view alone is 0.73 (see Figures 1A and B).



A B

Figure 1. A, Anteroposterior (AP) and B, lateral radiographic views of the lumbar spine of an ankylosing spondylitis patient, obtained on the same day. Syndesmophytes and fusion can be seen in the AP view but not in the lateral view. In a scoring system that uses only the lateral radiograph, the findings on the film in B could be classified as normal.

In the cervical spine, this situation was not evident (see Figure 2). Only 20 cases were available in the population studied, since AP views of the cervical spine were rarely taken. The AP view influenced the overall score only once.

Validation of the BASRI. *Intraobserver variation.* Two hundred blinded SI joint radiographs were assessed twice by a single observer, with 86% complete agreement, giving a kappa score of 0.69. Results for the lumbar and cervical spine were similar, with kappa scores of 0.65 (75% complete agreement) and 0.73 (81% complete agreement), respectively (see Tables 2 and 3). The main errors were reading the SI joints as grade 3 rather than grade 4 in 12 of 200 cases (6%), scoring the lumbar spine as grade 4 rather than grade 3 in 7 of 97 cases (7%), and in distinguishing suspicious (grade 1) from mild (grade 2) disease in the cervical spine in 5 cases. Variation of >1 grade occurred only twice when scoring the lumbar spine and never when scoring the SI joints or the cervical spine.

Interobserver variation. Reproducibility between 2 readers was assessed using 263 SI joint radiographs

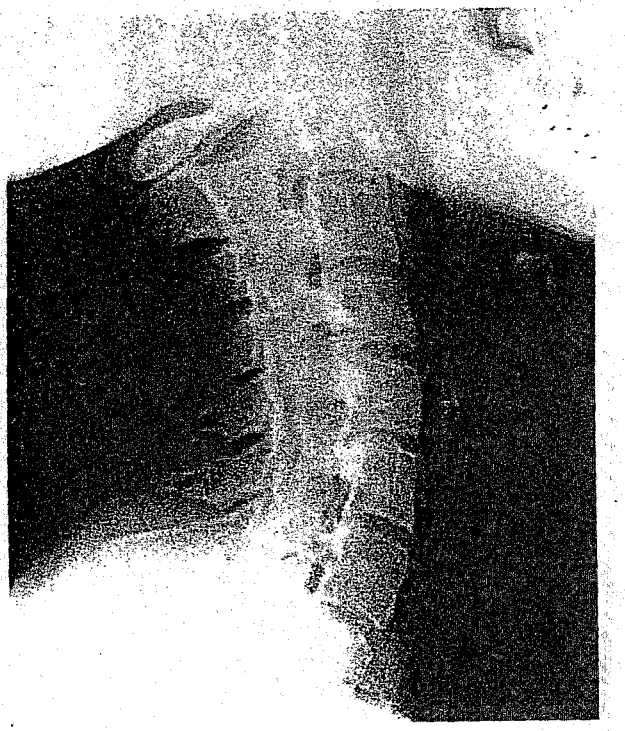


Figure 2. Cervical spine radiograph, showing fusion of the posterior elements but no anterior fusion. Any scoring system that ignored the posterior elements would classify the findings on this film as normal.

scored by each assessor on separate occasions. There was 78% complete agreement between observers, with a kappa score of 0.55. The 160 sets of lumbar spine radiographs used reached 73% complete agreement ($\kappa = 0.64$), and the 145 cervical spine radiographs reached 79% complete agreement ($\kappa = 0.69$) (see Tables 2 and 3). Both the lumbar and cervical spine scores outperformed the established NY criteria for SI joint assessment. Considerable difficulty in separating grades 3 and 4 existed in SI joint assessment (8 occasions), while distinguishing mild from suspicious disease was the main problem for the lumbar and cervical spine scoring (5 occasions). Discrepancies of >1 grade occurred while scoring the SI joints in 3 of 263 films, the lumbar spine in 5 of 160 films, and the cervical spine in 10 of 145 radiographs.

Table 2. Summary of intra- and interobserver variations at the various skeletal sites scored as part of the Bath Ankylosing Spondylitis Radiology Index

	Intraobserver variation		Interobserver variation	
Skeletal site	Complete agreement (%)	Kappa statistic	Complete agreement (%)	Kappa statistic
Sacroiliac joints	86	0.69	78	0.55
Lumbar spine	75	0.65	73	0.64
Cervical spine	81	0.73	79	0.69

Table 3. Kappa statistics and strengths of agreement

Kappa statistic	Strength of agreement
<0.2	Poor agreement
0.2–0.4	Fair agreement
0.4–0.6	Moderate agreement
0.6–0.8	Good agreement
0.8–1.0	Very good agreement

Disease specificity. Specificity for the lumbar spine was 0.89, and that for the cervical spine was 0.83. The positive predictive value for the lumbar spine was 0.97, and that for the cervical spine was 0.95.

Sensitivity to change. Using Wilcoxon's signed rank test for nonparametric data, the BASRI-s demonstrated a significant change in radiologic score ($P < 0.001$) at 24 months for the SI joints, the lumbar spine, and the cervical spine. Where the time interval between radiographs was 12 months, 30% of cases showed changes of at least 1 grade within this period, but this was not statistically significant ($P < 0.07$).

Scoring speed. The mean time taken to score 1 set of films (SI joints, lumbar spine, and cervical spine) was less than 30 seconds.

DISCUSSION

Any measure that documents disease status must be reproducible and sensitive to change. It should be disease specific and have both face validity and predictive validity (11). To be clinically useful, it needs to be easy and quick to use, with few training requirements. The use of standard measures is essential to allow comparison of results between clinical studies (28). This is illustrated well in the rheumatoid arthritis literature by the frequent use of radiologic grading systems, such as the Larsen and Sharp scores for the hand and the ACR (American College of Rheumatology) response criteria or EULAR (European League Against Rheumatism) Core Data Set (29–32). Using these criteria in epidemiologic studies can improve knowledge of disease and set a standard against which new treatments may be assessed. Knowledge of the natural history of a disease such as AS, which has an unknown etiology, can provide

insights into causal factors and provide patients with prognostic information and expectations (33). Distinguishing between markers of disease activity and those that attempt to measure damage and function is important (11). The BASRI was designed to fill a perceived gap in the range of outcome measures for AS.

Given that the NY criteria for the SI joints are well established, they were incorporated into the BASRI without change. To gain credibility, any newly developed score needs to perform as well as these criteria, and we have used the performance data for the NY criteria as the "gold standard." The BASRI was reproducible, with intra- and interobserver variations equivalent to or better than those of the NY criteria. The main problem for grading the lumbar and cervical spine was distinguishing suspicious disease from mild disease on 5 occasions because of difficulty in determining whether squaring was present. Difficulty in distinguishing between grades 1 and 2 was not seen with the SI joints because bilateral grade 2 or unilateral grade 3 sacroiliitis was part of the entry criteria for the study. A potential method of overcoming this problem for the spine would be to measure each vertebra individually to determine the presence or absence of squaring compared with the population mean, as done in the method described by Ralston and colleagues (18). However, this would considerably increase the time taken for scoring, thereby reducing the clinical usefulness of the BASRI.

The lumbar and cervical spine were shown to be disease specific, but the SI joints were excluded from this part of the study because the presence of sacroiliitis (as part of the NY criteria) was one of the entry criteria for the AS cohort. Since only 7 of the 89 non-AS cohort had psoriatic arthritis, further work is under way to determine whether the BASRI would be able to differentiate AS patients from those with Reiter's disease or psoriatic arthritis.

Little information has been available regarding radiographic sensitivity to disease progression and the frequency with which repeat radiographs should be performed. The BASRI was found to be sensitive to change over a 2-year period, which suggests that radiographs at intervals of <2 years, for either routine or study purposes, are not warranted. The radiographs in the study were blinded for the date, confirming that the BASRI could determine "forward progression" (i.e., could identify the earlier of 2 radiographs performed on the same individual).

Other radiologic scoring systems for the lumbar spine have used a single lateral radiograph to grade radiologic change (12,19). Although classic radiologic features can be seen on this view, some changes, such as syndesmophyte formation and fusion between vertebrae, can be missed. The score generated using the AP view alone differed from the combined score (using both the AP and lateral views) 15% of the time but less frequently than with the lateral view alone, which differed 36% of the time. The best screening view for assessing the lumbar spine appears not to be the traditional lateral projection, but rather, the AP projection. If grade 4 change is seen on this view, no further radiographs are required, but if lesser disease is evident, then both the AP and lateral views are essential to define fully the severity of change. This did not apply to the cervical spine. The combination of views therefore used to determine the BASRI for the spine was: a lateral cervical spine, an AP and lateral lumbar spine, and an AP pelvis.

The use of the AP lumbar spine radiograph does increase the radiation dose slightly. A lateral lumbar spine radiograph incurs a dose of 19.0 milliSieverts (mSv), the addition of an AP lumbar spine radiograph increases the dose by 7.0 mSv (34), which is equivalent to the radiation exposure incurred during a transatlantic flight. The total radiation exposure for AP pelvis and AP and lateral lumbar spine radiographs is 31.3 mSv (34). No data are available for the cervical spine, but the nearest comparable examination would be a lateral chest radiograph, incurring a dose of 0.66 mSv (34). The risk of death from a fatal cancer following a lumbar spine radiograph is ~1:10,000 (35). The risk of dying in a road traffic accident in 1 year is 1:8,000 (35).

The thoracic spine has not been included in the BASRI-s because of technical difficulties and excessive radiation exposure. The scapulae and ribs tend to overlie the vertebrae, making a good view impossible. So, it is difficult to produce a well-penetrated radiograph. Lung disease will also add to any difficulties because the lungs overlie the thoracic spine in the lateral position. Attempts to improve the penetrance will increase the radiation exposure by an amount that is dependent upon the individual (e.g., muscle thickness affects penetration). Standard radiographs (as used by Larsen for other conditions) (29) have not been used since there are no available "gold standard" radiographs in AS. The BASRI was compared with the only other available index (21) and was found to be more reproducible, equally sensitive to change, and easier to use. Larsen scored only the hips in AS but found less reproducibility than in other diseases, perhaps because new bone formation occurs in spondylarthropathies. He suggests

that his index should be used with caution in these conditions (29).

The BASRI was easy to use and to explain. The mean time taken to score a set of radiographs for 1 subject was <30 seconds, and the required training was minimal. Cross-sectional data generated using the original cohort of 470 patients suggest that the disease ascends with time (36), which is consistent with many earlier studies and supports the instrument's face validity. Additionally, these data suggest that radiology may help in defining subgroups of patients, especially if used in conjunction with a variety of other indices. Studies using longitudinal data to confirm the validity of the BASRI as a prognostic marker are in progress. A pilot study investigating the relationship between metrology and an earlier version of the BASRI revealed a good correlation between the 2 scores (37). Following from this, the relationships between radiology, metrology, function, and disease activity (3–5) are currently being investigated.

The BASRI, as described above, is a modified version of studies previously published in abstract form (38), involving the entire axial skeleton, including the hips. Further work has since been undertaken delineating the spinal score, or BASRI-s, allowing for a more precise interpretation of the grading system, and this system has been compared with other available radiologic scoring systems (20,21). The present study uses a separate cohort of patients from those used in the previous studies and was undertaken to validate the BASRI-s in a new AS population.

Hip changes have not been included in the BASRI-s because patients who develop hip disease appear to represent a distinct subgroup. Hip arthritis is associated with the age at disease onset, occurring at a younger age. Ascending spinal disease seems to be a product of time—the longer the disease, the greater the spinal change (22). The majority of patients with hip disease have developed some radiographic change by the age of 23 (23). In a prospective study begun in 1947, 150 war veterans with AS were followed up for 33 years. Peripheral joint disease occurred early, and those whose hips were normal after 10 years of AS did not subsequently develop hip arthritis (24). Other evidence has shown that hip disease is associated with a more severe outcome. Amor and colleagues (25) include hip arthritis as 1 of 7 entry variables correlating with disease severity (odds ratio 22.85; 95% confidence interval 4.43–118) (25). Because hip disease affects only 18–37% of the AS population (22), the use of a global score (BASRI-g) for every AS patient, with a maximum score of 16 rather than 12, may inappropriately dilute the score of the majority of AS patients. Those with severe, or grade 4, spinal disease without hip arthritis would rate only 12 on a 16-point global scale despite having a bamboo spine, poor metrology, and poor function. It may be better to grade these populations separately, using the BASRI-s for one and the BASRI-g for the other.

To maintain simplicity, the BASRI does not pick up minor radiologic change. The score does not change with each additional erosion. Evidence of squaring or sclerosis will always remain grade 2, or *mild* disease, until fusion between 2 vertebrae or the presence of ≥3 syndesmophytes is identified. This is because spinal restriction in patients without bridging syndesmophytes may be related to soft tissue inflammation and potentially reversible factors, and therefore should be classed as mild disease (12,22). As well as scoring the type of damage that occurs in AS (erosions, squaring, syndesmophytes), the BASRI also incorporates the extent of the involvement (i.e., number of vertebral levels with syndesmophytes or fusion). However, it does not differentiate between those with a complete "bamboo spine" and those who have ≥3 fused vertebrae. Both score a grade 4, or *severe* disease. This definition of severe disease has been used because fusion of ≥3 vertebrae involves at least 60% of the lumbar spine, which limits spinal movement significantly. Our preliminary work correlating radiology with metrology supports this (37), but it does mean that the BASRI suffers from a ceiling effect. However, the same plateau effect and broad grading system are seen in the NY criteria, which have been widely accepted for scoring the SI joints and were the blueprint for the BASRI.

