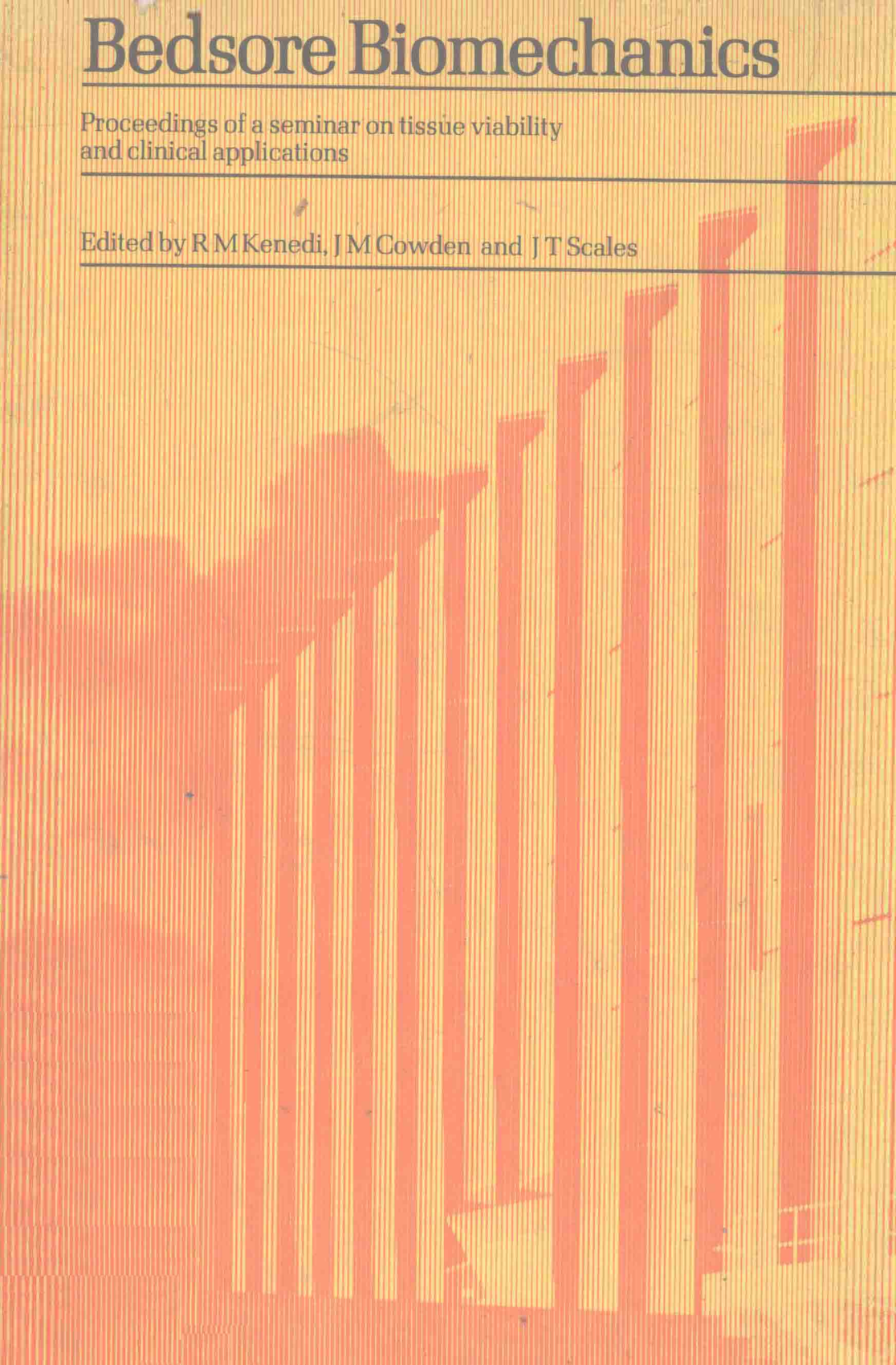


Bed sore Biomechanics

Proceedings of a seminar on tissue viability
and clinical applications

Edited by R M Kenedi, J M Cowden and J T Scales



STRATHCLYDE BIOENGINEERING SEMINARS

BEDSORE BIOMECHANICS

Proceedings of a seminar on Tissue Viability and Clinical Applications organised in association with the Department of Biomedical Engineering, the Institute of Orthopaedics (University of London), Royal National Orthopaedic Hospital, Stanmore, London, and held at the University of Strathclyde, Glasgow, in August, 1975

