
DRUG THERAPY IN

Rheumatology Nursing

Second Edition

Edited by
SARAH RYAN



John Wiley & Sons, Ltd

DRUG THERAPY IN

Rheumatology Nursing

DRUG THERAPY IN

Rheumatology Nursing

Second Edition

Edited by
SARAH RYAN



John Wiley & Sons, Ltd

Copyright © 2007

John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester,
West Sussex PO19 8SQ, England

Telephone (+44) 1243 779777

Email (for orders and customer service enquiries): cs-books@wiley.co.uk

Visit our Home Page on www.wiley.com

All Rights Reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except under the terms of the Copyright, Designs and Patents Act 1988 or under the terms of a licence issued by the Copyright Licensing Agency Ltd, 90 Tottenham Court Road, London W1T 4LP, UK, without the permission in writing of the Publisher. Requests to the Publisher should be addressed to the Permissions Department, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England, or emailed to permreq@wiley.co.uk, or faxed to (+44) 1243 770620.

Designations used by companies to distinguish their products are often claimed as trademarks. All brand names and product names used in this book are trade names, service marks, trademarks or registered trademarks of their respective owners. The Publisher is not associated with any product or vendor mentioned in this book.

This publication is designed to provide accurate and authoritative information in regard to the subject matter covered. It is sold on the understanding that the Publisher is not engaged in rendering professional services. If professional advice or other expert assistance is required, the services of a competent professional should be sought.

Other Wiley Editorial Offices

John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030, USA

Jossey-Bass, 989 Market Street, San Francisco, CA 94103-1741, USA

Wiley-VCH Verlag GmbH, Boschstr. 12, D-69469 Weinheim, Germany

John Wiley & Sons Australia Ltd, 42 McDougall Street, Milton, Queensland 4064, Australia

John Wiley & Sons (Asia) Pte Ltd, 2 Clementi Loop #02-01, Jin Xing Distripark, Singapore 129809

John Wiley & Sons Canada Ltd, 6045 Freemont Blvd, Mississauga, ONT, L5R 4J3

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic books.

Anniversary Logo Design: Richard J. Pacifico

Library of Congress Cataloging in Publication Data

Drug therapy in rheumatology nursing / edited by Sarah Ryan. — 2nd ed.

p. ; cm.

Rev. ed. of: *Rheumatology* / Jackie Hill and Sarah Ryan. 2000.

Includes bibliographical references.

ISBN-13: 978-0-470-02766-0 (alk. paper)

ISBN-10: 0-470-02766-5 (alk. paper)

1. Rheumatism—Chemotherapy. 2. Rheumatism—Nursing.

I. Ryan, Sarah. II. Hill, Jacqueline, 1946–. *Rheumatology*.

[DNL: 1. Rheumatic Diseases—nursing. 2. Nursing Assessment. 3. Patient Education.

4. Rheumatic Diseases—drug therapy. WE 544 D7935 2007]

RC927.D78 2007

616.7'23061—dc22

2006029324

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

ISBN-13: 978-0-470-02766-0 (alk. paper)

Typeset in 10/12pt Times by Integra Software Services Pvt. Ltd, Pondicherry, India

Printed and bound in Great Britain by TJ International Ltd, Padstow, Cornwall

This book is printed on acid-free paper responsibly manufactured from sustainable forestry in which at least two trees are planted for each one used for paper production.