The limited scale of 1–4, necessitating fairly broad categories of radiologic grade, potentially explain why sensitivity to change for the BASRI is seen at 2 years. However, it might be that relevant change is truly slow and can only be seen at 2 years whatever the design of the index. Thus, the 72-point scale of the Stoke Ankylosing Spondylitis Spine Score (SASSS) (12) was no more sensitive to change (21). Unlike rheumatoid arthritis, where erosions tend to occur within the first few years, progression in AS appears to proceed quite slowly. Only 35% of a 470-patient cohort (mean disease duration 21 years, range 2–50 years) developed grade 4 changes in the lumbar spine (36). It is likely that the majority are diagnosed with grade 4 SI changes because of the lateness of their presentation, not the speed of the radiologic change. This lack of radiologic progression to severe spinal disease in the majority suggests that the potential ceiling effect is of little consequence.

Various other radiologic scores for AS have been published in the past 10 years (12,17–19). These have not attempted to define progression in the entire axial skeleton. The SASSS, as mentioned above, grades the lumbar spine alone, using a scale of 0–72. It scores the edges of each vertebral body from the lower border of T12 to the upper border of S1, using a 0–3 scale (1 for erosions, squaring, or sclerosis; 2 for syndesmophytes; and 3 for a total bony bridge). The maximum possible score is therefore 72, which represents a completely ankylosed spine. The SASSS does not take into account the posterior elements. This means that a subject with only posterior fusion would have a low score, and the low SASSS would be inconsistent with the clinical picture (see Figures 1A and B and Figure 2). Using the SASSS is slow, taking more than twice the time of the BASRI to grade just the lumbar spine (21). It does not use the AP lumbar spine film, which we have shown to be necessary (see Figures 1A and B). It is less reliable than the BASRI and is not sensitive to progression (21).

The Glasgow Radiological Index (GRI) (18–19) is a composite score. The SI joints are scored using the NY criteria, but a maximum score of 8 can be attained (unlike the NY criteria, the mean of the SI joints is not taken). The lumbar spine score includes the Vertebral Concavity Index, which measures the concavity of an individual vertebra, comparing it with a normal reference range. If the vertebra is squared, it is scored 1. The maximum concavity score is 5. In addition, each syndesmophyte identified is scored 1, allowing for a maximum possible score of 12. All 3 scores are added for a potential total of 25. The GRI applies only to the lumbar spine and SI joints. It is slow to perform, taking $\geq$3 minutes (18). It scores syndesmophytes but not fusion. It ignores erosions, the posterior elements, and uses only a lateral radiograph. The followup study (19) evaluated 41 patients at 5-year intervals. The abstract states that progressive change was detected. There was no correlation between the GRI and other clinical and laboratory parameters, namely, chest expansion, spondylometry, the erythrocyte sedimentation rate, and IgG levels.

In conclusion, radiology is fundamental to the diagnosis and tracking the subsequent progression of AS. Apart from the New York criteria for the SI joints, no widely accepted radiologic criteria exist. The BASRI, as a radiologic classification system, aims to satisfy the OMERACT (Outcome Measures in Rheumatoid Arthritis Clinical Trials) filter goal: specifically, one aspires toward truth, discrimination, and feasibility (39). The BASRI fulfills these criteria because it is reproducible, specific, sensitive to change at 2 years, simple and quick to use, and easy to explain. It is a global index, scoring the SI joints and the lumbar and cervical spine.

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Erratum

In the article entitled "Outcome of Renal Transplantation in Ninety-Seven Cyclosporine-Era Patients with Systemic Lupus Erythematosus and Matched Controls" published in the August 1998 issue of *Arthritis & Rheumatism* (Stone et al, pp 1438–1445), the name of the third author of reference 4 was listed incorrectly. The correct reference is Reveille JD, Bartolucci A, Alarcón GS. Prognosis in systemic lupus erythematosus: negative impact of increasing age at onset, black race, and thrombocytopenia, as well as causes of death. Arthritis Rheum 1990;33:37–48. We regret the error.

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THE BATH ANKYLOSING SPONDYLITIS PATIENT GLOBAL SCORE (BAS-G)

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SUMMARY

In the absence of an ideal objective measure for assessing ankylosing spondylitis (AS), self-administered measures of disease activity (the Bath Ankylosing Spondylitis Disease Activity Index, BASDAI) and function (the Bath Ankylosing Spondylitis Functional Index, BASFI) have been developed, in addition to an objective measure of spinal mobility (the Bath Ankylosing Spondylitis Metrology Index, BASMI). However, a more global assessment is also desirable. We report on the design and validation of a global measure (the Bath Ankylosing Spondylitis Patient Global Score, BAS-G) which reflects the effect of AS on the patient's well-being. A pilot study was performed to select the most appropriate wording for BAS-G. Using 392 patients with AS, BAS-G's construct and predictive validity and test–retest reliability were assessed. Correlations between BAS-G and BASDAI/BASFI were calculated, and multiple regression was used to examine the significant correlates. The distribution of the responses covered the whole scale. As predicted, BAS-G correlated best with BASDAI ($r = 0.73$), followed by BASFI ($r = 0.54$). The best fitting regression equation included these scales as well as patients' gender and current age. One week and 6 month scores were significantly different ($P < 0.001$). Construct validity was good: BAS-G correlated more strongly with each component of BASDAI and BASFI than with BASMI or with gender. Predictive validity was satisfactory: there was an improvement (mean = 29%) in in-patient BAS-G scores over a 2 week treatment period ($P < 0.001$). Test–retest reliability was excellent (1 week $r = 0.84$, 6 months $r = 0.93$). BAS-G correlates well with both BASDAI and BASFI, suggesting that disease activity and functional ability play a major role in patients' well-being, whereas metrology does not. The score is sensitive to change, reliable, and meets face, predictive and construct validity criteria.

KEY WORDS: Ankylosing spondylitis, Global score, Validation, Well-being, Outcome.

THERE is no ideal objective measure for assessing ankylosing spondylitis (AS). The radiograph is the current 'gold standard', but X-rays are insensitive to change, expensive, time consuming to perform and potentially dangerous [1]. Thus, subjective measures may be better [2, 3].

For example, Hidding *et al.* [4] found only a negligible discordance between self-report questionnaires and observed functional disability in patients with AS, in contrast to patients with fibromyalgia. Further, it has previously been demonstrated that a single-item self-assessment indicator is a better predictor of outcome than assessment by a physician [5]. In recognition of this, two self-administered indices to measure disease activity (the Bath Ankylosing Spondylitis Disease Activity Index, BASDAI) and function (the Bath Ankylosing Spondylitis Functional Index, BASFI) have been created and validated [6, 7]. An objective measure of spinal mobility, the Bath Ankylosing Spondylitis Metrology Index (BASMI), has also recently been developed [8]. However, if clinicians are to obtain a comprehensive summary of the patient's situation, a self-administered global measure is desirable.

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In this paper, we report on the design and development of a single-item global assessment (the Bath Ankylosing Spondylitis Patient Global Score, BAS-G) which reflects the effect of AS on patients' well-being over a particular period of time. A firm association between BAS-G and patients' report of disease activity and function is hypothesized, with only a weak association between BAS-G and metrology.

PATIENTS AND METHODS

In a pilot study, the most appropriate wording for the global measure was ascertained. The final question (in two versions) asks patients to indicate the effect of AS on their well-being over the last week/6 months, using a 10 cm horizontal visual analogue scale, where none = 0 and very severe = 10 (Fig. 1). We chose the periods '1 week' to enable comparison with BASDAI and BASFI, and '6 months' because this is often the time between hospital consultations.

Using a sample of 392 patients with AS [mean current age = 50.7 yr, standard deviation (S.D.) = 12.5], the BAS-G was assessed for its variability, temporal reliability and construct validity. The sample consisted of 177 consecutive in-patients attending a 2 week physiotherapy-based programme (mean 1 week BAS-G = 5.18, S.D. = 2.37) and 215 respondents to a postal survey of patients diagnosed with AS (75% response rate; mean 1 week BAS-G = 5.16, S.D. = 2.64).

The Bath Ankylosing Spondylitis Patient Global Score

(BAS-G)

1. Please place a vertical mark on the scale below to indicate the effect your disease has had on your well-being over the last **week.**

NONE _____ VERY SEVERE

2. Place a vertical mark on the scale below to indicate the effect your disease has had on your well-being over the last **six months.**

NONE _____ VERY SEVERE

THANK YOU

FIG. 1.—*The Bath Ankylosing Spondylitis Patient Global Score (BAS-G).*

Respondents reflect the whole range from early AS to established late disease [7].

Correlations between BAS-G and BASDAI/BASFI, and between 1 week and 6 month scores, were assessed for the full sample. Since overall disease status is assumed to be multidimensional [9], ordinary least squares (OLS) regression was used to examine the significant correlates of BAS-G. Initial predictors included BASDAI, BASFI, gender, current age and age at disease onset. For ease of interpretation, continuous variables in the regression analysis were standardized.

Correlations, OLS regression and analysis of variance (ANOVA) were used to assess construct validity [3]. We hypothesized a stronger association between BAS-G and BASDAI, BASFI and each individual component of the indices than between BAS-G and either BASMI, gender or occupational status [10]. Paired *t*-tests were used to assess sensitivity to change in a representative subsample of in-patients who completed BAS-G at the beginning and end of the 2 week programme. We hypothesized significant change in the 1 week question and little, if any, change in the 6 month question. One-day test–retest reliability was examined in 40 in-patients.

RESULTS

Responses to BAS-G covered the whole 0–10 scale, for both time frames (Fig. 2). A paired *t*-test showed that the difference between the 1 week and 6 month scores was statistically significant (1 week minus 6 months, mean difference $= -0.53$, S.E. $= 0.097$, $P < 0.001$). The 1 week BAS-G correlated best with BASDAI ($r = 0.73$, Fig. 3), followed by BASFI ($r = 0.54$). The best fitting regression equation (adjusted $R^2 = 0.55$) included gender, current age, BASDAI and BASFI, suggesting that these are the main identified components of the BAS-G score (Table I).

Regarding construct validity, BAS-G correlated more strongly with each individual component of

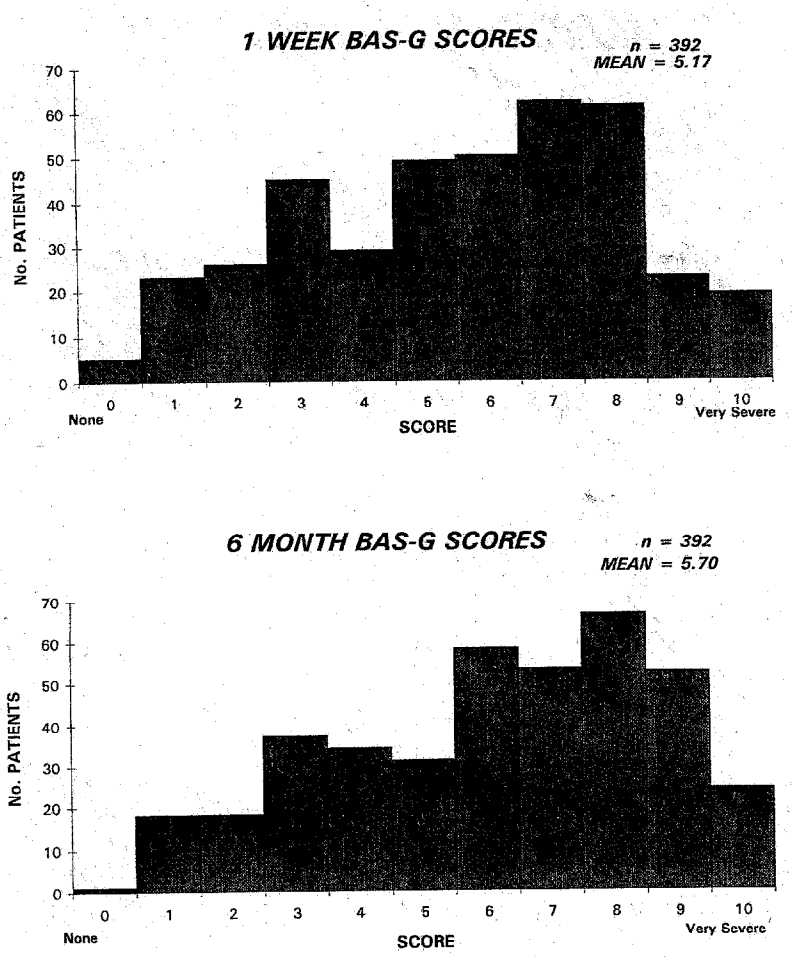

FIG. 2.—Use of the whole 0–10 scale by the 1 week and 6 month scores.