Edited by

R. M. KENEDI *and* J. M. COWDEN

*Bioengineering Unit
Wolfson Centre
University of Strathclyde*

in association with

J. T. SCALES

*Department of Biomedical Engineering
Royal National Orthopaedic Hospital
Stanmore*



University Park Press
Baltimore London Tokyo

© Bioengineering Unit, University of Strathclyde 1976

All rights reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, without permission

First published 1976 by
The Macmillan Press Ltd
London and Basingstoke

Published in North America by
UNIVERSITY PARK PRESS
Chamber of Commerce Building
Baltimore, Maryland 21202

Library of Congress Cataloging in Publication Data

Main entry under title:

Bedsore biomechanics.

At head of title: Strathclyde bioengineering
seminars.

Includes index.

1. Bed-sores—Congresses. 2. Skin—Wounds and
injuries—Congresses. 3. Bed-sores—Prevention—
Congresses. 4. Hospital beds—Congresses.
I. Kenedi, R. M. II. Cowden, J. M. III. Scales,
John Tracey.

RL675.B4 616.5'46 76-13445

ISBN 0-8391-0935-0

Printed in Great Britain

BEDSORE BIOMECHANICS

PREFACE

Bioengineering activities at the University of Strathclyde were initiated by the formation of a Medical Research Council Biomechanics Group in 1962. This has grown into the Bioengineering Unit, a research and postgraduate teaching department of the University housed in the Wolfson Centre.

The success of broad-spectrum symposia held in 1964 and 1972 has led to the establishment of the 'Strathclyde Bioengineering Seminars', an annual series the proceedings of which will be published by Macmillan Press. Each Seminar will explore in depth a clinically significant problem area within the Unit's activities.

The series was opened in August 1975 with a Seminar on the 'Biomechanics of Tissue Viability and Clinical Application to the Prevention of the Pressure Sore'. This particular Seminar was organised in association with the Department of Biomedical Engineering, Institute of Orthopaedics (University of London), Royal National Orthopaedic Hospital, Stanmore, London. Participation was gratifying: 207 attended, consisting of representatives from Australia, Canada, Denmark, England, France, India, Iraq, Israel, the Netherlands, Scotland, Sweden, the United States and Wales. In this context the organisers gratefully acknowledge the contribution of the National Fund for Research into Crippling Diseases towards travelling expenses of invited lecturers.

The details of the Scientific, Technical and Working Group Sessions are given in the contents list. There was also an Exhibition of Related Medical Engineering Equipment in which 19 firms and organisations participated (see list on page xxi). A visit to the Wolfson Centre was part of the programme, during which a variety of displays showing research projects in progress in the Bioengineering Unit were on show.

All the papers presented, together with additional contributions and the discussions, are printed complete in this volume, grouped in the six sections shown in the list of contents.

The organisers acknowledge with gratitude their sense of indebtedness to the Greater Glasgow Area Health Board for their support of the Seminar and for the very enjoyable open-air reception at the Wolfson Centre given by them in association with the University of Strathclyde, for participants and guests. They also wish to record their grateful thanks to the Institute of Orthopaedics, University of London, and to the Biological Engineering Society of the United

Kingdom for their support and co-operation in assembling the programme and publicising the Symposium.

All the work connected with the Symposium as regards advance information, registration, accommodation arrangements, correspondence and the day-to-day running of the meetings was carried out by the staff of the Bioengineering Unit with the unstinted co-operation of the University Administration.

The Directors of the Armour Pharmaceutical Co. Ltd very kindly provided the pre-Seminar Dinner Reception, and by courtesy of the Bank of Scotland and Messrs. Arbuckle Smith & Co., banking and travel agent facilities were made available to participants at the Seminar.

The organisers gratefully acknowledge the co-operation and whole-hearted assistance of all concerned.