Contents

List of Contributors xiii

List of Figures xv

List of Tables xvii

Preface xix

1 Rheumatological Conditions 1

Janet Cushnaghan and Jackie McDowell

1.1 Introduction 1

1.2 Features of rheumatic conditions 2

 Pain 3

 Stiffness 3

 Swelling 3

 Joint involvement 3

 Function 3

1.3 Epidemiology 4

1.4 Anatomy and physiology of the musculoskeletal system 5

 Muscle 5

 Bone 5

 Cartilage 6

 Synovium 6

 Ligaments and tendons 6

 Tendon sheaths and bursae 6

 Synovial joints 7

 Physiology 7

 Circulation 7

 Lymphatics 7

 Intra-articular pressure 8

 Motion 8

 Innervation 8

 Temperature 8

1.5 Anatomy and physiology of the musculoskeletal system in inflammatory arthritis 9

 Immunopathogenetic mechanisms 9

 Susceptibility 10

 Synovitis 11

1.6	An overview of the rheumatological conditions most commonly encountered in Western Europe	12
	Rheumatoid arthritis	12
	Juvenile idiopathic arthritis	19
	Polymyalgia rheumatica	21
	Inflammatory arthritis associated with spondylitis	22
	Ankylosing spondylitis	22
	Reiter's syndrome	23
	Psoriatic arthritis	24
	Septic arthritis	26
	Reactive arthritis	28
	Triggering factors	29
	Osteoarthritis	30
	Fibromyalgia syndrome	32
	Connective tissue disease	34
	Systemic lupus erythematosus	34
	Scleroderma (systemic sclerosis)	36
	Inflammatory muscle disease (polymyositis)	41
1.7	The impact of rheumatological conditions on physical, psychological, social and occupational function	45
	Personal impact of arthritis	47
	Financial impact of arthritis	48
	Impact on education	48
	Impact on employment	49
	The role of social support	50
	Impact on family relationships	50
	Depression	52
	References	53
2	Drug Therapy	61
	<i>Sarah Ryan, Susan Oliver and Ann Brownfield</i>	
2.1	Pain	61
	Physiology of pain	62
	Pain receptors	63
	The role of the brain	64
	Physiological effects of acute pain	64
2.2	Pharmacological interventions in rheumatology	65
	Non-opioid analgesia	65
	Compound analgesia	66
	Opioids	66
	Antidepressant drugs	71
	Non-steroidal anti-inflammatory drugs	71

2.3	Disease Modifying Anti-rheumatic Drugs (DMARDs)	81
	Use of DMARDs	81
	Early treatment of RA	81
	Combination therapy	82
	Mode of action and pharmacokinetics of DMARDs	82
	The anti-malarials	83
	Sulfasalazine	85
	D-penicillamine	85
	Myocrisin	86
	Auranofin	87
	Methotrexate	87
	Leflunomide	88
	Azathioprine	88
	Cyclophosphamide	89
	Ciclosporin	89
	Chlorambucil	90
	Phenylbutazone	90
	Dapsone	91
	Minocycline	91
	Mycophenolate Mofetil	91
2.4	Biologic therapies	92
	Introduction	92
	Biologically engineered therapies (biologics)	93
	Classifications – biologic therapies	93
	Mode of action – general	94
	Adverse reactions to biologic therapies	95
	Biologic therapies – treatment options	104
	General issues related to the mode of action – for all anti-TNF α therapies	107
	Side effects that should be considered for all anti-TNF α	108
	Pregnancy and breastfeeding	111
	Immunization	112
	Specific information on anti-TNF α	112
	Biologic therapies – patient issues	119
2.5	The use of steroids in the treatment of rheumatic disease	119
	Glucocorticoids	120
	The use of steroids in rheumatoid arthritis	120
	Corticosteroid sparing agents	121
	Adverse effects of corticosteroids	121
	The use of corticosteroids in other rheumatological conditions	123
	Bone mineral metabolism	124
	Peptic ulceration	125
	Atherosclerosis	125
	Reducing the dose of corticosteroids	125

	Pulsed corticosteroids	125
	Intramuscular corticosteroids	126
	Intra-articular/soft tissue injections of corticosteroids	126
2.6	Disorders of purine metabolism: gout	126
	Hyperuricaemia	126
2.7	Nurse prescribing	131
	Who should prescribe?	132
	Independent prescribing	132
	Supplementary prescribing	133
	Educational preparation	134
	Professional responsibilities	134
	Evaluation of prescribing	134
2.8	Self-medication	136
	The case for self-medication	136
	Advantages of self-medication	137
	Stages in the implementation of self-medication	138
2.9	Complementary medicine	139
	Diet	140
	Massage	141
	Aromatherapy	142
	Reflexology	142
	Acupuncture	142
	Herbal medicine	142
	Naturopathy	143
	Holism	143
2.10	Glucosamine	143
2.11	Capsaicin	145
	Conclusion	145
	Appendix 2.A What happens next?	145
	Appendix 2.B Guidelines for nurses on the use and administration of intra-articular injections	146
	References	148
	Appendix 2.C Patient group direction for the administration of methylprednisolone injection 40 mg/ml by intramuscular injection	148
	Case scenarios	152
	References	152