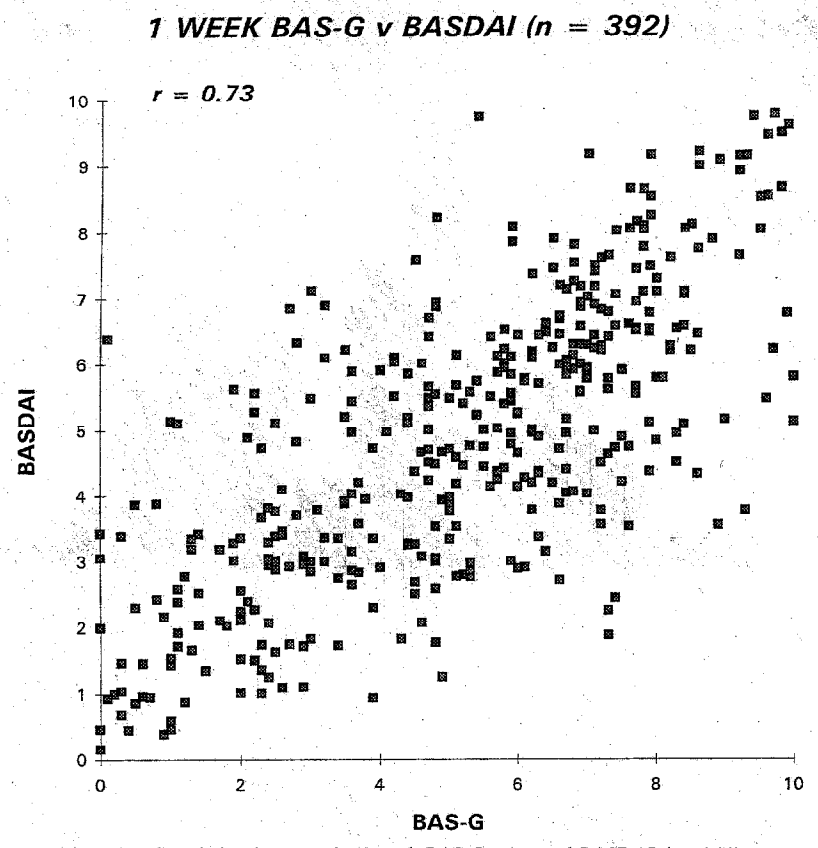

FIG. 3.—Correlation between the 1 week BAS-G score and BASDAI ($r = 0.73$).

BASDAI (Table II) and BASFI ($r = 0.30$–0.59) than with BASMI ($r = -0.16$) or gender ($r = 0.09$). Of the five BASDAI items, spinal pain correlated best with BAS-G ($r = 0.69$), followed by fatigue ($r = 0.66$). One-way ANOVA demonstrated that the association between BAS-G and occupational status was not statistically significant, although it may become so with a larger sample ($P = 0.12$). Comparison of separate regressions of BAS-G on BASDAI, BASFI and occupational categories showed that the R^2 statistics for BASDAI and BASFI (0.51 and 0.30, respectively) were much higher than the R^2 for occupation (0.06).

There was satisfactory sensitivity to change, in that improvement over a 2 week intensive self-management programme was expected, and observed, in pre/post global scores for the week prior to questioning (pre-course minus post-course, mean difference = 1.54, S.E. = 0.31, $P < 0.001$). Overall, there was a 29% improvement in 1 week scores (70% of patients improved; Fig. 4) and a 6% improvement in 6 month scores. The 24 h test–retest reliability was excellent (1 week $r = 0.84$, 6 months $r = 0.93$).

TABLE I
Results of regression of 1 week global score on relevant correlates ($n = 392$, adjusted $R^2 = 0.55$)

Variable	Coefficient (S.E.)
Male	−0.12 (0.08)
Current age	−0.08 (0.04)*
BASDAI	0.61 (0.04)***
BASFI	0.19 (0.05)***

Male is a dummy variable; all others are continuous and have been standardized; $*P < 0.05$, $***P < 0.001$; S.E. = standard error.

TABLE II
Correlations between BAS-G and all components of BASDAI ($n = 200$)

Variable	Correlation with BAS-G (r)	
BASDAI	Total	0.73
	Spinal pain	0.69
	Fatigue	0.66
	Morning stiffness	0.53
	Entheses	0.53
	Peripheral joint pain	0.38

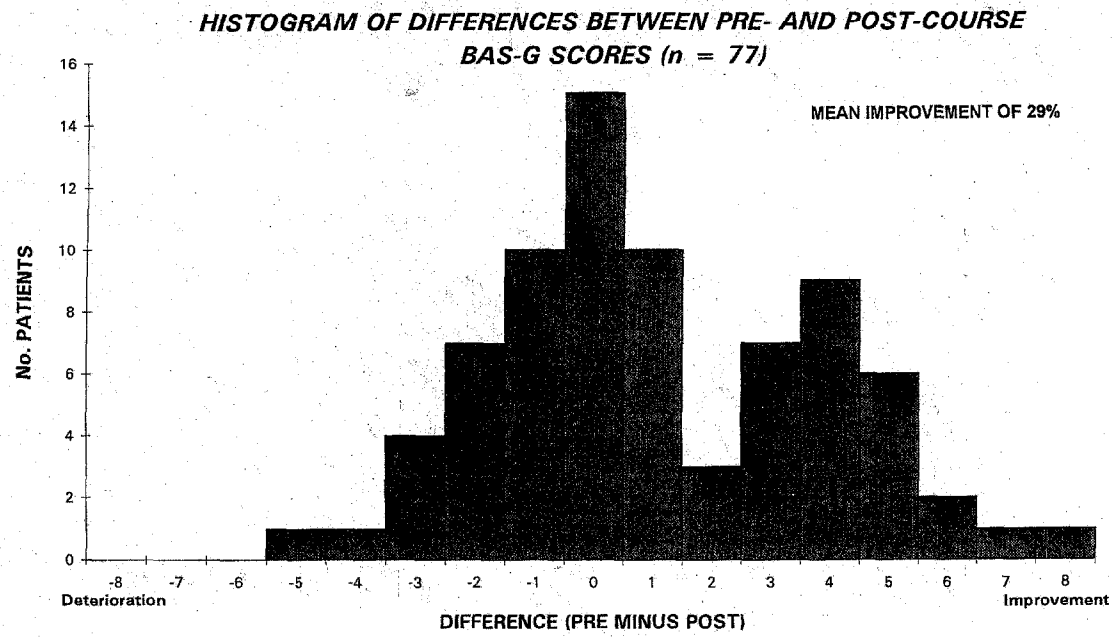

FIG. 4.—Differences between pre- and post-treatment BAS-G scores.

DISCUSSION

As concluded by Bakker *et al.* [2], health professionals should pay greater attention to the patient's point of view. Historically, clinicians have at least asked their patients the question 'How have you been over the last months?'. The main purpose of this study was to formalize this question and to provide health professionals with a quick, quantifiable and valid way to obtain the patient's perspective and monitor it over time. Thus, we developed the BAS-G. The secondary aim was to examine the relationship between this measure of overall patient well-being and other measures of specific components of disease in patients with AS.

The BAS-G was assessed for relevant validity criteria [face, discriminant, predictive (sensitivity to change) and construct] [11]. Neither content validity nor criterion validity were assessed, the former because the score resulted from a single question and was not a composite measure, the latter because there is no gold standard available. However, construct validity was more than satisfied: not only did BAS-G correlate well with BASDAI and BASFI but, appropriately, it correlated more strongly with these measures than with BASMI or any demographic variable.

Our results indicate that spinal pain and fatigue have the most influence on patients' well-being. Whilst pain has always been recognized as the main symptom in AS, it has only recently been demonstrated that fatigue is also a major component of disease activity [12]. Thus, intervention to reduce either should result in improved patient perception of health.

Several limitations to this study should be considered. First, although previous research suggests that our patients are representative of the whole AS population [13, 14], the possibility of sampling bias must be acknowledged. It is unlikely that hospital patients and members of a self-help group are perfectly representative of people with AS, some of whom may have the disease so mildly that it has yet to be diagnosed. However, as we would expect the main application of BAS-G to be in the environment of clinical consultations, this limitation should not be overestimated. Second, because it is hospital practice to develop continually the patient database, we relied on different sample sizes for these analyses. At every stage, the analysis utilized the fullest available data set at that point (e.g. 77/177 in-patients used to test predictive validity). This should not bias the results since no differences were found between patients included, and those omitted, in terms of a variety of demographic and clinical data.

Third, the psychological status of the patients involved in this research was not defined, but would be likely to increase understanding of what contributes to patients' perception of well-being. Finally, it is obvious that BAS-G cannot stand alone. It should be taken as only one element of a complete assessment of patient status.

There are two ways for clinicians to consider these results. The first is to treat them as simplistic and obvious answers to a simplistic and obvious question. What can be gained from asking patients to write down the effect their disease has on their well-being, when the

physician can just as easily obtain an adequate verbal answer? The value of BAS-G, and thus the second way of considering these results, is that with patients answering the question on a visual analogue scale, numerical scores can be entered into the medical notes to compare with scores at the previous or next consultation. From a practical perspective, this may be helpful where patients do not necessarily consult the same rheumatologist on each occasion. The patients should not have access to previous scores when answering the question at a later date.

Theoretically, it will now be possible to plot the scores over time to track changes in the perceived effect of the disease on patient well-being. The most subtle changes—certainly changes more subtle than those showing up in radiographs or in laboratory tests—should be detected. We propose the BAS-G as a valuable quantitative measure, developed to aid the clinician in assessing how patients perceive the effects of AS on their well-being. BAS-G may also be a useful instrument in clinical studies of AS. Further research could lead to an understanding of how the patient's perception compares to the physician's assessment. Finally, BAS-G is not disease specific in content (as are BASDAI, BASFI and BASMI), and may thus be applicable to other chronic or rheumatic diseases.

In conclusion, we have formalized and validated a simple question universally asked of patients by clinicians. The BAS-G generates a measurable answer in the form of a numerical score which lends itself to subtle comparisons over time. The score records change where change is expected, is reliable, and meets face, predictive and construct validity criteria. BAS-G correlates well with both BASDAI and BASFI, suggesting that disease activity and functional ability play a major role in the patient's perception of well-being. The contribution of pain and fatigue to this perception is particularly significant, and merits further study.

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A New Approach to Defining Disease Status in Ankylosing Spondylitis: The Bath Ankylosing Spondylitis Disease Activity Index

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ABSTRACT. Objective. Disease status, in terms of disease activity, disease progression and prognosis is difficult to define in ankylosing spondylitis (AS). No gold standard exists. Therefore, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), a self-administered instrument, has been developed as a new approach to defining disease activity in patients with AS.

Methods. The index, designed by a multidisciplinary team with input from patients, consists of six 10 cm horizontal visual analog scales to measure severity of fatigue, spinal and peripheral joint pain, localized tenderness and morning stiffness (both qualitative and quantitative). The final BASDAI score has a range of 0 to 10. The index was distributed to a cross section of patients, including inpatients receiving 3 weeks of intensive physiotherapy treatment and hospital outpatients. BASDAI was completed by a total of 154 patients. Validation of the new instrument was achieved through analysis of user friendliness, reliability (consistency), score distribution and sensitivity to change. Comparisons were made with a previous Bath disease activity index (DAI) and the Newcastle Enthesis Index.

Results. The BASDAI was found by patients to be quick and simple to complete (mean: 67 s). Test-retest reliability was good ($r = 0.93$; $p < 0.001$), as was the distribution of scores across the scale (score range: 0.5–10; mean: 4.31). BASDAI was sensitive to change, reflecting a 16% (mean) improvement in inpatient scores after 3 weeks of treatment. It is superior to the DAI in terms of construct and content validity and to the Enthesis Index in all aspects.

Conclusion. In summary, BASDAI is user friendly, reliability, sensitive to change and reflects the entire spectrum of disease. It is a comprehensive self-administered instrument for assessing disease activity in AS. (*J Rheumatol 1994;21:2286–91*)

Key Indexing Terms:
ANKYLOSING SPONDYLITIS
SELF-ADMINISTERED INSTRUMENT
DISEASE ACTIVITY
VALIDITY

Disease status, in terms of disease activity, disease progression and prognosis is difficult to define in ankylosing spondylitis (AS)[1]. Fundamental to investigating the natural history of the disease is the assessment of outcome[2], for which radiology, metrology, and measures of functional (dis)ability are tools[1,3]. Such measurements of damage and its functional consequences should, however, be distinguished from measures of disease activity[1]. The assessment of disease activity in a predominantly axial disease such as AS is notoriously difficult and, as yet, no gold standard exists[1,4]. In contrast to the situation in rheumatoid arthritis (RA), laboratory indicators of disease activity reflect neither clinical activity nor radiological progression, and their use in AS is controversial[1]. In RA, a core set of disease activity measures has been introduced[5-7], providing an advance over previous techniques[8-10]. In AS, such experience is limited. The Newcastle Enthesis Index[11] and a previous Disease Activity Index (DAI)[12] have been described, but these either fail as true measurements of disease activity or have not been adequately validated. In addition, neither are fully comprehensive. For example, recent research at the Royal National Hospital for the Rheumatic Diseases (RNHRD) has demonstrated that fatigue is a major component of AS for many patients[13] and this should now be incorporated into any measurement of disease activity. A new and comprehensive index is therefore necessary. To this end, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), a self-administered instrument, has been developed.