R. M. KENEDI

University of Strathclyde, Glasgow, Scotland

August 1975

SEMINAR ORGANISING COMMITTEE AND SECRETARIAT

| | |
|--------------------|-----------------------------|
| Joseph C. Barbenel | Monica M. Jordan |
| Frank Bell | Robert M. Kenedi (Chairman) |
| Jane Bowen | Flora Kennedy |
| James M. Courtney | Anne Lawson |
| Jennifer M. Cowden | James MacGregor |
| Rita F. Cuthbert | Sheila Milne |
| Ronald Donovan | John P. Paul |
| John H. Evans | John T. Scales |
| Anne Johnston | Rosemary Wilkinson |

SESSION REPORTERS

| | |
|-------------------------|----------------------|
| Joseph C. Barbenel | Derek Jones |
| Geoffrey I. Bardsley | Peter Lawes |
| Necip Berme | Arthur J. Loughran |
| Elizabeth Christian | David McClure |
| James M. Courtney | James MacGregor |
| John H. Evans | Philip F. Millington |
| Martin W. Ferguson-Pell | Paul Record |
| Maureen Gallagher | Peter J. Sharrock |
| Keith Gilroy | Carolyn F. Small |

LIST OF PARTICIPANTS AND AUTHOR INDEX

(*a*, participating author; *a*[•], non-attending author; *c*, chairman and chairman-associate)

- ADAMSON, M. R., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- ADAWAY, D., Sales Manager, Mycalex Instruments Ltd, Charlton Kings Industrial Estate, Cirencester Rd, Cheltenham GL53 8DZ, UK
- AFFARA, Miss F., School of Nursing, Victoria Infirmary, Langside, Glasgow G42 9TY, UK
- a*[•] (page 327) ALBISSER, A. M., Ph.D., P.Eng., Department of Medical Engineering, Hospital for Sick Children, 555 University Avenue, Toronto, Ontario M5G 1X8, Canada
- a* (page 109) ALEXANDER, H., Ph.D., Associate Professor, Department of Mechanical Engineering, Stevens Institute of Technology, Castle Point Station, Hoboken, New Jersey 07030, USA
- AL-HUSSAINI, Professor J., Department of Physics, College of Science, University of Baghdad, Baghdad, Iraq
- a*[•] (page 207) ANANTHAN, P. R., Division of Biomedical Engineering, Indian Institute of Technology, Madras 600036, India
- c, a* (pages 127, 181) ANDERSON, Sir Ferguson, O.B.E., K.St.J., M.D., F.R.C.P. & S., Department of Geriatric Medicine, Stobhill Hospital, Glasgow G21 3UW, UK
- ANDREWS, Dr J., Geriatric Unit, West Middlesex Hospital, Isleworth, Middlesex, UK
- a*[•] (page 207) ANTIA, N. H., The Tata Department of Plastic Surgery, Sir J. J. Group of Hospitals, Bombay 8, India
- a* (pages 25, 83, 225, 344) BARBENEL, J. C., B.D.S., M.Sc., L.D.S.(Eng.), University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 225) BARDSLEY, G. I., B.Sc., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- BARR, Dr P-O, Burns Unit, Karolinska Hospital, 10401, Stockholm, Sweden