3 The Role of the Nurse in Drug Therapy 163

Sarah Ryan and Margaret Ann Voyce

3.1	What is rheumatology nursing?	163
	The nurse—patient relationship	165

- 3.2 Telephone advice lines 166
- 3.3 The philosophy of rheumatology nursing 166
- 3.4 The role of the nurse in drug therapy 168
 - Empowerment 168
- 3.5 The commencement of DMARDs 169
 - Patient preparation 169
 - Monitoring clinics 170
 - Documentation 172
 - The use of protocols 172
 - Drug monitor clinic protocols 174
- 3.6 Investigations 177
 - Haematological investigations 177
 - Biochemical investigations 181
 - Assessment of rheumatic disease activity 182
- 3.7 Urine testing 184
 - Appearance 185
 - Odour 185
 - Measurement of specific gravity 185
 - Record keeping 186
- 3.8 Drugs that require surveillance 187
 - Gold (myocrisin) therapy 187
 - Auranofin (ridula) therapy in RA 190
 - D-penicillamine (distamine) 191
 - Sulfasalazine en therapy (salazopyrin) 194
 - Methotrexate 196
 - Azathioprine (imuran) therapy 199
 - Cyclophosphamide (endoxana) therapy 201
 - Ciclosporin 203
 - Chlorambucil 205
 - Phenylbutazone (butacote) 206
 - Dapsone 207
 - Minocycline (minocin) 208
 - Leflunomide 208
 - Mycophenolate Mofetil 211
- 3.9 Vaccination 212
- 3.10 Pregnancy 212
 - Contraception 214
- 3.11 The role of the community team in drug therapy 214
 - Minimizing confusion 215
- 3.12 Community drug monitoring 216
 - Documentation 217
 - GPs' concerns relating to practice-based monitoring 218
 - Patients' experiences of drug monitoring 218
- 3.13 Community clinics 218

3.14	General practice	219
3.15	Evaluation of community clinics	219
	Potential problems with consultant-based community clinics	220
3.16	Nurse-led community clinics	220
3.17	New ways of utilizing outpatient appointments	222
3.18	Drug therapy and osteoporosis	222
	Classification of osteoporosis	222
	Risk factors for osteoporosis fracture	223
	Investigations for osteoporosis	224
3.19	Hormone replacement therapy (HRT)	224
3.20	Pain management	225
3.21	Drugs to reduce fracture risk	225
	Bisphosphonates	225
	Etidronate	225
	Alendronate Sodium (fosamax)	225
3.22	Other drug treatments	226
	Calcitonin	226
	Calcium	226
	Vitamin D	227
	Calcitriol	227
	Formation stimulating agents	227
	Strontium ranelate (protelos)	227
3.23	Prevention (lifestyle strategies)	228
	Diet	228
	Smoking	228
	Alcohol	228
	Exercise	228
	Falls	228
	Conclusion	229
	Appendix 3.A	229
	Appendix 3.B	232
	References	235

4 Patient Education and Adherence with Drug Therapy 243

Jackie Hill

4.1	Definitions of patient education	243
4.2	Useful theories and models	244
	Learned helplessness theory	245
	Stress and coping theory	245
	Health belief model	246
	Self-efficacy theory	247

