MILITARY SPORTS AND REHABILITATION MEDICINE

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Abstract

This article summarises the presentations at the Sports Medicine and Rehabilitation Study Day held by the Haywood Club at The Medical Society of London on 21 September 2006. The event was attended by over 100 serving and retired DMS personnel and included talks on a diverse range of subjects from the newly established speciality of Sports and Exercise medicine, the role of physiotherapy, exercise therapy and podiatry, core stability, tendon disorders, anterior knee pain, and the management of chronic pain.

Introduction

Sports medicine has previously been regarded as a mixture of several disciplines including medicine, surgery, physiotherapy and podiatry. Until recently it had no clearly defined practitioner and was regarded as a sub-specialist interest of other practitioners such as GPs, rheumatologists and orthopaedic surgeons. Sports medicine entails prevention, diagnosis and treatment of injuries, use of exercise therapy and rehabilitation and ensuring optimum performance in the athlete/patient. The evolution of Sports and Exercise Medicine (SEM) reflects the enhanced role of exercise therapy for injury prevention/treatment as well as its public health role of improving general cardiovascular and musculoskeletal fitness for prevention of other diseases.

Sports and Exercise Medicine

Exercise benefits health and prevents disease. Runners have a 30% reduction in CHD over 10 years, and exercise has been shown to reduce hypertension, diabetes type II, osteoporosis and back pain. In 2002, 22.4% of UK population aged 15 and over were obese (BMI >30) compared with only 7% in 1980 (1). Physical inactivity is seen as a major factor in this obesity epidemic, however, the use of exercise in prevention is not without cost. There are 19 million injuries per year (50% potentially serious) and 8 million working days lost (2% of all certified incapacity) as a direct result of sporting activities. This results in an estimated financial cost of £645 million (£240m due to direct injury and a further £405m in lost productivity) (2).

The Department of Health's (DH) support for the speciality of SEM is based predominantly on the hope it will help combat this obesity epidemic. The DH created the speciality in February 2005 and the curriculum was agreed in July 2005. The Faculty of Sports and Exercise Medicine (FSEM) was announced in December 2005 as joint body between the Royal College of Physicians of London and Royal College of Surgeons of Edinburgh.

There are two levels of FSEM association – Member and Fellow. Those with a diploma or MSc in SEM are eligible for membership. All newly appointed fellows have to hold the certificate of completion of training (CCT) in SEM and be appointed to the Specialist Register. The route to obtaining this in the new MMC pathway is outlined in Figure 1.

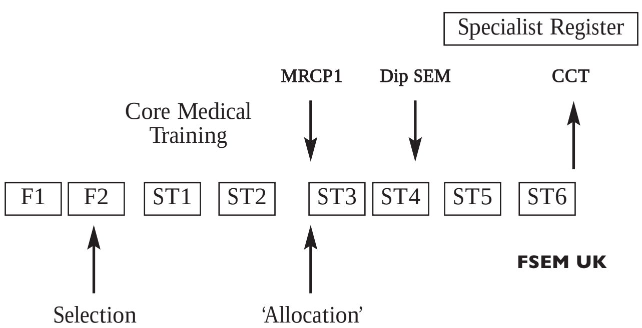

Fig 1: Run through training

There is a high incidence of injury within the military as a result of training and sport. These account for 37% of first attendances at primary care and 67% of working days lost (3). Training and exercise injuries account for 45% all medical discharge (3). The Defence Medical Services (DMS) has therefore been a key partner in establishing the new speciality and funding training posts for military doctors. The speciality of SEM within the DMS comes under the Rheumatology and Rehabilitation (R&R) medicine cadre. The Defence Consultant Advisor (DCA) in SEM is Director of Defence Rehabilitation (DDR) who also has a permanent seat on the FSEM Council as the Armed Forces Representative.