Combining individual variables, which may have little value as single measures, into an index bestows a number of advantages, such as improved validity[3], avoidance of duplicity and increased sensitivity to change[6,14], producing a more powerful indicator of outcome[15]. Increased sensitivity of an index can provide statistical advantages and may

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substantially reduce the size of the required sample[3,15]. As stressed by Bombardier and Tugwell[16], measurement indices must satisfy 5 recognized validity criteria: content (the choice and relative importance of each component is appropriate for the purpose of the index); face (the methods of weighting and aggregating components into an index are sensible); criterion (the index produces consistent results that reflect the true clinical state of the patient); discriminant (the index detects the smallest clinically significant difference between and within patients); and construct (the index agrees with expected results based on the hypothesis of the investigator). A self-assessment instrument should be reliable, reproducible and reflect the entire spectrum of the disease severity. It needs, in addition, to be quick and simple to complete. Finally it has the advantage of providing an inexpensive method of obtaining clinical information that can be safely and frequently repeated.

MATERIALS AND METHODS

The index BASDAI was developed, on the basis of clinical experience, by a team of physiotherapists, research associates and rheumatologists, with a major input from patients with AS. The resulting instrument consists of 6 questions relating to 5 major symptoms relevant to AS: fatigue, spinal pain, joint pain/swelling, areas of localized tenderness and morning stiffness (Figure 1). The last is measured in terms of both quality (degree of stiffness) and quantity (length of time for which stiffness persists). BASDAI

BASDAI

The Bath Ankylosing Spondylitis Disease Activity Index

PLEASE PLACE A MARK ON EACH LINE BELOW TO INDICATE YOUR ANSWER TO EACH QUESTION, RELATING TO THE PAST WEEK.

(1) How would you describe the overall level of fatigue / tiredness you have experienced?

NONE _____ VERY SEVERE

(2) How would you describe the overall level of AS neck, back or hip pain you have had?

NONE _____ VERY SEVERE

(3) How would you describe the overall level of pain/swelling in joints other than neck, back or hips you have had?

NONE _____ VERY SEVERE

(4) How would you describe the overall level of discomfort you have had from any areas tender to touch or pressure?

NONE _____ VERY SEVERE

(5) How would you describe the overall level of morning stiffness you have had from the time you wake up?

NONE _____ VERY SEVERE

(6) How long does your morning stiffness last from the time you wake up?

0 hrs | 1/2 | 1 | 1 1/2 | 2 or more hrs

Fig. 1. The BASDAI.

requires patients to indicate the degree to which they have experienced these symptoms over the past week.

Ten centimetre visual analog scales (VAS) were used to measure the patient's response to each question as they allow maximum reliability, and sensitivity to change and improve the capacity of an index to elicit a range of responses across the entire scale. In accordance with previous work[17] the VAS were unmarked, except by the words "none" at the start and "very severe" at the end of each line. The exception was a 0–2 h time scale (marked at every quarter of an hour) used to measure quantity of morning stiffness. The time scale given for this measurement was derived from an analysis of retrospective data regarding duration of morning stiffness, in about 2000 patient questionnaires (unpublished data). From the range of possible answers ("over 4 hours" to "do not have morning stiffness") the mean response was found to be 30 min to 1 h. Thus 1 h was taken as the midpoint of the time scale, with 2 or more h being given the maximum score.

Each visual analog scale was scored from 0 to 10. The mean of the 2 scores relating to morning stiffness was taken, providing an aggregate score. Thus each symptom is given equal weighting. The resulting 0–50 score for the overall index was converted to a 0–10 scale to give the final BASDAI score.

A pilot questionnaire was given to a group of patients on a 3-week intensive physiotherapy course. Modifications to the index, such as the wording of questions and the inclusion of quality of morning stiffness were made as a result of patient feedback.

The final version of the BASDAI was completed by 4 sets of inpatients (n = 46) on 4 separate occasions during their physiotherapy course: Days 0, 1, 8 and 18. One hundred and eight other spondylitics, including RNHRD outpatients and members of various NASS (National Ankylosing Spondylitis Society) self-help groups also completed the instrument. This resulted in a total of 292 questionnaires completed by 154 patients.

As a means of comparison, the earlier Bath DAI[12] was given to patients each time they completed the BASDAI. In addition, the Newcastle Enthesis Index[11] was carried out by a physiotherapist on Days 8 and 18 of treatment with 25 inpatients. Both the DAI and the Newcastle Enthesis Index scores were converted to a 0–10 scale to enable direct comparison with the BASDAI.

User friendliness, test-retest reliability, score distribution and sensitivity to change were all analyzed for the BASDAI and were compared to results from the DAI and the Newcastle Enthesis Index. Reliability was assessed by testing the correlation between BASDAI scores taken at the same time of day on Days 0 and 1 of the inpatient course; appropriate use of the scale was ascertained from the range and mean of scores given by the total patient population (using the Day 0 score for the inpatient cohort); while sensitivity of the BASDAI to change was analyzed by a comparison of inpatient scores on Day 0 and Day 18 of treatment.

Possible redundancy within the index was tested for by analyzing the degree of association between scores given for each of the 6 questions.

Analysis of results was carried out using the UNISTAT statistical software on an IBM compatible PC. The Pearson correlation coefficient was used to perform correlations; the Wilcoxon signed rank test and the Kruskal-Wallis one way ANOVA for analyses of difference.

RESULTS

The mean age of the 154 patients (115 men: 39 women — a 2.9:1 ratio) who completed the BASDAI was 47.7 (SD 11.29; inpatients: 47.1, outpatients 47.9), with a mean age at disease onset of 23.0 (SD 7.81; inpatients: 23.8, outpatients: 22.6), and a mean disease duration of 24.7 years (inpatients: 23.3, outpatients 25.3).

The BASDAI was found by patients to be both a quick and simple index, taking between 30 s and 2 min to complete (mean: 67 s). The index proved to be highly reliable in terms of the consistency of inpatient scores measured 24 h apart (Day 0 of treatment: mean score = 5.434, SD 2.38; Day 1: mean score = 5.438, SD 2.24; r = 0.93; p <0.001).

The capacity of the BASDAI to elicit a range of responses across the scale was good, with a score range of 0.5–10 from the whole patient sample (n = 154), with a mean score of 4.31, SD 2.12 (Figure 2). The mean BASDAI score for the inpatients (5.06) was significantly higher than that of the outpatients (4.0; p = 0.005).

All of the individual symptoms showed good score distribution, with scores spread across at least 95% of the scale. Correlations between each set of symptom scores ranged between r = 0.34 ("fatigue" versus "joint pain") and r = 0.66 ("spinal pain" versus "localized tenderness"). The correlation between quality and quantity of morning stiffness was closer: r = 0.79.

The comparison of inpatient scores on Day 0 with those on Day 18 of physiotherapy showed the BASDAI to be sensitive to change. The mean scores for Days 0 and 18 were 5.31 (SD 1.74) and 4.46 (SD 2.21), respectively, reflecting a significant improvement over this period of treatment (p = 0.009; mean score change = −0.85 [16.4% improvement]; range = −4.0 to +2.1).

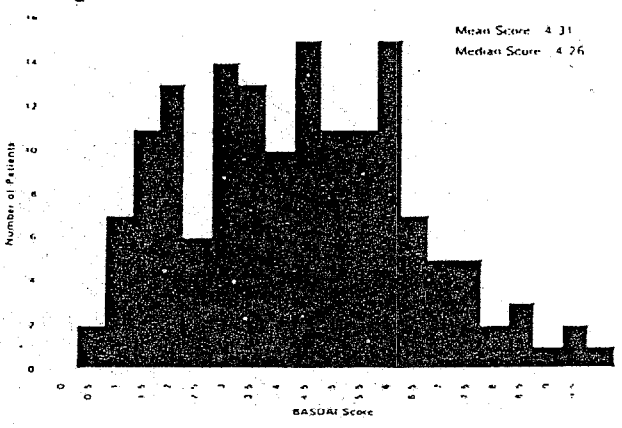

Fig. 2. The distribution of BASDAI scores among 154 patients (mean score = 4.31).

Table 1. *Comparison of DAI vs BASDAI in terms of the validity criteria analyzed*

	DAI	versus	BASDAI
Time (mean seconds)	75	NS	67
Reproducibility (Day 0 vs Day 1)	r = 0.96	NS	r = 0.93
Score distribution			
Mean:	4.12	NS	4.31
Range:	0–9.5		0.5–10
Sensitivity (Day 1 vs Day 18)			
Mean change:	−1.22 (p = 0.002)	NS	−0.87 (p = 0.009)
Range:	−6.3–+2.1		−4.0–+2.1
% Improvement:	22.8%		16.4%

The BASDAI correlated well with the DAI in all aspects of validity criteria (Table 1). However, a significantly higher number of patients ($\chi^2 = 7.21$, $p = 0.009$) felt that the BASDAI contained the most suitable questions for obtaining information on the symptoms of those with AS. Inpatients took a mean of 75 s (SD: 34.59) to complete the DAI which, like the BASDAI, was highly reliable (mean score on Day 0 of treatment = 5.38, SD 2.29; mean score on Day 1 = 5.66, SD 2.46: $r = 0.96$, $p < 0.001$). Score distribution across the scale was equal to that of the BASDAI (mean score = 4.12, SD 2.10; range = 0–9.5; Figure 3), and there was a good correlation between the 2 sets of scores ($r = 0.75$; $p < 0.001$). The mean inpatient DAI score (5.13) was again significantly higher than that of the outpatients (3.79; $p = 0.001$). The DAI reflected the sensitivity to change shown by the BASDAI, with mean inpatient scores improving from 5.34 on Day 0 of the 3 week course to 4.12 by Day 18 ($p = 0.002$; mean score change = −1.22 [22.8% improvement]; range = −6.3 to +2.1). There was no significant partiality among the patients for either the DAI or the BASDAI in terms of which questionnaire was the easiest to understand and complete, or overall questionnaire preference.

Among the cohort of 25 inpatients on whom the Newcastle Enthesis Index was also carried out, the BASDAI showed superior distribution of scores across the scale and greater sensitivity to change over 10 days of physiotherapy. The mean Enthesis Index score on Day 8 of treatment was 1.96, with a range of 0–5.33, compared to a mean BASDAI score of 5.06, with a range of 0.83–8.79. While the mean BASDAI score improved significantly from 5.06 to 4.15 by Day 18 of treatment ($p = 0.009$; mean score change = −0.91; range = −3.7 to +1.66), there was no comparable change in the Enthesis Index scores over this period (mean score on Day 8 = 1.96 vs mean on Day 18 = 1.79, $p = 0.35$; mean score change = −0.18; range = −1.73 to +1.22). Reliability of the Newcastle Enthesis Index has already been shown to be poor[11].

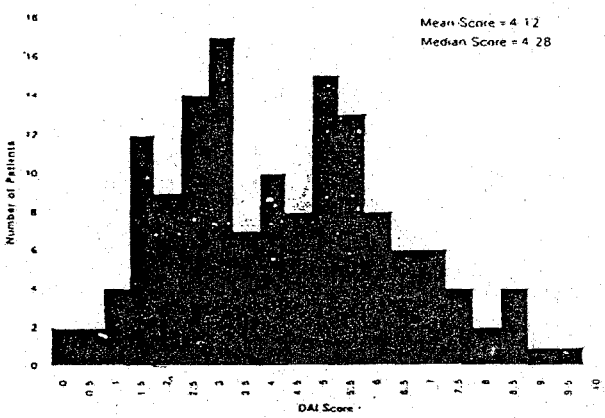

Fig. 3. DAI: The distribution of DAI scores among 154 patients (mean score 4.12).

DISCUSSION

The development of the BASDAI was stimulated by a dissatisfaction with existing measurements of disease activity. For example, the Newcastle Enthesis Index is inadequate. Specifically, it is very limited in content, focussing purely on the entheses, and thus does not fully address the range of symptoms in AS. It exhibits neither sufficient reliability, score range, nor sensitivity to change. A further (major) disadvantage of the measurement is that it requires a trained clinician or physiotherapist to perform the assessment and is thus expensive in terms of time and finance. Likewise, the earlier Bath DAI is not fully comprehensive. Specifically, it omits reference to fatigue, quality of morning stiffness and localized tenderness.

Naturally, the components included in any assessment instrument are not exhaustive, but represent only a few of the possible questions. If there is a very high correlation between the responses to 2 different questions, then the information obtained from one question mirrors that obtained from the other (internal redundancy). It is therefore possible to develop indices which adequately represent a dimension of disease (e.g., disease activity) without specifically addressing every possible question[18]. This is an important concept since there is an inverse correlation between the number of components included in an instrument and the accuracy of responses obtained[19].

The five components of the BASDAI were regarded as vital in ascertaining a comprehensive picture of a patient's disease activity. Fatigue, previously overlooked in AS, was included in the light of recent research concluding that it is an important and common symptom in this disease[8]. This research was a direct result of patient feedback. It was recognized that there are 2 main sources of pain in AS, spinal pain and pain in peripheral joints. These constitute separate symptoms and need to be measured as such. Localized tenderness was included in order to assess severity of enthesitis. Morning stiffness was recognized as having two significant aspects: not only is the length of time for which morning stiffness persists important, but the degree of stiffness should also be taken into account. For example, a patient with only 15 min of stiffness each morning but who suffers severe debility during this period is (arguably) as severely affected as a patient with stiffness for over 2 h each day but who suffers very little reduction of function as a result. The inclusion of both the quality and quantity of morning stiffness does not however give this symptom excess weighting in the index since an aggregate (mean) score is taken.