- Changing self-efficacy 248
- Mastery of skills 248
- Modelling 249
- Persuasion 250
- Reinterpretation of physiological state 250
- 4.3 Purpose of patient education 250
- 4.4 Limitations of patient education 251
- 4.5 Role of the nurse in patient education 252
 - Patient education and some fundamental aspects of nursing 252
 - Patient education and therapeutic nursing 252
 - Reciprocity 252
 - Professional closeness 253
- 4.6 Planning a patient education programme 254
 - The learning environment 254
 - Demographic considerations 255
 - Disease duration 255
 - Age range 255
 - Diagnosis 256
 - Mixed educational ability 256
 - The type of programme 256
- 4.7 Individual patient education 257
 - Preferences of drug therapy 257
 - Assess the patients' knowledge of drugs 258
 - Establishing shared goals 259
 - Preferred method of information transfer 259
 - Contracting 260
 - The activity to be accomplished 260
 - The plan of action 260
 - Checking that the contract is realistic 260
- 4.8 Teaching in groups 261
- 4.9 Opportunity education 262
- 4.10 The arthritis self-management programme 262
- 4.11 What to teach 263
 - Teaching about drug therapy 264
 - What to include 265
 - Risks and adverse effects 266
- 4.12 Teaching aids 267
 - Videos and CDs 270
 - Audiocassettes 270
 - Computer programs 270
- 4.13 The optimum timing of patient education 271
 - Readiness for change 271

4.14 Patient education and adherence 272

Conclusion 273

Appendix 4.A Methotrexate information sheet 274

References 277

Index 283

List of Contributors

Ann Brownfield, RGN, MSc, BSc (Hons)

Clinical Nurse Specialist, North and South Primary Care Trust, Haywood Hospital, Stoke on Trent

Janet Cushnagan, MSc, MCSP

MRC ERC, Southampton General Hospital, Southampton

Jackie Hill, PhD, MPhil, RN, FRCN

Arc senior lecturer in rheumatology nursing and Co-director ACUMeN, Chapel Allerton Hospital, Leeds

Jackie A McDowell, BSc (Hons), RGN, NDN

Clinical nurse specialist, Hereford Hospitals NHS Trust, Hereford

Susan Oliver, MSc

Nurse Consultant Rheumatology, Litchdon Medical Centre, Devon

Sarah Ryan, RGN, PhD, MSc, FRCN

Nurse Consultant Rheumatology, North and South Primary Care Trust, Haywood Hospital, Stoke on Trent

Margaret Ann Voyce, SRN

Rheumatology Nurse Practitioner, Rheumatology Department, Royal Cornwall Hospital, Truro

List of Figures

- 1.1 The inflammatory cascade 10
- 1.2 Joints affected by rheumatoid arthritis 14
- 1.3 An osteoarthritic knee joint 31
- 1.4 A possible mechanism of induction and perpetuation of fibromyalgia syndrome 32
- 1.5 Common hyperalgesic tender sites 33
- 2.1 Influences on the pain gate 62
- 2.2 Pathways influenced by NSAIDs 74
- 3.1 The rheumatology nurse forum problem model 173
- 3.2 Medication card 216
- 4.1 The combined multidisciplinary team 251

List of Tables

1.1	Classification of rheumatic diseases	2
1.2	Epidemiological definitions	4
1.3	Prevalence estimates for selected rheumatological disorders	4
1.4	Factors influencing disease susceptibility	11
1.5	1987 American Rheumatism Association Revised Criteria for the classification of RA	15
1.6	Extra-articular manifestations of RA	17
1.7	Classification of OA	31
1.8	Classification of systemic sclerosis	39
2.1	Adverse effects of compound analgesia	66
2.2	Opioids	67
2.3	Drug interactions of opioids	70
2.4	Adverse effects of opioids	70
2.5	Chemical classification of NSAIDs	72
2.6	Biologic prescribing issues	96
2.7	Key issues in caring for individuals receiving biologic therapies	101
2.8	Screening and management of infusion-related reactions	102
2.9	Half life of commonly used corticosteroids	121
2.10	Adverse effects of corticosteroids	122
2.11	Adverse effects of colchicine	129
2.12	What patients need to know about their medication (Quilligan, 1990)	138
2.13	Complementary therapies	140
2.14	Nutrients that can be lacking in the diet of patients with RA	141
3.1	Disease-modifying anti-rheumatic drugs	164
3.2	Functions of a nurse-led clinic (Hill, 1992)	170
3.3	Key nursing functions (Wilson Barnett, 1984)	171
3.4	White blood cells	179
3.5	Vaccines	212
3.6	Drugs and pregnancy	213
3.7	Members of the shared care team	214
3.8	Foods rich in calcium	223
3.9	Pain management (non-pharmacological)	225
4.1	Therapeutic activities in nursing	253
4.2	Types of patient education programme	257
4.3	Differing aspects of group teaching	261

Preface

This revised text provides a comprehensive exploration of the drug treatment used in the management of rheumatological and related conditions. It will provide a valuable resource to all nurses and other health professionals in the care of patients with a rheumatological condition, be it in the hospital, community or research setting.