Rehabilitation Medicine

The key elements for DMS rehabilitation medicine are musculoskeletal injuries, polytrauma, prosthetic limb fitting, spinal cord injury, and traumatic brain injury. 14 Regional Rehabilitation Units (RRUs) are now situated at Devonport, Portsmouth, Tidworth, Aldershot, Halton, Colchester, Honington, Cranwell, Catterick, Edinburgh, Aldergrove (Northern Ireland), Hohne (Germany), Gutersloh (Germany), and Lichfield (currently proposed) and deal with the majority of the simple musculoskeletal injuries in the Armed Forces. More complicated cases are treated at the Role 4 establishment for

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rehabilitation at DMRC Headley Court. For soldiers in theatre who suffer a minor musculoskeletal injury or exacerbate a pre-existing condition, Deployed Medical Rehabilitation Teams (DMRT have been established, and are placed within the Role 2+/3. Patients are reviewed in multidisciplinary assessment clinics and rehabilitation treatment initiated in theatre, decreasing the number of patients aeromedically evacuated to the UK and allowing maintenance of the fighting force. The DMRT was a core facility during Op TELIC and most recently has been established on Op HERRICK.

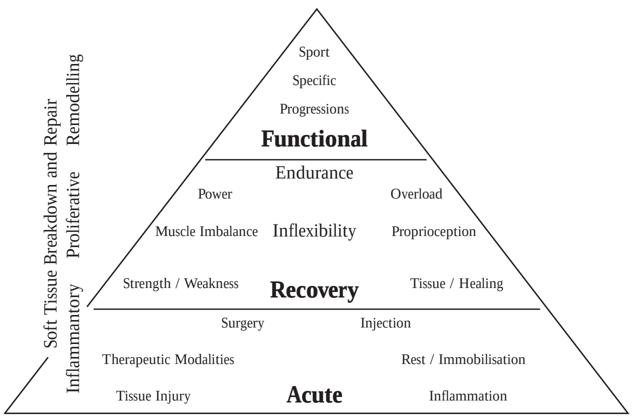

Fig 2: The principles of treatment staged by phases of rehabilitation

Injury Management

The principles of injury assessment are based on the mnemonic: SALTAPS (F) [see, ask, look, touch, active, passive, strength, special tests, (function)], and the importance of a good history cannot be stressed enough. The principles of treatment are displayed in Figure 2. In the acute phase, minimising the extent of initial damage is key, reducing pain and inflammation, and promoting healing of damaged tissue. When the patient is in the recovery phase, it is necessary to maintain or restore flexibility, strength, proprioception and fitness levels. In the late stages, it is necessary to rehabilitate to full functional fitness and to prevent recurrence of the injury. Short-term resolution may lead to failure unless the underlying cause is recognised e.g., a stress fracture may heal with rest but may have been caused by poor biomechanics, inadequate footwear, hard running surfaces or inappropriate training. It is likely to therefore recur if these underlying factors are not corrected.

Remedial Instructors and Exercise Therapy

Remedial instructors (RIs) are military exercise therapy professionals with a physical training background. Selected individuals from the physical training branch of all three Services are selected to undergo a demanding six-month academic and practical course at DMRC Headley Court. RIs possess a unique knowledge in rehabilitation and crucially understand Service ethos, the physical demands placed on Service personnel and the benefits of exercising in groups. In the typical military rehabilitation scenario, groups are made up to a maximum of 15 patients. The RI has responsibility for the delivery of exercise therapy as prescribed by doctors and physiotherapists. Treatment modalities/interventions offered by RIs include exercise therapy such as strengthening or mobilising, walking and running re-education, co-ordination and balance work, lifting and carrying re-education. Other more specialist treatments provided include hydrotherapy, cryotherapy, taping and strapping.

The goals of rehabilitation at each phase and the methods to achieve this are summarised in Table 1. Proprioceptive re-education (PRE) assesses the patient's ability to balance, followed by appropriate training for the deficits. When balance is compromised, automatic postural adjustments are made by reflex mechanisms to keep the centre of gravity within the base of support (which is the area between the feet in contact with the ground), widening the base and lowering the centre of gravity as required. The mechanism of balance can be subdivided: the ability to maintain balance when stationary is defined as static balance, whilst moving is called dynamic balance. The control of balance relies on adequate sensory information from vision, vestibular function, proprioception, tactile input in the afferent pathway and integration of all this sensory information into the central nervous system. Furthermore, effective muscle tone, strength, endurance, and joint flexibility are all key components in the efferent pathway. The restoration of this link between

Table 1: Goals and methods of rehabilitation

	Recovery Phase 1	Recovery Phase 2	Functional Phase
GOALS	Restore functional ROM Strengthen weak muscles Introduce functional activity	Restore full ROM Restore functional strength Progress functional activity	Progress to full function
METHODS	Passive/Assisted mobilisation Isometric/Isotonic exercise Walking re-education Non weight bearing PRE Hydrotherapy	Freely active mobility Isotonic PRE Running re-education Weight bearing PRE	Continued PRE Circuit Training Plyometrics CV training Running programme Sport specific conditioning Functional Testing