None of the individual components of the BASDAI correlated closely, signifying that none of the questions in the index are redundant and thus vindicating the inclusion of each symptom. The highest correlation in the index was, as expected, between the quality and quantity of morning stiffness ($r = 0.79$, $p < 0.001$). However, there was sufficient

noncorrelation to justify the inclusion of both aspects of the symptom (Figure 4).

Although, after validation, the DAI showed greater change over 3 weeks of treatment than did the BASDAI (22.8 vs 16.4% score improvement; NS), this may be a result of its bias towards pain and its inclusion of a scale measuring the patient's well-being. The score change is, arguably, more likely to be a reflection of the effects of the intensive physiotherapy program on these aspects than a greater sensitivity of the DAI to change in disease activity as a whole. The BASDAI does not differ from the DAI in any of the other areas analyzed (reliability, use of the scale and user friendliness), but is superior, from the perspective of both patients and clinicians, in terms of face and content validity, comprehensiveness of symptoms and their weighting. The BASDAI has, in addition, proved to be superior in all aspects to the Newcastle Enthesis Index as a measure of disease activity.

The difference apparent between the mean scores of the inpatients and outpatients for both the BASDAI and the DAI were predictable, since patients on an intensive hospital course would naturally tend to be those with worse disease.

The ability of the BASDAI to distinguish clinically significant differences in both inter and intrapatient responses (discriminant validity)[9] was shown by the total range of scores among patients, reflecting the entire disease spectrum, and further by the sensitivity of the index to change within patients on the 3-week physiotherapy course. The 16% (mean) improvement in the symptoms of those patients after 3 weeks of physiotherapy is likely to be of clinical significance. Further study is required however into the sensitivity of the index in relation to drug therapy. This may have a more dramatic effect on results than did the inpatient program of physiotherapy. Although there is no disease modifying drug for AS (in contrast to the perceived situation in RA), nonsteroidal antiinflammatory drugs do have a marked effect on symptoms and therefore on disease activity. BASDAI could thus be incorporated into clinical pharmaceutical studies.

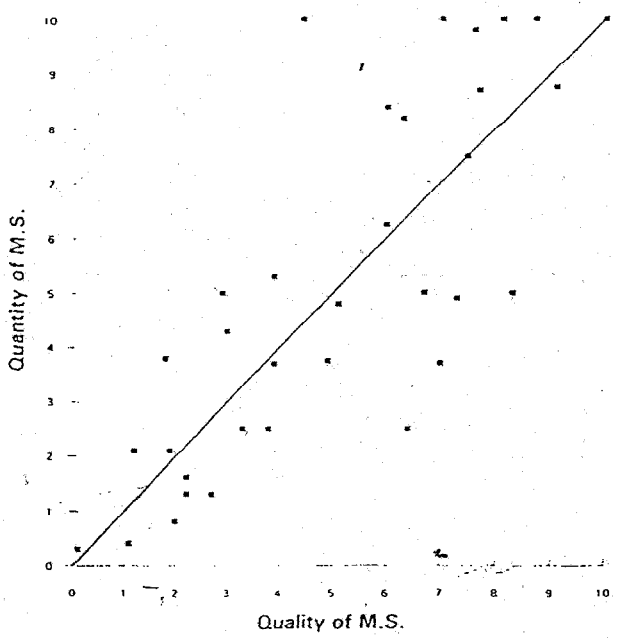

Fig. 4. Morning Stiffness: The degree of association between the quality and quantity.

In summary, BASDAI is a comprehensive new index for the measurement of disease activity in AS. It is user friendly, highly reliable, reflects the entire spectrum of disease and exhibits the ability to be sensitive to clinical changes. Most striking is its recognition of the five major symptoms experienced by patients with AS, some of which have not been addressed in previous measurements of disease activity. A more precise definition of disease activity will lead to an enhanced understanding of outcome and prognosis in AS[20].

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Defining Spinal Mobility in Ankylosing Spondylitis (AS). The Bath AS Metrology Index

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ABSTRACT. ***Objective.*** To determine the most appropriate clinical measurements for the assessment of ankylosing spondylitis (AS) and to develop the new metrology index.

Methods. One hundred and ninety-three individuals with AS were studied. The patients reflected the entire spectrum of cases of AS. Metrology was performed on 327 occasions. First the metrology (20 measurements) of 43 patients was analyzed. From this, 5 simple clinical measurements were defined which most accurately reflect axial status: cervical rotation, tragus to wall distance, lateral flexion, modified Schober's, and intermalleolar distance. These measurements were assessed for reliability, speed and both inter and intraobserver variability in another 40 patients.

Results. Analysis of the first group of 43 patients and a subsequent group of 54 patients, using the 5 measurements that constitute this new Bath AS Metrology Index (BASMI), demonstrated that they accurately and reliably mirror the 20 clinical measurements assessed previously ($r = 0.92$, $p < 0.001$). In a new group of 40 patients the measurements were demonstrated to be accurate and reproducible for both intraobserver variability ($r = 0.99$, $p < 0.001$) and interobserver variability ($r = 0.97$, $p < 0.001$). In a further 56 patients, admitted for inpatient therapy, an improvement in the BASMI from 3.34 (SD 2.71) to 2.16 (SD 2.42) was noted over a period of 3 weeks (regardless of disease severity) which indicates a sensitivity to change ($\chi^2 = 6.55$, $p < 0.01$). The mean improvement over baseline was about 30%.

Conclusion. Five clinical measurements provide a composite index (BASMI) and define disease status in AS. The BASMI is quick (7 min), reproducible and sensitive to change across the disease spectrum. (*J Rheumatol 1994;***21:1694–8**)

Key Indexing Terms:
METROLOGY INDEX SPINAL MOBILITY AXIAL STATUS
RELIABILITY SENSITIVITY DISEASE PROGRESSION

Disease status in ankylosing spondylitis (AS) can be defined by metrology, radiology, laboratory variables and functional capacity[1]. The relationship between these and disease activity, disease progression, and response to treatment remains unclear[2]. Limitation of spinal movement is an early feature of AS and its importance as a clinical sign is emphasized by its inclusion in the New York diagnostic criteria[3]. Methods of determining disease progression include sequential assessment of spinal mobility. Numerous physical measurements have consequently become widely used since the original assessments defined by Moll and Wright[4]. Frequently these measurements are not standardized or assessed for reliability, validity, or sensitivity to change[5].

Historically up to 20 separate measurements have been used in the assessment of patients with AS attending the Royal National Hospital for Rheumatic Diseases in Bath. The patient population encompasses the whole spectrum of disease in AS. Inpatient treatment is not restricted to those patients with severe disease but is considered appropriate for all patients including those with early disease. Regular and specific exercise therapy is considered necessary for patients with AS in order to maintain or improve their mobility and as a consequence their overall level of function and quality of life. Our aim was to determine the minimum number of clinically appropriate measurements that assess accurately axial status (i.e., cervical, dorsal and lumbar spine, hips and pelvic soft tissue) and from these derive a metrology index (the Bath Ankylosing Spondylitis Metrology Index; BASMI) to define clinically significant changes in spinal movement.

MATERIALS AND METHODS

In total 193 consecutive inpatients were studied, reflecting the entire spectrum of disease in AS, and metrology was performed on 327 separate occasions. First the metrology of 43 patients fulfilling the New York criteria[3] for definite AS was analyzed by a research team consisting of rheumatologists, physiotherapists and research associates with a specialist interest in AS. Intuitively, and following an extensvie review of the literature, 5 simple clinical measurements which were considered most accurately to reflect axial status were defined: cervical rotation, tragus to wall distance, lateral flexion, modified Schober's and intermalleolar distance.

In an attempt to relate clinically important changes in spinal mobility to function, further analysis of the 20 measurements resulted in a metrology

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table from which a total score of 0–10/patient could be derived (Table 1). Subsequent examination of the metrology on a further 54 patients was performed comparing the total metrology score of the 20 measurements versus the composite score (also with a range of 0–10) of the 5 measurements that comprise the BASMI (Table 2).

These measurements were assessed for interobserver, intraobserver variation and reliability. The observers were 3 physiotherapists, all of whom had experience in assessing AS. Twenty patients completed the interobserver assessments. Each patient was measured, using the 5 clinical measurements that form the BASMI, by each of the 3 observers separately with the removal of any skin markings following each assessment. The results were also documented separately so that the observers were blinded to their colleagues' results. The intraobserver assessments were determined by each of the 3 observers measuring a further 20 patients on consecutive days at about the same time. Measurements were recorded from mid-morning to allow for resolution of morning stiffness and were documented separately so that the observers were blinded to their previous results and those of their colleagues.

Cervical rotation was measured with a gravity action goniometer, the mean of right and left results being calculated. The patient lies supine in the neutral position and the goniometer is placed centrally on the forehead. The patient is then asked to turn the head as far as possible to the right and then to the left[6]. For measurements of the tragus to wall distance the patient stands with heels and buttocks touching the wall, knees straight, shoulders back and places the head as far back as possible, keeping the chin in[7]. Lateral spinal flexion is measured by fingertip to floor distance in full lateral flexion without flexing forward or bending the knees, using a rule mounted on a floor stand[5]. The patient bends laterally to push the middle finger of the right or left hand down the rule and the difference between start and end points is recorded and the mean calculated. Lumbar flexion is assessed by the Macrae and Wright modification of the Schober index[8]. A mark is placed at the lumbosacral junction, which is represented by the spinal intersection of a line joining the dimples of Venus. Further marks are placed 5 cm below and 10 cm above the lumbosacral junction. The patient is asked to bend forwards as far as possible, keeping the knees straight, and the distraction between these 2 marks is recorded. Intermalleolar distance is measured with the patient supine, the knees straight and the feet pointing straight up. The patient is asked to separate the legs as far as possible and the distance between the medial malleoli is measured[9].

A further 56 patients were assessed at the start and end of a 3 week hospital admission for an intensive exercise regimen in order to assess the BASMI for sensitivity to change over a short treatment period. Statistical analysis was performed through the UNISTATS programme on an IBM compatible PC, using Pearson's correlation coefficient and Kruskal-Wallis tests for reliability and sensitivity respectively.

Table 1. *Original metrology assessment (20 measurements)*

	Score 0	1	2
1. Tragus to wall	<15 cm	15–30 cm	> 30 cm
2. Lumbar flexion	> 4 cm	2–4 cm	< 2 cm
3. Intermalleolar distance	>100 cm	70–100 cm	< 70 cm
4. Cervical rotation (L)	> 70°	20–70°	< 20°
5. Cervical rotation (R)	> 70°	20–70°	< 20°
6. Lumbar side flexion (L)	> 10 cm	5–10 cm	< 5 cm
7. Lumbar side flexion (R)	> 10 cm	5–10 cm	< 5 cm
8. Cervical side flexion (L)	> 40°	10–40°	< 10°
9. Cervical side flexion (R)	> 40°	10–40°	< 10°
10. Fingers to floor	< 20 cm	20–40 cm	> 40 cm
11. Lumbar extension	> 1.5 cm	1.5–0.5 cm	< 0.5 cm
12. Cervical extension	> 40°	15–40°	< 15°
13. Cervical flexion	> 45°	20–45°	< 20°
14. Vital capacity	> 3.51	2.0–3.51	< 2.01
15. Chest expansion	> 6 cm	3–6 cm	< 3 cm
16. Height loss	0 cm	0–1 cm	> 1 cm
17. Shoulder flexion (L)	> 140°	110–140°	< 110°
18. Shoulder flexion (R)	> 140°	110–140°	< 110°
19. Shoulder abduction (L)	> 140°	100–140°	< 100°
20. Shoulder abduction (R)	> 140°	100–140°	< 100°

The original 20 metrology assessments with the scoring system: 0 = indicating mild disease involvement. 1 = moderate disease and 2 = severe disease involvement. (L = left side, R = right side). Scoring range = 0–10.

Table 2. *BASMI (bath ankylosing spondylitis metrology index)*

	Score 0	1	2
1. Tragus to wall	< 15 cm	15–30 cm	> 30 cm
2. Lumbar flexion	> 4 cm	2–4 cm	< 2 cm
3. Cervical rotation	> 70°	20–70°	< 20°
4. Lumbar side flexion	> 10 cm	5–10 cm	< 5 cm
5. Intermalleolar distance	> 100 cm	70–100 cm	< 70 cm

BASMI 0 indicates mild disease involvement, 1 = moderate disease and 2 = severe disease involvement. Results for cervical rotation and lumbar side flexion are the means of the left and right measurements. Scoring range 0–10.

RESULTS

The total metrology scores derived from 20 measurements on each of 43 patients (39 men: 4 women) were compared to the new BASMI. The mean age of this cohort was 45.9 years (SD 11.4 years), the mean age at symptom onset was 22.6 years (SD 7.8 years) and the mean disease duration 23.3 years. BASMI correlated with both age ($p < 0.01$) and the disease duration ($p < 0.004$) as did the total metrology score. (Age $p < 0.005$, disease duration $p < 0.002$.) The comparison between BASMI and the original 20 measurements gave a good correlation value ($r = 0.92$, $p < 0.001$) (Figure 1). To verify the reliability of the BASMI, the metrology of a 2nd cohort of 54 patients (40 men: 14 women), mean current age 43.4 years (SD 9.3), mean age at symptom onset 23.5 years (SD 7.51) and mean disease duration 19.7 years (SD 9.4) was analyzed. The BASMI compared favorably to the total metrology score ($r = 0.94$, $p < 0.001$).