The text has been revised to include the management of patients receiving biologic therapies, my thanks to Susan Oliver who has written this comprehensive section. It is amazing to think that when this book was originally published in 1999, biologic treatments were primarily being used for patients in research studies, whereas now, they have become a mainstream therapy for many patients with an active inflammatory condition. Drugs such as Leflunomide and Mycophenolate are also being used more widely. Also new evidence has altered our use of non steroidal anti-inflammatory drugs (NSAIDs) in practice, this is addressed within this new text and the use of case scenarios will help nurses develop their clinical decision-making skills in the context of the current evidence. There is also a review of community-based provision for patients with a rheumatological condition.

Not only have there been dramatic changes in drug therapy for patients, nurse prescribing has become law and the implications of this for rheumatology nurses are discussed.

Patients will often require a combination of drug therapy to provide symptomatic control and disease suppression. The addition or alteration to a patient's drug treatment will require exploration of the patient's (and their significant others') expectations to ensure that all treatment has meaning and relevance within the patient's contextual framework.

The revised book contains four chapters, each divided into several short sections; each part begins with learning objectives which will guide the reader as to the content of the chapter. The book is based on clinical and research findings to ensure the adoption of evidence-based practice within clinical settings.

The primary aims of this book include:

- An understanding of those rheumatological conditions where drug treatment can be effective.
- The provision of information on different disease processes, so that the utilization of drug therapy can be placed in context.
- Increasing knowledge for nurses and other health professionals on the classification of drugs in common usage, including analgesia, NSAIDs, disease modifying anti-rheumatic drugs (DMARDs), biologic therapies, cytotoxic drugs, steroids, treatments for gout and osteoporosis.

- An exploration of the role of the nurse in the management of drug therapy, focusing on the knowledge and skills required to undertake drug surveillance and assessment of interventions.
- A comprehensive exploration of patient education: theories, principles, content and delivery of education are discussed.
- A review of community based provision for patients with rheumatological conditions.

This book can be used as a reference text for those nurses who seek specific answers regarding an aspect of practice, for example what advice should be given to a patient regarding pregnancy who is taking Leflunomide, as well as providing in-depth information on the principles and components of a wide range of drug therapies for clinicians specializing in this field.

The nurse performs a pivotal role in guiding, supporting and educating the patient and the family to manage their condition effectively. The utilization of this text will enable practitioners to develop and advance their practice to the benefit of the patient.

Sarah Ryan

1 Rheumatological Conditions

JANET CUSHNAGHAN AND JACKIE McDOWELL

Learning objectives

After reading this chapter you should be able to:

- Discuss the anatomy and physiology of the musculoskeletal system in health and illness.
- Describe the process of inflammation and the immune response.
- Develop an understanding of the rheumatic diseases where drug therapy is required.
- Discuss the effects of rheumatic disease on physical, psychological and social well-being.

1.1 INTRODUCTION

The primary objective of this book is to provide the nurse with the knowledge and subsequent understanding of the role drug therapy plays in the management of rheumatological conditions. It is essential therefore that nurses must have a good knowledge and understanding of rheumatological conditions themselves.

Rheumatology is the branch of medicine dealing with disorders of the joints, muscles, tendons and ligaments. Arthritis and the rheumatic diseases in general constitute the major cause of chronic disability in the United Kingdom. It is estimated that musculoskeletal diseases account for one third of the physical disability experienced in the community in the United Kingdom and have an economic cost that exceeds that of heart disease and cancer.