ROM = range of motion
PRE = proprioceptive re-education

	Cause	Clinical problems
Excess Pronation	limb length discrepancy genu varus/valgus tibial varus/valgus ankle equines subtalar joint varus/valgus supinatus dorsiflexed 1st ray tibialis posterior dysfunction tarsal coalition systemic causes e.g. rheumatoid arthritis	overuse injuries medial knee pain retropatellar pain achilles tendinopathy tibialis posterior tendinopathy plantar fasciitis stress fracture digital deformity lumbar back pain
Excess Supination	limb length discrepancy genu varus tibial varus subtalar joint varus plantarflexed 1st ray iatrogenic (foot orthoses)	decreased shock absorption osteoarthritis stress fractures lateral knee pain lateral ankle sprain digital deformity iliotibial band friction syndrome

Table 2: Biomechanical alterations to foot position by aetiology and resulting pathology

"input and output" is key in achieving PRE, with a step-wise progression getting the patient to maintain stability on a stable base, to performing a movement whilst maintaining body stability on a moving base, to eventually being able to control posture and movement whilst not looking at the limb(s) involved.

Foot and gait biomechanics

Clinical biomechanics are assessed using a mixture of patient non-weight-bearing assessments, weight bearing assessments, gait-analysis (with or without video or computer tracking assistance), plantarfoot pressure measurements, and radiological investigations. The key action of subtalar joint movement is to allow pronation (allowing the foot to become a mobile adapter) or supination (allowing the foot to become a rigid lever). The causes of abnormal subtalar pronation or supination are numerous and include congenital as well as acquired injuries local to the foot or further up the kinetic chain in the ankle, leg, knee, hip or back. Table 2 summarises the causes and effects associated with excess pronation and supination. Foot and ankle problems related to sport often result from abnormal biomechanics or injury mechanisms to the foot that alter the biomechanics of the joint or unmask an existing defect. These include pathologies listed in Table 2 as well as *de novo* fracture of the bones from acute overload, stress fracture, osteochondritis, interdigital neuroma, dislocation of peroneal tendons and tendinopathies.

The management of abnormal foot biomechanics requires an integrated approach that does not solely focus on the orthotic as cure. A foot orthotic is an insert placed between plantar sole and the shoe, which supports the weightbearing foot and changes its position, thereby altering the loading of force upon the limb. Muscular balance (strength and flexibility), proprioception and balance, core stability, any training errors and footwear should all be addressed whilst customised orthoses are issued.

Core Stability

Core stability is integral to all forms of rehabilitation, although is most established in back pain. It is promoted as preventative regimen, a form of rehabilitation and as a performance-enhancing programme for all types of sport. Truncal movement is controlled by superficial stabilisers (rectus abdominis, external oblique) whilst deep stabilisers of the trunk and lumbar spine (transversus abdominus, multifidus and internal oblique muscles) control posture. The lumbar spine is inherently unstable and relies on the musculature for stabilisation. 'Core stability' training targets these deeper muscles and exercises involve 'inner range' holding of the muscles (which involves contraction of the muscle in its shortened functional position), eccentric control, muscle balance and proprioception. Thus if the core is stable, then there is less shearing across the lumbar spine. However, pure muscle strength alone is insufficient; the timing of muscle recruitment is also important. The concept of core muscle strengthening with recruitment and timing is not new; these are evident in Joseph Pilates 1920's 'girdle of strength' teaching.

Back pain results in a local stability muscle dysfunction and slow motor unit recruitment. Transversus abdominis is the deepest abdominal muscle and acts as the corset muscle of the spine and pelvis. Normally it contracts in anticipation of body motion, however it is easily inhibited if a patient suffers low back or pelvic pain, and it does not automatically resume its function after the precipitating insult has ceased. Multifidus are short multi-articular muscles that act over 1-2 vertebral segments. They act as segmental stabilisers of the lumbar spine and allows controlled rotation of the trunk, assisted by semispinalis, which act over 4-5 vertebral segments. Assessment of return function can be done clinically (by the patient reporting decreased pain) or by using objective biofeedback measurements such as electromyography (EMG) or ultrasound imaging.