The BASMI was assessed in another 20 patients for interobserver variation. The patients were measured independently by 3 physiotherapists. Cervical rotation ($r = 0.98$, $p < 0.001$), tragus to wall ($r = 0.99$, $p < 0.001$), lumbar side flexion ($r = 0.94$, $p < 0.001$), modified Schober ($r = 0.96$, $p < 0.001$), and intermalleolar distance ($r = 0.98$, $p < 0.001$) demonstrated little interobserver variation.

A further 20 patients were assessed for intraobserver variation. Cervical rotation ($r = 0.99$, $p < 0.001$), tragus to wall ($r = 0.99$, $p < 0.001$), lumbar side flexion ($r = 0.98$, $p < 0.001$), modified Schober ($r = 0.99$, $p < 0.001$), and intermalleolar distance ($r = 0.99$, $p < 0.001$) were found to be accurate and reproducible.

A 4th cohort of 56 patients completed the BASMI at the start (mean BASMI = 3.34, SD 2.71) and on completion of 3 weeks' inpatient treatment (mean BASMI = 2.16 SD 2.42). This change reflected an improvement of about 30%

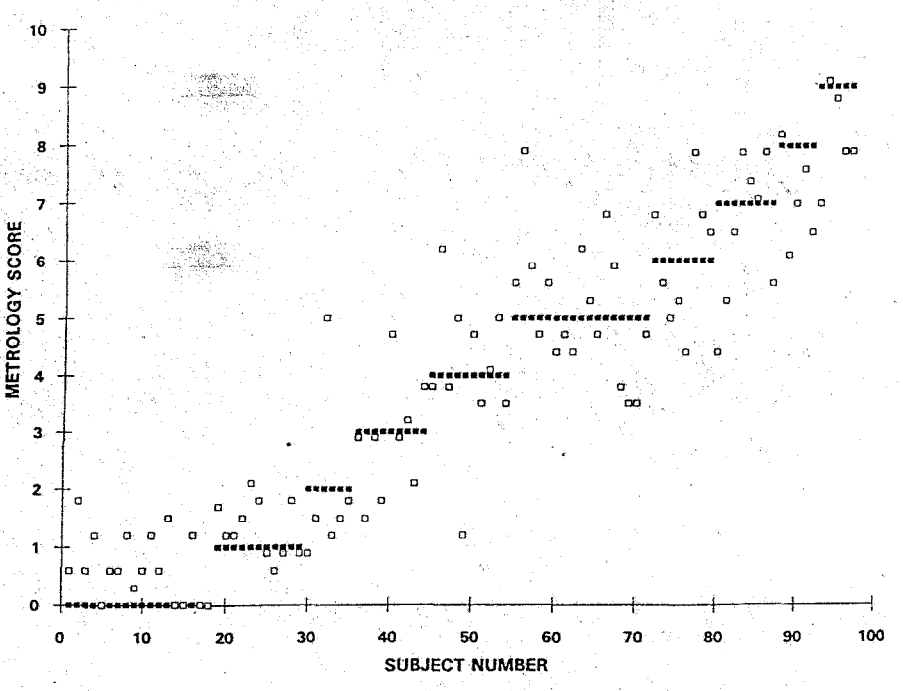

Fig. 1. A graph to show the relationship between BASMI and the original measurements in 97 patients ($r = 0.92$, $p < 0.001$). ■ BASMI score, □ = original assessment score (both on scale of 0–10).

over baseline. The mean current age of the cohort (46 men: 10 women) was 41.3 years (SD 10.1), mean age at symptom onset 21.5 years (SD 6.5) with a mean disease duration 19.9 years (SD 11.6). Seventy-one percent of the patients improved, 29% remained the same and no patients deteriorated over the 3 week treatment period (Figure 2). Of the 16 patients who failed to improve 8 had an initial BASMI score of 0, with a further 4 having an initial score of 3 or less out of 10.

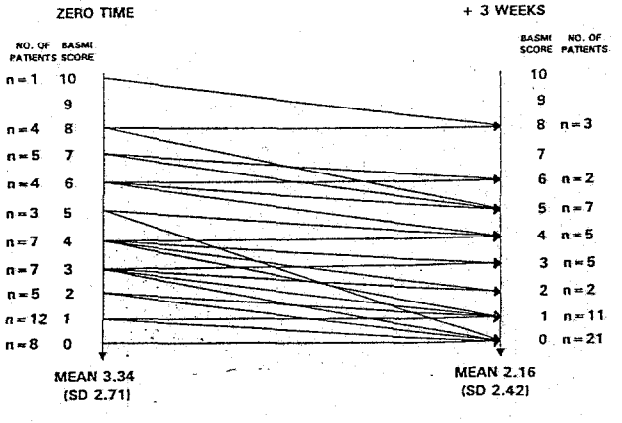

Fig. 2. A chart showing both the initial BASMI score of 56 patients at zero time and their score after 3 weeks of intensive inpatient physical therapy — 71% improved, 29% remained the same.

Table 3. *Inter and intraobserver reliability*

Interobserver Reliability Measurement	r Value	p Value
Tragus to wall	0.99	<0.001
Lumbar flexion	0.96	<0.001
Intermalleolar distance	0.98	<0.001
Cervical rotation	0.98	<0.001
Lumbar side flexion	0.94	<0.001
Intraobserver Reliability		
Tragus to wall	0.99	<0.001
Lumbar flexion	0.99	<0.001
Intermalleolar distance	0.99	<0.001
Cervical rotation	0.99	<0.001
Lumbar side flexion	0.99	<0.001

DISCUSSION

The present study was prompted by the numerous methods available for measuring spinal mobility as many of them are not validated or reliable and some require special instrumentation or radiography. There is a need for a standardized set of measurements that are simple to perform, reproducible and clinically relevant. Standardized serial measurement of spinal movement not only provides an accurate assessment of disease progression in AS, but will also provide improved evaluation during antirheumatic drug research[10]. The variability of the methods of assessment in use at the present time compromises research in this field. However, metrology remains an appropriate method of assessing response to treat-

ment as there is no universal agreement on the methods of measuring disease activity or function in AS[11]. In addition, it is possible that disease activity indices should be separated from those purporting to measure disease progression and its functional consequences[12].

With this in mind, a team of rheumatologists, physiotherapists and research associates with a specialist interest in AS undertook an extensvie review of the literature to determine those measurements found to be most reliable and clinically useful. The measurements considered most accurately to reflect axial status include cervical rotation, tragus to wall distance, lateral spinal flexion, modified Schober's, and intermalleolar distance.

Cervical rotation occurs at the atlantoaxial joint, is a reproducible measurement and is an important reflection of neck function[13]. Cervical rotation was measured with a gravity action goniometer and this method has been demonstrated to be simple, cheap, accurate and reliable[13]. Rotation can also be measured by means of a neck protractor; the neutral position being 0°, with the 90° mark over the acromioclavicular joints and a perpendicular line through the nose being the intercept[20]. This method has also been shown to be highly reproducible[5]. Although lateral cervical spine flexion is often reduced in AS, significant interobserver variations have been demonstrated in its measurement[15].

Tragus to wall distance is a measure of lower cervical spine flexion and upper thoracic kyphosis. It provides an accurate assessment of proximal axial disease progression and is highly reproducible[7].

Lateral spinal flexion occurs at the lower thoracic and the lumbar spine and is often the earliest movement restricted in AS[14]. The fingertip to floor distance on lateral flexion using a rule is considered to be the most reliable method of assessment[15]. Lumbar side flexion was initially found to be the most variable measurement. Attention has to be paid to the starting position and downward movement of the rule should be a consequence of lateral flexion only. Using trick movements patients can attempt to depress the rule by downward movement of the arm without lateral flexion. The difference between the start and end positions is recorded and the mean calculated. This ensures that the assessment is not affected by the initial position of the rule which can be influenced by the degree of kyphosis of the patient. Once these practical changes were adhered to, lumbar side flexion was found to be as reliable as the other measurements used in the index.

Fingertip to floor distance was originally described as a measurement of erector spinae and hamstring extensibility, and includes not only spinal movement but also hip mobility, posterior leg muscle and ligament tightness[21]. Although it has been shown to be a reproducible measurement, it is invalid as a measure of vertebral flexion and is of little value in the spinal assessment of AS[22]. As a result lumbar spine flexion is assessed by the modified Schober Index[8,17].

The hip is the most commonly involved joint in AS, with insidious loss of movement and function, often resulting in more incapacity than a rigid spine. Unfortunately, assessment of the hip is often neglected in the assessment of AS. Furthermore standard assessments using goniometric measurements are unreliable. We have therefore used intermalleolar straddle as a simple and accurate method of assessing the hip and pelvic soft tissues.

Historically, up to 20 separate clinical measurements have been performed as part of the AS metrology assessment. Not only is this expensive in terms of valuable physiotherapy time but many of the measurements have not been assessed for reliability. We have demonstrated, in 2 separate cohorts totalling almost 100 patients, that our new metrology score (BASMI) mirrors the information given by a much larger number of measurements and is an accurate reflection of axial status ($p < 0.001$). In addition, our results confirm the inter and intraobserver reliability of cervical rotation, tragus to wall distance, lumbar flexion and intermalleolar distance.

Furthermore, the BASMI demonstrates sensitivity to change across the whole disease spectrum, including those patients with severe disease of long duration. This is important as it is often considered that the disease causes most of its disability during the first decade after diagnosis and that response to treatment in late disease is limited[18]. Small improvements may be clinically important if they represent reversal of a deteriorating trend over a 30 year course[19]. Almost half of the patients (14%) showing no improvement began the treatment with a BASMI score of zero. The improvement noted in 71% of patients occurred within a 3 week period of intensive exercise and physiotherapy.

In conclusion, (1) 5 simple clinical measurements provide a composite score (BASMI) and define disease status in AS and (2) this metrology score is quick (7 min), valid, reliable, reproducible and is sensitive to change across the disease spectrum. Further studies are required to address the relationships between metrology, radiology, disease activity, and function.

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A New Dimension to Outcome: Application of The Bath Ankylosing Spondylitis Radiology Index

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ABSTRACT. Our aim was to develop a reproducible and simple radiological scoring system for ankylosing spondylitis (AS) to use in cross sectional and prospective studies. Regarding validation of the BASRI (Bath Ankylosing Spondylitis Radiology Index), radiographs of 470 patients with AS were scored using the New York criteria for the sacroiliac joints. The lumbar and cervical spine, and hips were similarly graded 0–4. These scores were added together to give BASRI-t (total) and if the hips are excluded to give BASRI-s (spine). Radiographs of 188 patients were used to test reproducibility. Blinded radiographs of 89 non-AS patients were included randomly to assess disease specificity. Sensitivity to change was assessed using 177 radiographs from 40 patients. Regarding the cross sectional study, 2200 radiographs of 550 (104 F:446 M) patients were randomly selected and scored using BASRI. The frequency distribution of BASRI-t and BASRI-s were plotted using a probit plot. Inter and intraobservation showed between 73 and 82% and 73 and 88% complete agreement, with specificity of 0.78–0.89, suggesting scores are disease-specific. Sensitivity to change became apparent at 2 years ($p < 0.05$). Scoring required 30 seconds to complete. BASRI-t was found to be normally distributed using a probit plot. The mean BASRI scores (total, spinal, hip) increased with disease duration. The correlation, however, was poor ($r = 0.293$, 0.347, 0.263, respectively). Those with hip involvement had more severe spinal disease ($p < 0.0001$). Men had more severe spinal disease than women ($p < 0.0001$). We conclude BASRI is a reliable and rapid method to grade radiographic changes in AS. Using this scoring system it can be seen that AS is a slowly progressive disease with much individual variation. Hip patients have more severe spinal disease than those without hip involvement and men have more severe spinal disease than women. (J Rheumatol 1999;26:988–92)

Key Indexing Terms:
ANKYLOSING SPONDYLITIS RADIOLOGY BASRI OUTCOME

Ankylosing spondylitis (AS) is a chronic inflammatory progressive disorder mainly affecting the axial skeleton and the peripheral joints. The disease is a result of interaction between genetic and environmental triggers. A number of measures can be used simultaneously to monitor outcome and these are fundamental in assessing the natural history of AS[1-6]. Characteristic radiological appearances at the sacroiliac (SI) joints are essential for diagnosis of AS[7], but no classification completely defining axial and hip radiological change exists in AS. The Bath Ankylosing Spondylitis Radiology Index-total (BASRI-t) is a new system for scoring radiological change for the spine and hip in AS[8]. Results can be divided into Bath Ankylosing Spondylitis Radiology Index-spine (BASRI-s), which combines the scores of the SI joints, lumbar spine, and the cervical spine, and the BASRI-hip (BASRI-h). We describe BASRI-t, BASRI-s, and BASRI-h and demonstrate their value in a cross sectional study.