- c,a* (pages 55, 257) BARTON, A. A., B.Sc., M.D., Department of Geriatric Medicine, Nunnery Fields Hospital, Canterbury, Kent, UK
BAXTER, Miss B., 596 Oldfield Lane, Greenford, Middlesex, UK
BEHAN, J. T., 173 Scott Street, Galashiels, Selkirkshire, UK
- a* (pages 189, 225) BELL, F., B.Sc., Ph.D., C.Eng., M.I.Mech.E., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
BELL, Miss J. M., Principal Nursing Officer, General Nursing Division, Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, UK
BENDALL, T. J., Technical Manager, Hugh Steeper Ltd, Westland Square Industrial Estate, Westland Road, Leeds LS11 4SS, UK
BENSON, G. B., G. D. Searle & Co. Ltd, P.O. Box 11, Coronation Road, High Wycombe, Bucks, UK
- a* (page 344) BERME, Dr N., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
BISSETT, Miss E. M., Senior Nursing Officer, Langside Geriatric Unit (South Eastern District), Queens Park House, Langside Road, Glasgow G42 9TT, UK
- a* (page 235) BLACK, R., B.Sc., B.A.Sc., P.Eng., Rehabilitation Engineering, Ontario Crippled Children's Centre, 350 Rumsey Road, Toronto, Ontario M4G 1R8, Canada
BOTS, R. A. A., Groesbeekseweg 362, Nijmegen, the Netherlands
BOWEN, Miss J., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
BOWKER, Dr P., University of Aberdeen, Department of Medical Physics, Foresterhill, Aberdeen AB9 2ZD, UK
BOWMAN, Mrs N. K., Senior Nursing Officer, Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- a** (page 103) BRAKKEE, A. J. M., Ph.D., Laboratorium voor Medische Fysica, Geert Grooteplein Noord 21, Nijmegen, the Netherlands
- c,a* (pages 19, 37, 183) BRAND, Dr P. W., C.B.E., F.R.C.S., Chief, Rehabilitation Branch, Department of Health, Education and Welfare, Public Health Service, US Public Health Service Hospital, Carville LA 70721, USA
- c,a* (pages, 63, 257) BRÄNEMARK, Professor P-I, Director of Research, University of Göteborg Faculty of Medicine, Department of Anatomy, Fack S-400-33, Göteborg, Sweden.
- a** (page 185) BRATTGÅRD, S. O., Department of Handicap Research, University of Göteborg, Övre Husargatan 36, S41314, Göteborg, Sweden

BURKE, Dr D. C., Spinal Injuries Unit, Austin Hospital, Heidelberg, Victoria 3084, Australia

CAMPBELL, Miss M., Philipshill Hospital, Busby, Clarkston, Glasgow, UK

*a** (page 185) CARLSÖÖ, S., Department of Handicap Research, University of Göteborg, Övre Husargatan 36, S 413 14, Göteborg, Sweden
 CAVINUE, Mrs M., 20 Peacock Loan, Carlisle, ML8 5RU, UK
 CHETTY, K. M., Remedial Gymnast, Spinal Unit, Philipshill Hospital, Busby, Clarkston, Glasgow, UK

*a** (page 69) CHIMOSKEY, J. E., M.D., University of Washington, Seattle, Washington 98195, USA

*a** (page 95) CHOW, W. M., Ph.D., Kenner Products, 912 Sycamore Street, Cincinnati, Ohio 45202, USA

CHRISTIAN, Miss E., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

a (page 95) COCKRELL, J. L., Ph.D., Department of Physical Medicine and Rehabilitation, University of Michigan Medical Centre, Ann Arbor, Michigan 48104, USA

CONDIE, D., Dundee Limb Fitting Centre, 133 Queen Street, Broughty Ferry, Dundee DD5 1AG, UK

*a** (page 109) COOK, T. H., Ph.D., Stevens Institute of Technology, Hoboken, New Jersey 07030, USA

COPELAND, K., General Secretary, Biological Engineering Society, Department of Biophysics, University of London, Gower Street, London WC1, UK

COURTNEY, Dr. J. M., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

COWDEN, Miss J. M., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

CRAIG, Miss E., Group Head of Occupational Therapy, Philipshill Hospital, Busby, Clarkston, Glasgow, UK

CROSS, J., 'Gaidrew', 33 Callander Drive, Larbert, Stirlingshire, UK

a (page 39) CRUICKSHANK, C. N. D., M.D., M.R.C.P., F.R.C.Path., Director, M.R.C. Unit on the Experimental Pathology of Skin, The Medical School, The University, Birmingham 15, UK

CUTHBERT, Mrs R., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

DALLEY, C., 60 Blackett Place, Newington, Edinburgh, UK

a (page 69) DALY, C. H., Ph.D., Associate Professor, Department of Mechanical Engineering, University of Washington, Seattle, Washington 98195, USA