Exercise programs do not specifically address the underlying pathology causing muscle/movement dysfunction, which may be due to a myriad of insults (such as disc degeneration or prolapse, facet joint degeneration or spinal ligament overstretch) most of which are self-limiting. Movement dysfunction will remain however, unless retrained. The benefits of the strengthening programs include the placebo effect and other psychosocial benefits gained from exercise, in addition to overcoming intrinsic muscle stiffness and enhancing stability and strength.

Management of Tendon Disorders

Tendon and soft tissue disorders account for 60% of new Rheumatology referrals. The prevalence of Achilles tendinopathy is 11% in runners (4). The tendons most commonly involved are the rotator cuff (particularly suprapinatus) and biceps brachii at the shoulder, extensor and flexor tendons of the forearm, hip adductor tendons at the groin, patella and quadriceps tendons at the knee and Achilles and tibialis posterior tendons in the foot and ankle.

Histological studies demonstrate disorganised tissue with mucoid degeneration, a loss of tightly bundled collagen with 'focal thickening' and 'core degeneration', a lack of an inflammatory infiltrate, and neovascularisation, which is also evident on power doppler ultrasound scanning of the tendon. Inflammation is not characteristic of established disease but may be involved early on in the disease process. Only 2 human studies have been reported with conflicting results (5,6), and the terminology remains confusing. Tendinitis implies inflammation and is therefore not appropriate. Tendinosis is a degenerate condition without inflammation, and tendinopathy makes no assumption of pathology/inflammation and is thus the preferred term.

The mechanical theory for the aetiology of tendinopathy is most widely accepted. It states that tendons can elastically deform to 6% strain. Strains in excess of 6% result in partial failure/rupture and >10% in complete rupture. Sub-maximal strain with repeated loading can still result in partial failure explaining how repetitive loading can lead to cumulative damage and increased incidence of degenerative pathology with increasing age. It however does not account for the expected strengthening with physiological use and explain why specific tendons are particularly vulnerable.

Various treatments have been studied including NSAIDs (7) and corticosteroids (8,9). The role of NSAIDs is controversial due to the absence of inflammation in established tendinopathy but their analgesic property may be more significant. The use of corticosteroids has been demonstrated as providing some benefit, however there are reports of tendon rupture following corticosteroid injection (10). These studies have used pain relief as the outcome but not tendon healing. Other treatments such as heparin, dextrose (prolotherapy), aprotinin, autologous red cell injections, sclerosants, ultrasound guided electrocoagulation, therapeutic ultrasound, cryotherapy, laser, deep transverse friction massage, soft tissue mobilisation, biomechanical alterations, extracorporeal shock wave therapy, and topical glyceryl trinitrate have been used in smaller trials and it is difficult to draw conclusive evidence from them (11).

Eccentric loading is the preferred exercise therapy and was first investigated in 1986 on Achilles tendinopathy (12), however the landmark study was by Alfredson in 1998 (13). The evidence for eccentric training in Achilles tendinopathy is supported by long term evidence, with normalisation of tendon structure and reduction of neovascularisation. This concept has been applied to

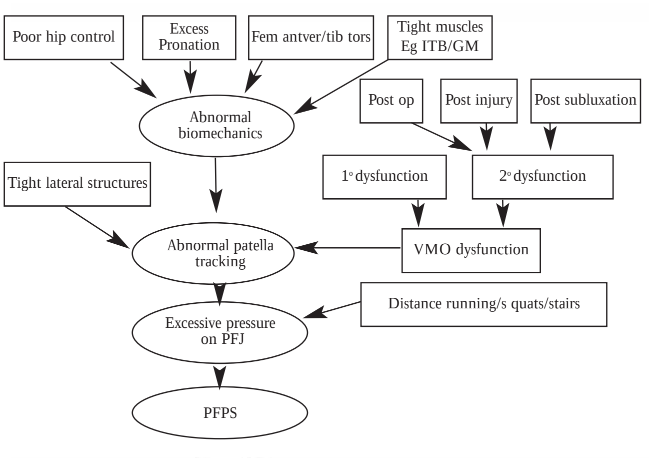

Fig 3: Predisposing factors to PFPS

patella (14,15) and supraspinatus (16) tendinopathy with encouraging results in trials so far, however certain challenges exist with eccentric loading regimes. The mechanism by which it works remains poorly understood, the exercises can be difficult to comprehend and therefore do, and it is a tough training protocol even for motivated patients to perform as it requires multiple repetitions several times a day on a daily basis for several weeks. There is often a flare-up of symptoms before the patient notices any improvements. The best evidence is for mid-tendon lesions and it is often unsatisfactory for insertional or muscle-tendon junction tendinopathies. Further research will undoubtedly help improve future exercise protocols.