The terms arthritis and rheumatism or rheumatic disease encompass a host of conditions causing much pain and suffering to those affected. The burden of these diseases is felt not only by the sufferer and their family, but also by the community, in terms of the cost of healthcare and the loss of working days. Because of the diversity of rheumatic conditions it is helpful to classify them into groups. This may be undertaken in different ways incorporating:

- clinical and laboratory features;
- disease mechanisms — for example, autoimmunity;
- anatomic structures involved;
- genetic factors;
- involved organ systems and specific abnormalities or deficiencies.

Table 1.1 Classification of rheumatic diseases.

Inflammatory arthritis
Rheumatoid arthritis
Juvenile arthritis
Polymyalgia rheumatica
associated with spondylitis
Ankylosing spondylitis
Reiter’s syndrome
Psoriatic arthritis
associated with infectious agents
Septic arthritis
Reactive arthritis
associated with crystals
Gout
Pseudogout
Non inflammatory
Osteoarthritis
Fibromyalgia
Connective tissue disorders
Systemic lupus erythematosus
Scleroderma
Polymyositis

Classification is hampered by the absence of firm aetiological evidence for most diseases but for this chapter we intend to use a simplified classification, which will correspond to the philosophy of drug therapy which is the main purpose of this text. Table 1.1 classifies the rheumatic diseases according to the presence or absence of inflammation and further subclassifies inflammatory arthritis according to associations that may be present.

1.2 FEATURES OF RHEUMATIC CONDITIONS

Symptoms of rheumatic disease can be determined by a clinical history taking and thorough physical examination. Laboratory and radiographic investigations can aid diagnosis and eliminate certain features but nothing can replace the clinician’s clinical skills and pattern recognition. Patients with a rheumatological condition often experience symptoms of pain, swelling, stiffness and loss of function. These symptoms give rise to impairments, which in turn may produce handicap or disability, depending on the interaction of environmental, resource and psychological factors.

One of the primary objectives of the clinical history is to ascertain a greater understanding of the pain:

- Is it inflammatory?
- What is the origin of its presentation?
- What are the aggravating factors?
- What is its temporal pattern?
- Are there any constitutional symptoms suggesting a systemic illness, such as fever or weight loss?

PAIN

Arthralgia implies pain originating from or around a joint, but not necessarily from within the joint itself. Periarticular structures may be responsible for the pain or it may be referred from somewhere away from the joint. Pain originating from joint structures should be improved by resting the joint and aggravated by stretching the joint or weight bearing.

STIFFNESS

Stiffness after prolonged immobility suggests inflammatory joint disease or synovitis. Stiffness alone is a non-specific symptom and can be present in other diseases such as Parkinsonism. It is also present in older individuals. Clinically significant stiffness lasts more than 30 minutes, and in inflammatory disease the duration of stiffness is proportional to the severity of inflammation.

SWELLING

Swelling may be due to synovitis, cellulitis or oedema and it is important to distinguish between them. Joint swelling may be due to soft tissue swelling or synovitis or it may be due to bony swelling indicating osteoarthritis (OA).

JOINT INVOLVEMENT

The pattern of joint involvement, including its symmetry, is helpful in making a diagnosis, although it should be noted that there is considerable overlap between the major causes of inflammatory polyarthritis.

FUNCTION

Loss of function is an important consequence to the patient and should be assessed in work, leisure and home activities. Functional ability depends on need, motivation and environmental factors. The assessment of function will be discussed later in this chapter.

1.3 EPIDEMIOLOGY

Epidemiology is the study of the incidence, distribution and determinants of disease in populations in order to identify causes and ultimately lead to prevention (Table 1.2). In studying the epidemiology of rheumatic disease it is important that diagnostic criteria are used to ensure standardization of disease definition and allow comparisons between populations. Criteria that are designed for research purposes or for entry into clinical trials may not be suitable for routine clinical practice. The prevalence estimates for selected rheumatological disorders are shown in Table 1.3.

Mortality from musculoskeletal disorders is low. The major impact in the population is in terms of morbidity and disability. OA is the most common type of arthritis and its frequency increases with age. Back complaints represent a quarter to a third of all musculoskeletal morbidity.

Table 1.2 Epidemiological definitions.