- DEGREMONT, O., Vice-President, Medical Division, Dosapro Milton Roy S.A., 3 Rue D'Edimbourg 75008, Paris, France
- DOBBIE, A. I., Department of Health and Social Security, Room 312, 286 Euston Road, London NW1 3DN, UK
- DONALDSON, Miss R., Victoria Infirmary, Langside, Glasgow G42 9TY, UK
- DONOVAN, R., University of Strathclyde, National Centre for the Training and Education in Prosthetics and Orthotics, 119 Rottenrow, Glasgow G4 0NW, UK
- a* (page 315) DORNAN, J., M.B., Ch.B., F.R.C.P.(C), Department of Rehabilitation Medicine, Toronto Western Hospital, 399 Bathurst Street, Toronto, Ontario, Canada
- DRAYCON, P. R., Product Group Manager, Smith & Nephew Ltd, Bessemer Road, Welwyn Garden City, Herts AL7 1HF, UK
- a* (pages 25, 189, 344) EVANS, J. H., B.Eng., M.Sc., Ph.D., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- EVANS, R. E., Talley Surgical Instruments Ltd, 47 Theobald Street, Borehamwood, Herts, UK
- a* (page 133) EXTON-SMITH, Professor, A. N., M.A., M.D., F.R.C.P. St. Pancras Hospital, University College Hospitals, 4 St. Pancras Way, London NW1 0PE, UK
- FAGE, C. B., Acting Superintendent, Physiotherapy Dept., Foresthall Hospital, Springburn, Glasgow, UK
- FAIRLEY, Dr A., Geriatric Unit Office, North Nottingham Teaching District, Sherwood Hospital, Hucknall Road, Nottingham NG5 1PD, UK
- FAIRLEY, Dr D., 64 Terregles Avenue, Glasgow G41, UK
- FERGUSON, J., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 189) FERGUSON-PELL, M. W., B.Sc., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 315) FERNIE, G. R., B.Sc. Ph.D., C.Eng., M.I.Mech.Eng., Co-Director, Amputee Centre, Toronto Hospital, 82 Buttonwood Avenue, Weston, Ontario, Canada
- GALLAGHER, Miss M., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- GERMANS, Dr F. H., Institute of Medical Physics, TNO, Da Costakade 45, Utrecht, the Netherlands

- GERRARD, D., Johnson & Johnson Ltd, Southampton Road, Cosham, Portsmouth, Hants, UK
- a*• (page 207) GHISTA, D. N., Ph.D., Head, Division of Biomedical Engineering, Indian Institute of Technology, Madras 600036, India
- GIBBS, Dr J. R., Egerton Ltd, 2 Walters Yard, High Street, Bromley, Kent, UK
- a*• (page 327) GIBSON, D. A., M.D., F.R.C.S.(Eng & C.), Hospital for Sick Children, 555 University Avenue, Toronto, Ontario MG5 1X8, Canada
- a*• (page 83) GIBSON, F., B.Sc., Department of Mechanical Engineering, Paisley College of Technology, Paisley, UK
- c, a* (pages 25, 344) GIBSON, Professor T., M.B.Ch.B., D.Sc., F.R.C.S.(Ed.), F.R.C.S.(Glasg.), Regional Director, Plastic Surgery Unit, Caniesburn Hospital, Glasgow G61 1QL, UK
- GILROY, K., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- GOUDIE, W. W., 46 Waverley Crescent, Greenfaulds, Cumbernauld, Glasgow, UK
- GOURLEY, Miss M., Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, UK
- GRAHAM, Miss D., Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, UK
- GRANT, Mrs E., Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, UK
- a*• (page 169) GRANT, R. A., Ph.D., D.Sc., Ecotech Systems (UK) Ltd, Poole, Dorset, UK
- a* (page 311) GRANT, W. Russell, M.A., M.R.C.S., L.R.C.P., D.Phys.Med., Director, Rheumatology and Rehabilitation, Royal Hampshire County Hospital, Winchester, Hants, UK
- GRAZEBROOK, M. W., Sales Director, Watkins & Watson Ltd, 14 High Street, Chislehurst, Kent, UK
- GRIFFITHS, Miss S., General Hospital, Ayresome Green Lane, Middlesbrough, Cleveland TS5 5AZ, UK
- GUIDOIN, Dr. R. G., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- GUNN, W. F., Scottish Home and Health Department, Pentland House, 47 Robb's Loan, Edinburgh EH14 1TY, UK
- a* (page 153) GUTTMANN, Sir Ludwig, C.B.E., M.D., F.R.C.P., F.R.C.S., Director, Stoke Mandeville Sports Stadium for the Paralysed and Other Disabled, British Paraplegic Sports Society Ltd, Harvey Road, Aylesbury, Bucks, UK