Anterior Knee Pain

Non-specific retropatellar pain has been described over the years variously as chondromalacia patella (CP), anterior knee pain (AKP) and most recently as patello-femoral pain syndrome (PFPS). Initially patients were classified as having CP because it was believed that softening of the retropatellar cartilage was responsible. Further understanding led to the terminology being changed to the non-specific term AKP, which describes a symptom and not the diagnosis, leading to the current and more appropriate term, PFPS. The common differential diagnoses of AKP are PFPS, patellar tendinopathy, fat pad impingement, patellofemoral instability, and patellofemoral joint osteoarthritis. Less common causes include pre-patellar bursitis, quadriceps tendinopathy, infrapatellar bursitis, traction apophysitis (Osgood Schlatter's disease [apophysitis of the tibial tuberosity] or Sinding-Larsen-Johansson disease [apophysitis of the infrapatellar pole]), stress fracture of the patellar, osteochondritis dissecans and referred pain from the hip.

PFPS is defined as peripatellar and/or retropatellar pain that results from physical and biomechanical changes in the patellofemoral joint (PFJ), in the absence of other specific pathology. Thus the diagnosis of PFPS can only be made when all other causes of AKP have been excluded. The source of the pain in PFPS is not thought to be generated from the articular cartilage as there is no relationship between cartilage damage observed on arthroscopy and the level of pain (17). Articular cartilage is also aneural (18). It has been suggested that the pain originates from the subchondral bone (19), intraosseous hypertension (20) or the lateral retinaculum. The most probable source however is the synovium, which is richly innervated. A chronic mechanical overload of the PFJ causing chemical irritation leading to synovitis is the most likely pathophysiology.

The epidemiology of PFPS makes it the most common presenting symptom in clinical sports medicine practice (21), and it is reported as responsible for 10% of all visits to a sports clinic (22). The diagnosis of PFPS is a clinical one based on a six week history of peri- or retropatellar pain during typical activities such as running, squatting, prolonged sitting with knees flexed (cinema sign) or whilst descending stairs. Other common symptoms are pseudo-locking and giving way. Giving way of the knee typically ascending or descending stairs is characteristic of PFPS. Giving way during turning or cutting activities is usually due to intra-articular pathology. On examination, 2 of the 4 following signs (23,24) are required: pain on patella compression, pain on palpation of the retropatellar facets, pain on resisted leg extension or pain on isometric contraction of the quads while restraining the patella (Clarke's test). Investigations are only required to exclude other pathology.

Predisposing factors that contribute to PFPS are summarised in Figure 3. These all end in the final common pathway of abnormal biomechanics with abnormal patella tracking, resulting in a laterally placed patella rather than one that is placed symmetrically in the femoral trochlea, resulting in excessive pressure on the PFJ and thus PFPS. Various treatments have been postulated over the years but the best outcomes observed with an integrated, progressive and functional rehabilitation programme which involves quadriceps (in particular vastus medialis obliquus) and gluteus medius strengthening and stretching, iliotibial band/lateral retinaculum stretching and massage, correction of abnormal biomechanics, taping (most commonly the correction of a lateral glide of the patella) and patient education (25). The Pre-patellar Pain Group (PPG) rehabilitation programme used at the RRUs and DMRC is based on this.

The prognosis is generally good if a rehabilitation programme following the above principles has been undertaken (24,26). In a 7 year follow up, 75% had complete subjective and functional recovery at 6 months, and 80% "excellent" outcome at 7 years, (66% full recovery) (17). The experience at DMRC using the PPG programme was demonstrated in a prospective study from 2001 to 2002. 106 patients (16 female, mean age (sd) 31 years ± 5) had a median duration of anterior knee pain of 4.4 years. The programme duration was 6 months and patients were assessed at the start, at 3 months and at 6 months. At 3 months, 70% of patients had reduced pain intensity and 80% reported that the pain affected them less in the daily activities. There was also a 70% improvement in the Chesworth (27) Functional Index questionnaire score at 6 months.