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MATERIALS AND METHODS

Validation of BASRI. Existing Radiographs of 470 patients, diagnosed using the New York criteria for AS, were used to develop the method. They were scored openly and placed in one of 5 severity grades based on the NY scale for SI joint disease. The radiographs were an anteroposterior (AP) pelvis, an AP and lateral lumbar spine, and a lateral cervical spine. The lumbar spine was defined as extending from the lower border of T12 to the upper border of S1, and the cervical spine from the lower border of C1 to the upper border of C7. The discriminating features of each group were defined and used as the basis to describe a method of assessing severity of radiological change in AS. The system was then repeatedly tested in a blinded fashion by 3 experienced readers and modified openly on several occasions before a final format was agreed on. Rules for scoring the lumbar, cervical and hip radiographs are shown in Table 1.

To assess whether AP or lateral radiograph was more appropriate, 58 sets of lumbar and cervical spine radiographs with both AP and lateral views were scored using (1) AP alone, (2) the lateral alone, and (3) both views' contribution (as a composite score). Sensitivity and specificity for each view was determined and compared to Score 3.

After definition of the scoring system, radiographs of 188 consecutive patients with AS and 89 without AS were scored randomly and blindly by the 3 readers to validate BASRI. The mean age of the population was 44.5 ± 10.9 years and the sex ratio 3:1 (M:F), disease duration = 23 years. Assessment included inter and intraobserver variation, sensitivity to change over a yearly period (1, 2, 3 yrs, etc.), and specificity (cutoff of grade 2 = definite disease). The non-AS cohort studies were consecutive outpatients attending the Royal National Hospital for Rheumatic Diseases and had

Table 1A. BASRI-spine.

Score	Grade	System Applies to Both Lumbar and Cervical Spine
0	Normal	No change
1	Suspicious	No definite change
2	Mild	Any number of erosions, squaring, sclerosis ± syndesmophytes on ≤ 2 vertebrae
3	Moderate	Syndesmophytes on ≥ 3 vertebrae ± fusion involving 2 vertebrae
4	Severe	Fusion involving ≥ 3 vertebrae

Table 1B. BASRI-hip.

Score	Grade	Description
0	Normal	No change
1	Suspicious	Focal joint space narrowing
2	Mild	Circumferential joint space narrowing > 2 mm
3	Moderate	Circumferential joint space narrowing ≤ 2 mm or bone-on-bone apposition of <1 cm
4	Severe	Bone deformity or bone-on-bone apposition ≥1 cm

NB: Increase the grade by 1 if 2 of 3 of the following bony changes are present: erosions, osteophytes, protrusion.

pelvic radiographs taken. Their mean age was 57.9 ± 16.8 years, sex ratio 1:3 (M:F). The cohort included 41 rheumatoid arthritis, 21 mechanical back pain, 10 fibromyalgia, 10 osteoporosis, 7 psoriatic arthritis.

Cross sectional study. We randomly selected and scored 2200 sets of films of 550 (4:1, M:F) patients with AS using BASRI-t. The frequency distributions of BASRI-t and BASRI-s were plotted using a probit plot to establish parametric distribution. The probit plot is a scatter diagram that is linear if data are normally distributed and curved if they are not. Of the 550 patients, there were 423 with known disease duration.

Statistical methods. For validation of BASRI: The data were nonparametrically distributed; therefore an unweighted kappa statistic was used to determine the significance of inter and intraobserver variability. The Wilcoxon signed rank test was used to assess significance of change over time. For the implementation of BASRI: correlations were established using Pearson's correlation coefficient for normally distributed variables or Spearman's rank order for non-normally distributed variables. Independent t tests or Wilcoxon rank sum test and chi-squared were used to evaluate mean scores. The SPSS software program was used for all analyses.

RESULTS

Lumbar spine: which film should be used. Using 58 sets of AP and lateral lumbar spine radiographs, 3 scores were derived as described above. The combination score differed from both the AP and lateral scores if syndesmophytes or fusion was seen at different levels on each projection and occurred in 3/58 cases. The combination score differed from the AP alone in 9/58 (16%) cases and the lateral alone in 21/58 (36%) cases. Over all, the use of 2 projections changed the score 46% of the time.

Intraobserver variation. The complete agreement and kappa scores were (Table 2): 86% agreement (kappa 0.69) for the SI joints, 75% agreement (kappa 0.65) for the lumbar spine, 81% agreement (kappa 0.73) score for the cervical spine, and 87 and 88% agreement (kappa 0.70 and 0.75) for the right and left hip.

Interobserver variation. Reproducibility between readers revealed 78% agreement (kappa 0.55) for the SI joints, 73% agreement (kappa 0.64) for the lumbar spine, 79% agreement (kappa 0.69) for the cervical spine, and 82 and 78% agreement (kappa 0.64 and 0.57) for the right and left hip.

Disease specificity. To validate lumbar and cervical spine, radiographs of 89 non-AS outpatients were scored. For the hip component 51 non-AS outpatients were scored. Grade 2 was taken as the cutoff. A sample of 188 patients with AS was used (disease duration = 23 yrs; age 44.5 ± 10.9). Specificity for the lumbar spine was 0.89, for the cervical spine it was 0.83, and for the hips 0.78.

Table 2. Summary of inter and intraobserver variation in BASRI-total.

Skeletal Site	Intraobserver Variation		Interobserver Variation	
	Complete Agreement, %	Kappa	Complete Agreement, %	Kappa
SI joints	86	0.69	78	0.55
Lumbar spine	75	0.65	73	0.64
Cervical spine	81	0.73	79	0.69
Hips	87	0.70	78	0.57

Sensitivity to change. Serial radiographs of 40 patients were scored over 177 time intervals (4.4 intervals/patient). All radiographs were blinded for the name and date of radiograph. Scoring was performed by a single observer. The patients were assessed over a time period of one year [years between radiographs: 1 yr (n = 24), 2 yrs (n = 31), 3 yrs (n = 30), 4 yrs (n = 26)]. A significant change in radiological score ($p < 0.05$) at 2 years was observed for the SI joints, lumbar and cervical spine, and the hips. The magnitude of change for the BASRI-spine was from 7.0 to 7.9 in a 2 year period. Forty-two percent of patients had a change in BASRI-s score in a 2 year period. The smallest detectable difference between scores over a 2 year period is a change in BASRI-s of 0.5, i.e., 0.5 change in SI joints score, and a change in score of 1 for the lumbar spine and cervical spine.

Frequency distribution of BASRI-t and BASRI-s. BASRI-t was normally distributed using a probit plot. BASRI-s was not normally distributed.

Cross sectional study. The mean BASRI-t and BASRI-s scores over 5 year intervals were plotted against disease duration (Figure 1). Correlation was poor: $r = 0.293$, $p < 0.01$ and $r = 0.347$, $p < 0.01$, respectively.

BASRI-s for those patients with hip disease (n = 101) and those without (n = 322) was plotted against disease duration (Figure 2). The BASRI-s was higher for those with hip disease ($p < 0.0001$). There was no difference in disease duration between the 2 groups (20 and 21 yrs, respectively; $p < 0.2$).

The mean BASRI-t was higher for men (n = 351) than for women (n = 72) (8.9 vs 7.2, respectively; $p < 0.0001$). Disease duration was comparable (20 vs 21 yrs; $p < 0.27$) (Figure 3). More men than women had severe disease in the SI joints (odds ratio, OR = 1.74; 95% confidence interval, CI, 1.1–2.7; $p < 0.016$). More men than women had severe lumbar spine disease (OR = 2.6, 95% CI 1.4–4.6; $p < 0.001$). More men than women had severe cervical spine disease (OR = 2.3, 95% CI 1.3–3.9; $p < 0.002$). The numbers of men and women with severe hip disease were comparable at all stages of disease.

DISCUSSION

The BASRI is reproducible, with inter and intraobserver variation equivalent to or better than the NY criteria. The BASRI was found to be sensitive to change over a 2 year period, which suggests radiographs at intervals of less than 2 years are not warranted. The BASRI was easy to use; the mean time taken to score a set of radiographs was less than 30 seconds. To maintain simplicity, BASRI does not pick up minor radiological change. The score does not change with each additional erosion or sclerosis, and will always remain grade 2 or mild disease until there is fusion between 2 vertebrae or ≥ 3 syndesmophytes are identified.

The changes in BASRI-t and BASRI-s over time may

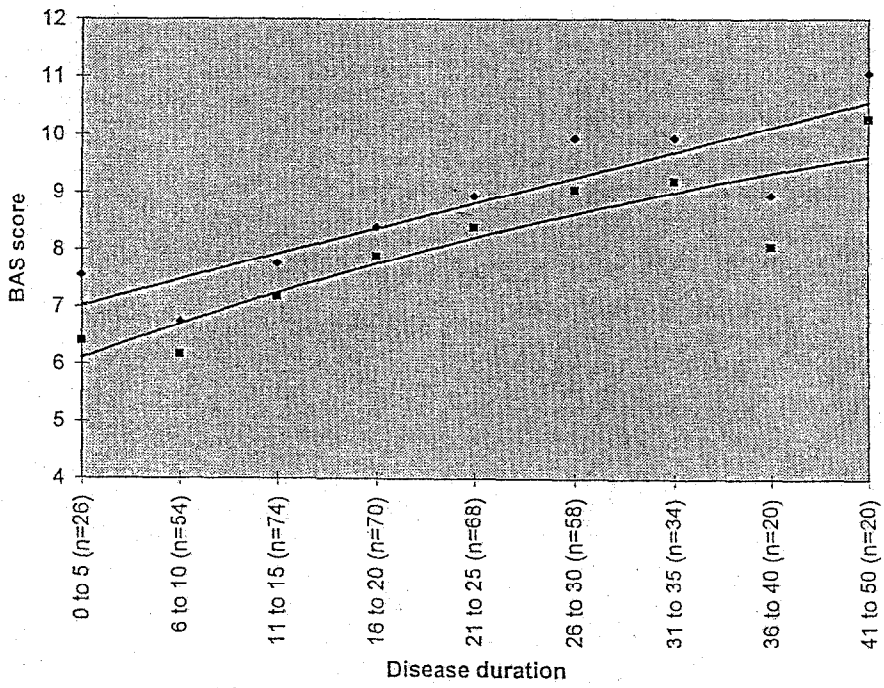

Figure 1. BASRI-total and BASRI-spine versus disease duration (n = 423). ◆ BASRI-t, r = 0.293. ■ BASRI-s, r = 0.347.

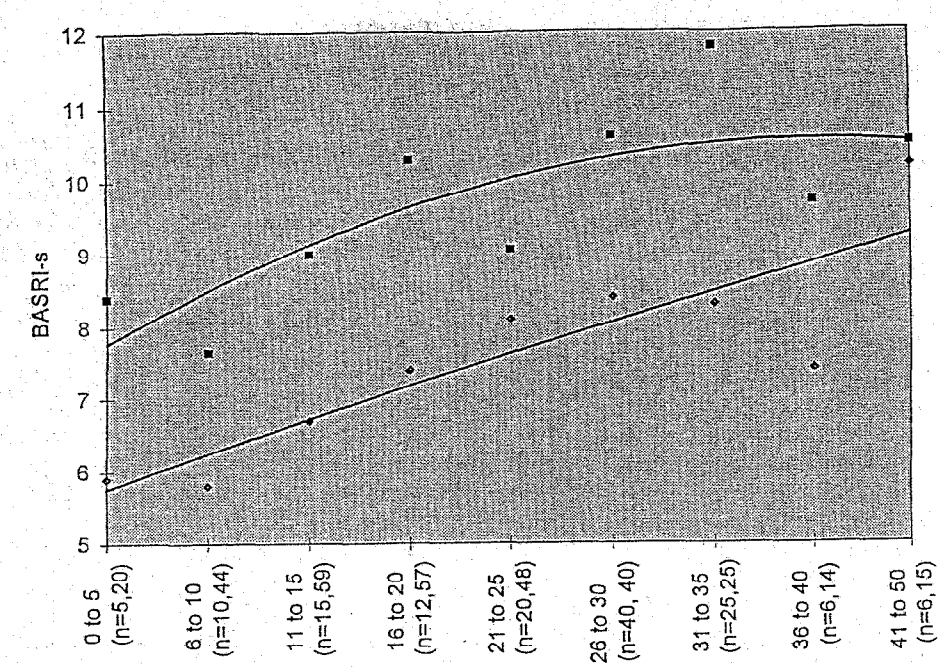

Figure 2. BASRI-spine — patients with hip disease (n = 101) versus no hip disease (n = 322). ■ BASRI-s (H). ◆ BASRI-s (NH). $p < 0.001$.