HARDY, Dr. A. G., Consultant in Charge, Spinal Injuries Unit,

- Lodge Moor Hospital, Sheffield S10 4LH, UK
- a* (page 269) HARGEST, T. S., B. A., Director, Division of Clinical Engineering, Medical University of South Carolina, 80 Barre Street, Charleston, South Carolina 29401, U.S.A.
- HENDERSON, Miss M., Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- HOLDSWORTH, L., Department of Health and Social Security, Kingston By-Pass Road, Surbiton, Surrey KT6 5QN UK
- a*^{*} (page 69) HOLLOWAY, G. A., M.D., University of Washington, Seattle, Washington 98195, USA
- HORNE, Miss C., 35 Church Street, Alloa, Clackmannanshire, UK
- HORRELL, P., Johnson & Johnson Ltd, 160 Bath Avenue, Slough, Berks, UK
- c* (page 344) HUGHES, J., B.Sc., C.Eng., M.I.Mech.E., F.I.S.P.O., University of Strathclyde, National Centre for Training & Education in Prosthetics and Orthotics, 119 Rottenrow, Glasgow G4 0NW, UK
- a*^{*} (page 169) HULME, M. J., B.Sc., Department of Biological Sciences, University of Dundee, Dundee DD1 4HN, UK
- HUTCHISON, Miss W., District Nursing Officer, Argyll and Clyde Health Board, Dumbarton District, Westonlee House, Bonhill Road, Dumbarton, UK
- a*^{*} (page 243) HUTTON, W. C., Polytechnic of Central London, 115 New Cavendish Street, London, W1M 8JS, UK
- ILAH, M., 845 Great West Road, Isleworth, Middlesex, UK
- c* (page 3) ILLINGWORTH, Sir Charles, C.B.E., M.D., Ch.M., D.Sc., LL.D., S.R.C.S., S.A.C.S., 57 Winton Drive, Glasgow G12, UK
- a* (page 165) ISHERWOOD, P. A., M.B., Ch.B., Department of Health and Social Security, Biomedical Research and Development Unit, Roehampton Lane, London SW15 5PR, UK
- a*^{*} (page 199) JACOBS, J. E., Ph.D., D.Sc., Director, Biomedical Engineering Centre, North Western University, Evanston, Illinois 60201, USA
- a* (page 287) JENEID, Miss P., S.R.N., B.T.A., Regional Plastic and Jaw Surgery Centre, Burns Unit, Mount Vernon Hospital, Northwood, Middlesex, UK (Seconded from the Department of Biomedical Engineering, Institute of Orthopaedics, RNOH, Stanmore, Middlesex, UK)
- JENKINS, Miss E., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

- JOHNSTON, Miss A., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- JORDAN, Miss M., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 95) JUVINALL, R. C., M.S.M.E., Department of Mechanical Engineering, The University of Michigan, College of Engineering, Ann Arbor 48104, USA
- c* (page 343) KENEDI, Professor R. M., B.Sc., Ph.D., A.R.C.S.T., C.Eng., F.I.Mech.E., M.R.Ae.S., F.R.S.E., Head, Bioengineering Unit, Wolfson Centre, University of Strathclyde, 106 Rottenrow, Glasgow G4 0NW, UK
- a** (page 69) KENNEDY, D., University of Washington, Seattle, Washington 98195, USA
- KENNEDY, Mrs F., University of Strathclyde, Administration Office, Royal College Building, George Street, Glasgow G1 1XW, UK
- a** (page 327) KIRBY, L., 12 Lower Road, Stoke Mandeville, Bucks, UK
- KORESKA, J., M.A.Sc., M.Eng.F., P.Eng., Department of Medical Engineering, Hospital for Sick Children, 555 University Avenue, Toronto, Ontario, M5G 1X8, Canada
- LANCKERSTER, M. J., Egerton Ltd, Walters Yard, High Street, Bromley, Kent, UK
- LAWES, P., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- LAWSON, Mrs A., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- LAY, J., Medical Products Manager, Medelec Ltd, Manor Way, Old Woking, Surrey GU22 9JD, UK
- LEGGAT, Mrs M.A., Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- LILDHOLT, T., Teglgardsvej 3, DK 8270, Højebjerg, Denmark
- LONG, D. J., Technical Director, Mycalex Instruments Ltd, Charlton Kings Industrial Estate, Cirencester Road, Cheltenham GL53 8DZ, UK
- LOUGHRAN, A., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 141) LOWTHIAN, P. T., S.R.N., Epidemiology and Medical Care Unit, Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3DJ, UK
- LYON, H. F., Ellangowan, 18 Keir Street, Bridge of Allan, Stirling FK9 4AY, UK