Management of chronic pain

The rationale for treating pain focuses on the economic cost of this condition, the burden it places on the wellbeing of patients and the demand for treatment in the population. With regard to the economic burden, musculoskeletal diseases account for 1-2.5% GNP of many western countries (28). This economic burden comprises both the direct costs of medical interventions and indirect costs, such as premature mortality, chronic and short-term disability. Back pain is in the top ten costly conditions (29). The direct health care cost of back pain in 1998 was estimated to be £1.6 billion whilst the cost of informal care and the production losses related to it, total £10.7 billion in the UK (30). The probability of successfully returning to work diminishes with time (31,32). Epidemiological studies report that in 4600 subjects from a GP database in Scotland, 16% had moderate to severe disability from pain (33) and 4 years later 79% remained in pain (34). Studies on the Danish population report a 19% overall prevalence with 40% of those with chronic pain not satisfied with the treatment offered, despite using the health care system twice as much as the control group (35,36).

Acute pain management is well established according to the WHO Acute Pain Ladder System, illustrated below:

Paracetamol +/- NSAID ➤Combination/weak opioid ➤ Morphine

Chronic pain management is not so simple however. This is in part because in chronic pain, the aetiology and mechanisms are not understood, there is no agreed treatment protocol and the prognosis is not always good. Examples of chronic pain include low back pain (LBP), complex regional pain syndrome (CRPS) and phantom pain following amputation. Thus a different approach is required with a range of treatments. Patients are asked what they consider the cause of their pain is (ranging from 'Emotional' to 'Physical') and what treatments they feel would help ('Psychology' to 'Needle') and point this out on a scale. Figure 4 reproduces this diagrammatically and is used in military chronic pain clinics.

Fig 4: "Spectrum" of approaches to pain management. This diagram is used in military chronic pain clinics and patients point on the scale what they believe the cause of their pain is from and then, what will help treat it.

"Yellow Flags" are important factors to identify from the history as they consistently predict poor outcomes. These include a belief that back pain is harmful or potentially severely disabling, fear-avoidance behaviour (avoiding a movement or activity due to misplaced anticipation of pain) and reduced activity levels, a tendency to low mood and withdrawal from social interaction, and expectation of passive treatment(s) rather than a belief that active participation will help. To overcome these "yellow flags", it is essential to include patient education, patient-led decisions in the patients management, and explanation that a 'cure' will often require a change in the patient's outlook.

The emotional component of chronic pain, including anxiety, unhappiness and frustration, is part of the symptomatology and talking about this with the patient is important. In addition, the use of antidepressant drugs used in the correct depression dose may be helpful. The options for treatment of the physical component include doing nothing, physiotherapy and exercise therapy, osteopathy and chiropractic, the use of topical NSAIDs or capsaicin, oral medications, and "Needles" (explained below).

Pharmacological options include analgesics, tricyclic antidepressants, anticonvulsants (such as carbamazepine/ gabapentin), local anaesthetics, and antispasmodics (such as baclofen). The "Needles" option is presented to patients as an opportunity to break the pain cycle, rather than a cure. Epidural injections of local anaesthetic and corticosteroid can be delivered via the caudal route or directly into the lumbar, thoracic or cervical spaces, and are performed under fluoroscopy . Facet joints in the lumbar, cervical or thoracic vertebrae can also be directly injected under fluoroscopic guidance often with a good response. Radiofrequency ablation may be used when lumbar facet joint injections are insufficient for pain control. Pulsed or continuous radiowaves are used for "neuromodulation". Intravenous regional anaesthesia using guanethedine and atropine or magnesium has been used for CRPS, but the evidence for their effectiveness is mixed (37,38).

Conclusion

The high levels of physical activity in the Armed Forces ensure a steady stream of injured Service personnel with musculoskeletal injury. This article aims to impress upon the reader the military need for SEM specialists and emphasise the cross-over with other specialities within medicine and allied health specialties. Exercise therapy is the mainstay of rehabilitation in DMRC and its satellite RRUs, and is targeted to the occupational demands of the injured soldier, sailor or airman. Key advances in the understanding of common conditions as back pain, tendinopathy and knee pain have improved the quality of exercise programmes to maximise the retention of valuable highly-trained personnel. For those that do not benefit from exercise therapy alone, alternative non-operative approaches such as from chronic pain teams are available. In today's shrinking military, it has never been so important to ensure as many personnel are healthy and fit for task as possible.

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