Incidence	The number of new cases of disease per unit time (for example, cases per annum)
Prevalence	Total number of cases of the disease at a given time point in a defined population
Morbidity	Number of cases with a defined outcome of the disease
Mortality	Number of cases dying from the disease per unit time (for example, deaths per annum)

Table 1.3 Prevalence estimates for selected rheumatological disorders.

Rheumatic disorder	Estimated percent prevalence
Arthropathies	
RA	1.0
In children <16 yrs	0.06
Osteoarthritis	
Moderate/severe X-ray changes in hands or feet	23.0
Knee	3.8
Hip	1.3
Ankylosing spondylitis	0.1
Psoriatic arthropathy	0.1
Crystalline arthritis	1.0
Connective tissue disease	
Systemic lupus erythematosus (SLE)	0.006
Systemic sclerosis	0.002
Back troubles	>20.00

1.4 ANATOMY AND PHYSIOLOGY OF THE MUSCULOSKELETAL SYSTEM

Before learning about the pathology of rheumatic diseases it is important to have an understanding of the anatomy and physiology of the musculoskeletal system in health. The musculoskeletal system serves several purposes:

- it provides stable support;
- it facilitates movement
- it protects vital organs
- it allows for growth and renewal over the lifetime of the individual (Simkin, 1994).

Components of the musculoskeletal system are muscle, bone, tendons, ligaments, cartilage and synovial tissue. All musculoskeletal tissues are supplied by the circulation and guided and protected by their innervation.

MUSCLE

Skeletal or striated muscle provides the energy or driving force for musculoskeletal activity. Chemical energy derived from foodstuffs is ultimately converted to the mechanical energy required to do work. Individual striated fibres are bundled in perimysial tissue that transmits the force of muscle contraction through tendons to attachments on bone. Each fibre can only work in the direction of its long axis and it is only the variety of arrangements within muscles and the cooperation between muscles that allow the full range of possible human activities.

BONE

No muscle contraction would be effective unless it could produce directed motion through a skeletal lever. Each effective motion comes about as muscles act on bones to move the limbs, head or torso. In some cases the mechanical advantage of the muscles is poor and they exert substantial transarticular compressive forces in order to generate the desired movement. The bones of the skeleton have evolved to withstand and distribute these forces. Bone is characterized by the deposition of hydroxyapatite crystals in a well organized, collagenous matrix. There are two types of mature bone: compact and trabecular.

Compact bone is predominant and found in the shafts of long bones. The shafts of long bones contain little or no internal osseous structure, but have a marrow cavity filled with fat and loose interstitial tissue. The bone is covered by a sensitive periosteum that is capable of new bone formation.

Trabecular bone refers to the cross-braced architecture found beneath articular surfaces and in the vertebral bodies. All trabeculae undergo remodelling through ongoing processes of osteoclastic resorption and osteoblastic formation of bone.

CARTILAGE

The contact surfaces of bones are covered by a cushion of cartilage. For the most part this is hyaline articular cartilage, which is principally comprised of water. Its structure is of proteoglycan aggregates restrained within a framework of type II collagen fibres. These aggregates are made up of keratan sulfate and chondroitin sulfate. Cartilage is remarkably firm and resilient. It undergoes continuous turnover, the principal players in this being the chondrocytes that are individually active but are relatively sparse in numbers so the overall metabolic activity of cartilage is relatively low. Normal hyaline cartilage lacks blood vessels and nerves and relies on adjacent structures for nutrition, namely the synovial microvessels.

The synovial fluid is the vehicle carrying nutrients to the chondrocytes and returning waste products to the blood stream. The absence of nerves in articular cartilage means that damage to this structure alone cannot be painful but in conjunction with the involvement of adjacent soft tissues or subjacent bone it will cause pain. A second type of cartilage is fibrocartilage, found at sites subject to shearing forces or under tensile stress. Examples include the moon-shaped cartilages called menisci over each tibial plateau and the principal load-bearing region in the roof of the acetabulum. This type of cartilage is more notable for its fibrous component (mainly type I collagen) than for its proteoglycan composition.

SYNOVIUM

This is a living lining and covers all intra-articular surfaces other than the articulating areas of cartilage. It is a thin structure, in health, with a normal depth of 25–35 μm . It is comprised of a well-organized matrix of numerous microfibrils and abundant proteoglycan aggregates. Within this matrix lie the synovial cells. The structure has protective and synthetic capabilities.