LYTHE, Professor S. G. E., M.A., F.S.A.(Scot.), Vice Principal,
University of Strathclyde, McCance Building, Richmond Street,
Glasgow G1 1XQ, UK

McCALL, Mrs J., District Nursing Officer, Southern General
Hospital, Govan Road, Glasgow G51 4TF, UK

McCLURE, D., University of Strathclyde, Bioengineering Unit,
Wolfson Centre, 106 Rottenrow, Glasgow, G4 0NW, UK

McCONVILLE, Miss C., 64 Campsie Road, Wishaw,
Lanarkshire, UK

a (page 147) McCREADIE, D.W.A., Ph.D., M.F.C.M., F.H.A., Scottish
Home and Health Department, St. Andrews House, Edinburgh
EH1 3DT, UK

McDONALD, Miss V., Philipshill Hospital, Busby, Clarkston,
Glasgow, UK

a (page 161) McDOUGALL, A., M.B., Ch.B., F.R.C.S.(Edin.), F.R.C.S.
(Glasg.), Department of Orthopaedics, Victoria Infirmary,
Glasgow G42 9TY, UK

MacGREGOR, Dr J., University of Strathclyde, Bioengineering
Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

McGROUTHER, D. A., Plastic Surgery Unit, Canniesburn
Hospital, Glasgow G61 1QL, UK

MACINTYRE, Dr I. D., 327 North Christina, Sarnia, Canada

MacKENZIE, Mrs E., Philipshill Hospital, Busby, Clarkston,
Glasgow, UK

MACKIE, R., 32 Waverly Drive, Wishaw, Lanarkshire, UK

MacLACHLAN, D. F. A., Gaeltec Ltd, Stein, Waternish, Isle of
Skye, Invernesshire 1V4 19QA, UK

McMAHON, Miss M., Senior Nursing Officer, 3 Cumming
Drive, Mount Florida, Glasgow G42 9A1, UK

McROBERTS, Mrs E., Southern General Hospital, 1345 Govan
Road, Glasgow G51 4TF, UK

MARKS, Dr R., Consultant Physician, Department of Medicine,
Welsh National School of Medicine, Heath Park, Cardiff CF4
4XN, UK

MELROSE, Miss A. L., Knowepark Hospital, Galashiels,
Selkirkshire, UK

MIDDLETON, B. A., Clinical Adhesives, 110 Leavesden Road,
Watford, Herts, UK

MILLINGTON, Dr P. F., University of Strathclyde,
Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow
G4 0NW, UK

MILNE, Miss S., University of Strathclyde, Bioengineering Unit,
Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK