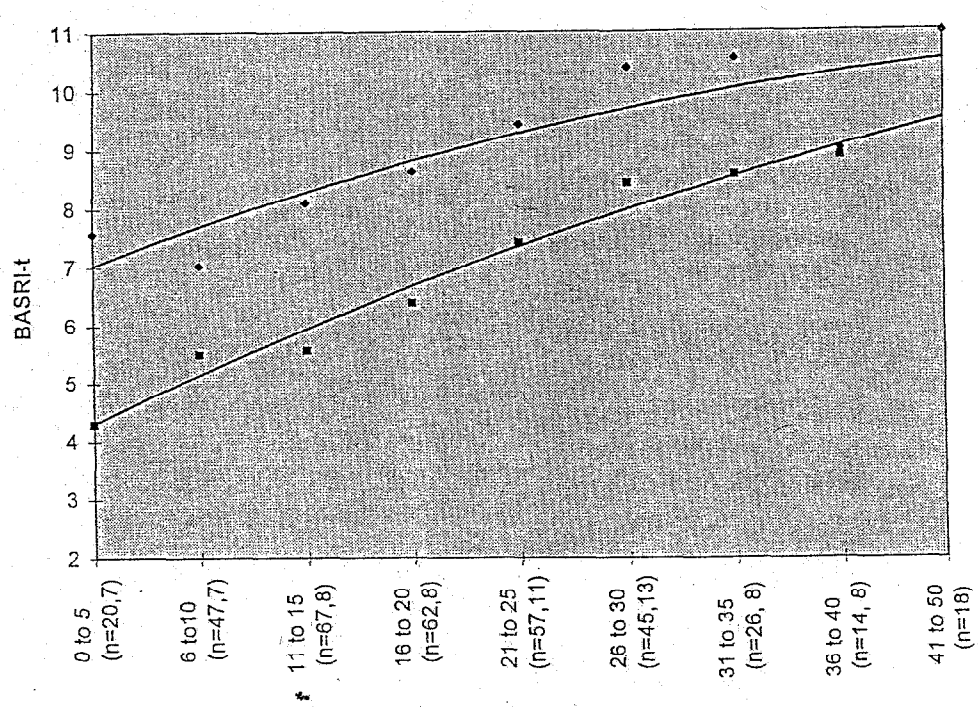

Figure 3. BASRI-total — radiology of men (n = 354) versus women (n = 72). ◆ Male. ■ Female. $p < 0.0001$.

indicate that AS is a slow progressive disease, or of course, that BASRI is too insensitive to pick up clinically relevant change. However, lack of correlation between BASRI scores and disease duration shows that outcome is extremely variable for different individuals. The change in BASRI-s in patients with and without hip involvement shows that patients with hip disease have more severe axial disease. This supports other studies that suggest hip involvement is predictive of more severe disease[9]. Comparison of male versus female has shown that men have more severe disease in the SI joints, lumbar spine, and the cervical spine, but not in the hips. Clearly, clinical significance does not equate with statistical significance. Further studies will be required to define the value of these findings.

The correlation of severity with disease duration is poor if taken individually. In the scoring of the lumbar spine, only half the patients develop severe disease after 45 years. For the cervical spine, 25% never develop any cervical involvement.

In conclusion, radiology is fundamental to diagnosis and progression of AS. Apart from the New York criteria for the SI joints, no widely accepted radiological criteria exist. BASRI as a radiological classification system is a valuable tool that is reproducible, specific, sensitive to change at 2 years, simple, and fast to use. Using the BASRI in cross sectional study of AS shows that this is a slowly progressive disease with much individual variation. Some of this variation can be accounted for: patients with hip involvement have more severe spinal disease and men have more spinal involvement than women. In conclusion, BASRI is an important outcome measure joining the metrology index (BASMI)[1], functional index (BASFI)[3], disease activity index (BASDAI)[5], and global score (BAS-G)[6] in the assessment of our patients.

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QUESTIONNAIRE FOR ANKYLOSING SPONDYLITIS

Any information you give is confidential and will be seen only by Dr Calin and co-workers at the Royal National Hospital for Rheumatic Diseases, Bath

PLEASE PRINT

FULL NAME: _____ **DATE:** _____

ADDRESS _____ **SEX:** _____

_____ **MARITAL STATUS:** _____

_____ **DATE OF BIRTH:** _____

HOME TELEPHONE NO.: _____ **WORK TELEPHONE NO.:** _____

NAME OF GP: _____ **TELEPHONE NO. (GP):** _____

ADDRESS OF GP: _____

OFFICE USE ONLY

1.a) When did your ankylosing spondylitis (AS) begin?

(Year and age) _____

b) When was the diagnosis of AS made?

(Year and age) _____

c) Have you ever seen a rheumatologist YES/NO

(a specialist in arthritis or AS)?

If YES, on average, how many visits do you make to your rheumatologist per year because of your AS? _____

d) Have you ever had X-rays taken of your back? YES/NO

e) If YES, please say when and where the most recent ones were taken:

When: _____

Where: _____

2. What level of education have you reached? (*Please tick each relevant box*)

Education Level	
O'Level standard (incl. CSEs, GCSEs etc.)	
A'Level standard (incl. BTEC, Scottish Highers etc.)	
Higher Education (incl. degree, diploma, HND etc.)	

OFFICE USE ONLY

3.a.i) Are you currently employed? (incl. self-employed) YES/NO

ii) Occupation when employed (*if housewife / husband, please state*).

_____

b) If YES (for **3.a.i**), how much time off work have you had per year because of your AS?

None	
Less than 1 week	
1 - 4 weeks	
1 - 3 months	
More than 3 months	

c) If NO (for **3.a.i**), are you:

(i) Unemployed & intending to work	
(ii) Retired	

d.i) If RETIRED, at what age did you retire? _____

d.ii) What is the usual age of retirement for your occupation? _____

e) Are you UNEMPLOYED / RETIRED:

Solely because of your AS?	
Partly because of your AS?	
For reasons other than your AS?	

4. In your opinion, which is the main symptom of your AS? (please tick one)

Fatigue	
Spinal pain (neck/back/hip)	
Stiffness	
Joint pain / swelling	
Areas tender to touch/pressure	
Other (please specify)	
Cannot distinguish one main symptom	

OFFICE USE ONLY

5.a) Do you get iritis (uveitis)? YES/NO

If YES, who made the diagnosis?

GP	
Rheumatologist	
Eye specialist	
No doctor	

b) Have you had any treatment for it? YES/NO

Please specify: _____

c) Approximately how many attacks have you had overall? _____

d) Approximately how many attacks do you have per year? _____

e) When was your last attack? _____

f) Has the uveitis resulted in persistent deterioration of vision? YES/NO

6.a) Do you get psoriasis? YES/NO

If YES, who made the diagnosis?

GP	
Rheumatologist	
Skin specialist	
No doctor	

b) Have you had any treatment for it? YES/NO

Please specify: _____

7. Have you ever been diagnosed as having:

a) Crohn's disease YES/NO

b) Ulcerative colitis YES/NO

If YES, who made the diagnosis?

	(a)	**(b)**
GP		
Rheumatologist		
Gastroenterologist		
No doctor		

OFFICE USE ONLY

8. Have you had during the past year unexplained (i.e. not due to an accident or injury) pain or swelling in any of the following joints? (*please circle the relevant joint/s*):

1. HAND 2. ELBOW 3. SHOULDER 4. HIP

5. KNEE 6. ANKLE 7. FOOT 8. HEEL

9.a) Have you ever had surgery for your joints or spine as a result of your AS?

YES/NO

b) If YES, please specify the type of surgery and give year(s):

_____

_____

10.a) For how many hours per week on average have you taken part in sports, AS exercises or hydrotherapy during the last three months?

10 or more hours	
5 - 9 hours	
2 - 4 hours	
1 hour	
0 hours	

b) Place a vertical mark on the scale below to indicate the effectiveness which your exercise has on relieving your symptoms: (*see *example on back page*)

NONE _____ VERY EFFECTIVE

11.a) Place a vertical mark on the scale below to indicate the effect your disease has had on your well-being over the last week:

NONE _____ WORST POSSIBLE

b) Place a vertical mark on the scale below to indicate the effect your disease has had on your well-being over the six months:

NONE _____ WORST POSSIBLE

OFFICE USE ONLY

12.a) Are you currently taking any medication for your AS? YES/NO

If YES, please give the name and dosage that is on the bottle or packet:

_____

b) For how long have you regularly used this (or similar) medication?

_____

c) Place a vertical mark on the line below to indicate the effectiveness of the medication in relieving your symptoms

NO EFFECT _____ VERY EFFECTIVE

13. PLEASE PLACE A MARK ON EACH LINE BELOW TO INDICATE YOUR ANSWER TO EACH QUESTION, RELATING TO THE PAST WEEK.

1) How would you describe the overall level of fatigue / tiredness you have experienced?

NONE _____ VERY SEVERE

2) How would you describe the overall level of AS neck, back or hip pain you have had?

NONE _____ VERY SEVERE

3) How would you describe the overall level of pain/swelling in joints other than neck, back or hips you have had?

NONE _____ VERY SEVERE

4) How would you describe the overall level of discomfort you have had from any areas tender to touch or pressure?

NONE _____ VERY SEVERE

5) How would you describe the overall level of morning stiffness you have had from the time you wake up?

NONE _____ VERY SEVERE

6) How long does your morning stiffness last from the time you wake up?

0 hrs | 1/2 | 1 | 1 1/2 | 2 or more hrs

14. PLEASE PLACE A MARK ON EACH LINE BELOW TO INDICATE YOUR LEVEL OF ABILITY WITH EACH OF THE FOLLOWING ACTIVITIES DURING THE PAST WEEK:

N.B. An aid is a piece of equipment which helps you to perform an action or movement

1) Putting on your socks or tights without help or aids (e.g. sock aid)

EASY _____ IMPOSSIBLE

2) Bending forward from the waist to pick up a pen from the floor without an aid

EASY _____ IMPOSSIBLE

3) Reaching up to a high shelf without help or aids (e.g. helping hand)

EASY _____ IMPOSSIBLE

4) Getting up out of an armless dining room chair without using your hands or any other help

EASY _____ IMPOSSIBLE

5) Getting up off the floor without help from lying on your back

EASY _____ IMPOSSIBLE

6) Standing unsupported for 10 minutes without discomfort

EASY _____ IMPOSSIBLE

7) Climbing 12 - 15 steps without using a handrail or walking aid. **One foot on each step**

EASY _____ IMPOSSIBLE

8) Looking over your shoulder without turning your body

EASY _____ IMPOSSIBLE

9) Doing physically demanding activities (e.g. physiotherapy exercises, gardening or sports)

EASY _____ IMPOSSIBLE

10) Doing a full day's activities whether it be at home or at work

EASY _____ IMPOSSIBLE

OFFICE USE ONLY

15.a) Are you a **twin**? YES/NO

If YES, are you: *i. IDENTICAL / ii. NON-IDENTICAL ?

(**delete as applicable*)

b) Are there any (other) twins in your family? YES/NO

If YES, please state their relationship to you:

_____

16. Do you have any **brothers or sisters**? YES/NO

If YES, Please state their age(s) and sex:

Age _____ Sex _____ Age _____ Sex _____

Age _____ Sex _____ Age _____ Sex _____

17. Do you have any **children**? YES/NO

If YES, please state their age(s) and sex:

Age _____ Sex _____ Age _____ Sex _____

Age _____ Sex _____ Age _____ Sex _____

18.a) To your knowledge, do any members of your family have ankylosing spondylitis?

If YES, please state which relative(s): _____

We would like to contact any of the above relatives who have ankylosing spondylitis. Please would you ask any such relatives if they would be willing to participate in our study and let us see any medical records or X-rays relating to their disease. On the following page you will find space for you to fill out the names and addresses of any such relatives.

****

Please sign here if you give us permission to contact **YOUR** general practitioner, hospital consultant or view your X-rays.

Signed _____ Date _____

DETAILS OF RELATIVES WITH ANKYLOSING SPONDYLITIS

YOUR NAME _____

The relatives named below may be contacted and invited to participate in the study.

Name of relative with **ankylosing spondylitis:** _____

Relationship to you: _____

Address of relative: _____

_____

Name of relative with **ankylosing spondylitis:** _____

Relationship to you: _____

Address of relative: _____

_____

N.B. The results of the on-going research for which this data is vital, are published in the twice-yearly newsletter of the National Ankylosing Spondylitis Society (NASS).

Fergus Rogers, Director of NASS

PO Box 179, Mayfield, East Sussex TN20 6ZL

If you have any queries or suggestions regarding our research into AS, we would be pleased to hear from you.

THANK YOU FOR YOUR HELP

_____

* **EXAMPLE:**

EASY _____/_____ IMPOSSIBLE

The Bath Ankylosing Spondylitis Functional Index (BASFI)

PLEASE DRAW A MARK ON EACH LINE BELOW TO INDICATE YOUR LEVEL OF ABILITY WITH EACH OF THE FOLLOWING ACTIVITIES DURING THE PAST WEEK:

EXAMPLE:

EASY ——|—— **IMPOSSIBLE**

N.B An aid is a piece of equipment which helps you to perform an action or movement

1) Putting on your socks or tights without help or aids (e.g sock aid)

EASY _____ IMPOSSIBLE

2) Bending forward from the waist to pick up a pen from the floor without an aid

EASY _____ IMPOSSIBLE

3) Reaching up to a high shelf without help or aids (e.g helping hand)

EASY _____ IMPOSSIBLE

4) Getting up out of an armless dining room chair without using your hands or any other help

EASY _____ IMPOSSIBLE

5) Getting up off the floor without help from lying on your back

EASY _____ IMPOSSIBLE

6) Standing unsupported for 10 minutes without discomfort

EASY _____ IMPOSSIBLE

7) Climbing 12 - 15 steps without using a handrail or walking aid. **One foot on each step**

EASY _____ IMPOSSIBLE

8) Looking over your shoulder without turning your body

EASY _____ IMPOSSIBLE

9) Doing physically demanding activities (e.g physiotherapy exercises, gardening or sports)

EASY _____ IMPOSSIBLE

10) Doing a full days activities whether it be at home or at work

EASY _____ IMPOSSIBLE

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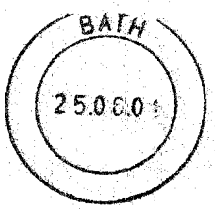

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