LIGAMENTS AND TENDONS

Ligaments are strong bundles of parallel type I collagen fibres that serve as ‘check-reins’ to prevent inappropriate movements. Each hinge joint, for example, is bordered by collateral ligaments to limit movements to flexion and extension. Every ligament runs from bone to bone. Tendons act as active drivers of joint motion as opposed to passive restrainers (ligaments). Tendons and ligaments insert into bone at anatomic sites known as entheses.

TENDON SHEATHS AND BURSAE

Tendons connect muscle bodies to, sometimes distant, insertion sites, and therefore often run through sheaths to avoid adherence to other structures. Similarly, points of potential friction, such as those between ligaments, bony prominences and overlying

skin are often protected by lubricating bursae. These flimsy structures are flattened sacks lined by a tissue that is histologically indistinguishable from synovium. They contain a fluid that appears synovial. It is no surprise therefore that tendon sheaths and bursae are the targets of the same inflammatory diseases that affect synovial joints.

SYNOVIAL JOINTS

These are the commonest type of articulation in the body. They are actively driven by muscles and tendons, stabilized by ligaments, cushioned by hyaline cartilage and are both nourished and lubricated by synovial tissue. A film of synovial fluid lubricates the bearing surfaces and the adjacent interfaces of synovium on cartilage and synovium on synovium.

PHYSIOLOGY

Physiology is the study of how living things work. The principal function of almost all joints is movement. Microscopic examination of synovium and cartilage shows them to be composed of metabolically active cells. This implies that they have the same nutritional requirements as other tissues, produce similar waste products and respond to hormonal and other metabolic stimuli in ways analogous to other tissues. Joints age as do other tissues, with subsequent effects on function. Aspects of physiology include circulation, lymphatics, pressure, diffusion, temperature and innervation. Changes in one 'system' can have clinically important effects on another and all are uniquely modified by physical movement.

CIRCULATION

Joints require a blood supply to ensure the health of the cartilage, which lacks blood vessels of its own. The nearest available blood vessels are the capillaries of the synovium. Transport of nutrients is dependent on diffusion. The synovium and synovial space have a major role in facilitating metabolic exchange and in maintaining a normal joint space environment. Large blood vessels of the limbs pass the articular regions, and feeder vessels enter and leave the joint capsule at positions that protect them from mechanical embarrassment during movement.

LYMPHATICS

There is a typical lymphatic system in the synovium but not in the cartilage. Synovial lymphatics carry excess fluid, high molecular weight solutes and protein,

tiny particulates and some cells out of the joint. This transfer is powered by normal movement of the joint.

INTRA-ARTICULAR PRESSURE

Normal intra-articular pressure in a resting joint is subatmospheric. In conditions where there is an abnormal volume of fluid in the joint the pressure will rise nonlinearly. The resulting pressure volume curve defines the compliance of the joint space and its surrounding connective tissue.

MOTION

Motion is the function of diarthrodial joints, but motion itself affects the physiology and health of the joint. If a joint is immobilized cartilage thins and loses its mechanical properties. The application and release of weight-bearing forces play a part in joint lubrication and in the diffusion of substances in and out of cartilage. Joint movement is also required to maintain health by:

- Maintaining normal strength and coordination of muscles
- Preserving bone mass
- Maintaining desired weight
- Preserving normal range of joint motion
- Increasing blood flow to the synovial tissues
- Permitting the lymphatic system to clear the joint of particulates and excess fluid.

INNERVATION

There are no nerves in articular hyaline cartilage. Most of the synovium is insensitive but there are small and isolated areas that are painful when stimulated mechanically. Small diameter nerve fibres are present within the confines of the capsule. The capsule, intra-articular fat pads, ligaments, periosteum, muscles and adjacent bone have abundant innervation. The major function of joint innervation appears to be proprioception — the perception of joint position, and the direction and velocity of movement.

TEMPERATURE

The normal intra-articular temperature of peripheral joints is far less than 37°C. Temperature is largely a function of blood flow. Joint movement increases joint temperature.