- MOLNAR, G., Armour Pharmaceutical Co. Ltd, Hampden Park, Eastbourne, Sussex BN22 9AG, UK
- MOORE, Miss M. J., Nursing Officer, 7 Banchory Avenue, Eastwood, Glasgow G43 1EX, UK
- MORRISON, Miss C., Victoria Infirmary, Grange Road, Glasgow G42 9TY, UK
- MORRISON, Miss J., General Hospital, Ayresome Green Lane, Middlesbrough, Cleveland TS5 5AZ, UK
- a** (page 169) MUDIE, A., Department of Biological Sciences, University of Dundee, Dundee DD1 4HN, UK
- c* (pages 125, 344) MURDOCH, Professor G., M.B., Ch.B., F.R.C.S.(Edin.), Surgeon in Charge, Dundee Limb Fitting Centre, 133 Queen Street, Broughty Ferry, Dundee DD4 1AG, UK
- MURRAY, Miss I., 88 Myrtle Crescent, Kirkcaldy, Fife, UK
- NAIRN, Miss M., Chief Area Nursing Officer, Greater Glasgow Health Board, 351 Sauchiehall Street, Glasgow G2 3HT, UK
- NEALE, Mrs E., Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- NEUMARK, O. W., Beaufort (Air-Sea) Equipment Ltd, Wren Nest Mill, High Street West, Glossop, Derbyshire SK13 8EZ, UK
- NICOLL, Miss E., Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- NUNN, Mrs G., Philipshill Hospital, Busby, Clarkston, Glasgow, UK
- a** (page 169) OLIVER, R. F., B.Sc., Ph.D., Department of Biological Sciences, University of Dundee, Dundee DD1 4HN, UK
- PAGE, D. C., Dylade Co. Ltd, 45 Brindley Road, Astmoor Industrial Estate, Runcorn, Cheshire, UK
- PARROT, C., Sales Manager, Dunlop Ltd, Dunlopillo Division, Pannal, Harrogate, North Yorks HG3 1JL, UK
- PATTERSON, J., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- c* (page 3) PAUL, Professor J. P., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 219) PETERSEN, N. C., M.D., Surgeon in Charge, Department of Plastic Surgery, Århus University Hospital, 8000 Århus C., Denmark
- PIGOTT, R. W., Consultant Plastic Surgeon, Frenchay Hospital, Bristol, UK
- RECORD, P., University of Strathclyde, Bioengineering Unit,

- Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 211) REDFERN, Miss S. J., B.Sc., S.R.N., Applied Psychology Department, University of Aston, College House, Costa Green, Birmingham B4 7ET, UK
- REHANA, Miss B., Doncaster Royal Infirmary, Doncaster, South Yorkshire, UK
- c, a* (pages 147, 344) REID, Miss A. A., Cameron Hospital, Windygates, Fife, UK
- REID, Miss E. A., M.Phil., R.G.N., R.S.C.N., S.C.M., Senior Nursing Adviser, Scottish Health Service, Common Services Agency, Buildings Division, 11 Drumsheugh Gardens, Edinburgh, UK
- RENFREW, Mrs J., The Elms, 11 Grove Park, Lenzie, near Glasgow, UK
- c, a* (pages 181, 301, 344) RESWICK, J. B., Sc.D., Director, Rehabilitation Engineering Centre, Rancho Los Amigos Hospital, H121, 743 Golandrinis Street, Downey, California 90242, USA
- a* (page 5) ROAF, Professor R., F.R.C.S., M.Ch., Orth., M.A. (Oxon), Department of Orthopaedic Surgery, The University of Liverpool, P.O. Box 147, Liverpool L69 3BX, UK
- ROBERTSON, J., University of Strathclyde, Bioengineering Unit, Wolfson Centre, 106 Rottenrow, Glasgow G4 0NW, UK
- a* (page 301) ROGERS, J. E., M.S., 1400 North Carol Street, Lahabra, California, USA
- a* (page 79) ROMANUS, E. Mikael, M.D., University of Göteborg, Faculty of Medicine, Department of Anatomy, Fack, S-400, 33, Göteborg, Sweden
- ROPER, Miss N., M.Phil., S.R.N., R.S.C.N., R.N.T., Nursing Officer (Research), Room 25, St. Andrews House, Edinburgh EH1 3DE, UK
- RYAN, D. M., 22 Viewfield Cottages, Stoney Chryston, near Glasgow, UK
- SACHS, Dr. M. L., Hospital of the University of Pennsylvania, 3400 Spruce Street, G1, Philadelphia 19104, USA
- c, a* (pages 11, 125, 259, 344) SCALES, Professor J. T., F.R.C.S., C.I.Mech.E., Department of Biomedical Engineering, The Institute of Orthopaedics, Royal National Orthopaedic Hospital, Stanmore, Middlesex HA7 4LP, UK
- SCOTT, I., Biomedical Engineering, 42/43 Gerrard Street, London W1V 7LP, UK
- SCOTT, Miss K. A., Nursing Officer, South Eastern District, Victoria Infirmary, Glasgow G42 9TY, UK
- a* (page 185) SEVERINSSON, K., University of Göteborg, Department of Handicap Research, Övre Husargatan 3, S 413-1, Göteborg,