This clinical guideline was endorsed by the Chartered Society of Physiotherapy in September 1998. The endorsement process has included review by relevant external experts as well as peer review. The rigour of the appraisal process can assure users of the guideline that the recommendations for practice are based on a rigorous and systematic process of identifying the best available evidence, at the time of endorsement.

Review date: 2002

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The Association of Chartered Physiotherapists in Sports Medicine put in a bid to the Chartered Society of Physiotherapy for Department of Health funding to develop clinical guidelines in the profession. We were successful in our bid and this document is the outcome of this process.

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Contents

Opening statement

In the autumn of 1995, the Clinical Interest Groups of the Chartered Society of Physiotherapy (CSP) were approached to submit proposals for funding (provided by the Department of Health) to develop clinical guidelines for practice, as part of the move towards evidence-based practice. The funding body (Department of Health, through the CSP) provided no priority areas in which guidelines should be developed, so the decision to participate, and the focus of the guidelines was made independently by the individual group.

The committee of the Association of Chartered Physiotherapists in Sports Medicine (ACPSM) decided to become involved in this process, and debated a suitable choice of topic. As the PRICE regimen in the early management of soft tissue injuries is so widely accepted, both in practice and in the literature, we felt strongly that this topic area would deliver sound supporting evidence which would form the basis for practice. Furthermore, it appeared that there existed considerable variation in practice, so it was deduced that an extensive review of the evidence would provide information on the most effective mode of application of the regimen.

This document, in the form of a reference manual, is aimed at professional practitioners in sports medicine (or in accident and emergency care), and records the process undertaken in the development of the guidelines (**Appendix A**), a review of the literature and an analysis of current practice, and the final outcome in the form of guideline statements supported by the evidence. It also projects future developments regarding the implementation, evaluation and review of the guidelines. Supporting leaflets, based on the guidelines from this document, will be developed for wider distribution.

Guideline development group

The core group responsible for the development of these guidelines consisted of physiotherapists, both clinical practitioners and academics, all of whom were members of ACPSM. The original discussion group who made the decision to proceed with the guidelines was eight in number, but the geographical distribution and professional demands suggested that it would be more effective to set up a smaller working party which could meet regularly. This working party (the development group) then reported to and sought advice from a larger group of physiotherapists who formed the Executive Committee and Regional Representatives of ACPSM. This also acted as a forum to gain consensus when evidence was not available from the literature. Members of the development group were:

Kate Kerr	PhD; BA; MCSP; Post Grad Dip Health Ed; Cert Ed (Senior Lecturer, Physiotherapy, University of Nottingham); Education Chairman ACPSM
Lynda Daley	MCSP; SRP (Director, Physiotherapy Sports Injury Clinic); Chairman ACPSM
Lynn Booth	MSc; MCSP; SRP (British Olympic Association Physiotherapy Chairman); Vice Chairman ACPSM.
Julie Stark	MSc MCSP SRP (Private Practitioner)

Representation of teachers, leisure centre staff, athletes and patients will be included in the development of supporting leaflets for wider distribution.

1 Introduction

Before reading this document it is important to recognise the precise remit of these guidelines and to understand the target population to whom these clinical guidelines should be applied. A number of factors need to be considered:

- When an individual is injured, many different tissues in the body may be damaged by the mechanism of injury - for example, bones may be broken, major blood vessels or nerve trunks may be ruptured, severed or compressed and the central nervous system may be damaged through head and spinal injuries.
- Furthermore, a relatively straightforward soft tissue injury may be complicated by other factors - for example, a rugby player sustaining a knee ligament injury in a tackle may also sustain concussion in the same incident.
- Although PRICE is generally accepted as being an appropriate form of management immediately following acute soft tissue injury, there are other alternatives which can be used in conjunction with PRICE and which should not be ignored.
- There are different degrees of severity of injury to the soft tissues that must be considered in decisions about management.

This introduction will therefore attempt to provide **definitions of terms** to identify different types of injury, degrees of soft tissue injury and alternative approaches to management during the first 72 hours.

1.1 Degrees of severity of soft tissue injury

A soft tissue injury is an acute connective tissue injury that may involve muscle, ligament, tendon, capsular structures and/or cartilaginous structures. These injuries can be categorised into three grades or degrees of severity of injury.

First degree (mild):
the result of a mild stretch of ligament or capsular structures, or over-stretch or direct blow to muscle. There is minimal swelling and bruising but mild pain is felt at the end of range of movement or on stretch or contraction of muscle. There is no joint instability, minimal muscle spasm and no loss of function.

Second degree (moderate):
the result of moderate stretch of ligament or capsular structures, or excessive stretch or direct blow to muscle, causing tearing of some fibres. There is moderate swelling and bruising, with moderate pain felt on any movement which interferes with the ability of the muscle to contract or lengthen. There may be some joint instability with ligament/capsular injuries. Moderate muscle spasm may result as a reflex response to both ligamentous/capsular injuries and muscle injuries. Due to the tearing of some fibres, there is a decrease in the tensile strength of ligament/capsule or a decrease in the contractile strength of muscle, both of which cause interference with function.

Third degree (severe):
the result of a severe over-stretch of ligament, or excessive stretch or direct blow to muscle, causing a complete tear of the injured structure. There is significant swelling and bruising with severe pain even at rest which significantly interferes with function Ligament injuries result in gross instability and significant decrease in tensile strength, with muscle injuries causing severe muscle spasm and 'splinting', while the injured muscle is incapable of exerting force. Function is severely impaired.

1.2 Other injuries

Here follows a brief definition of some of the injuries that may occur in conjunction with soft tissue injury as defined in this document. As a general rule, any patient presenting with any of the injuries listed below should receive immediate emergency first aid and should be referred on for further investigation. The list is in alphabetical order and consequently the order gives no indication of severity.

Abdomino-thoracic injury:
Any injury which results in chest pain, shortness of breath, severe abdominal pain, haematuria.

Blocked airway:
Any injury that causes respiratory arrest.

Cuts / lacerations:
Any injury that results in open, bleeding wounds.

Head injury /unconsciousness:
Any injury that results in altered cerebral function, leading to disturbed consciousness, vomiting, drowsiness or amnesia.

Nerve injury:
Any injury causing changes in motor and/or sensory function.

Spinal injury:
Any injury to the back or neck that causes changes in motor or sensory function. Any injury that is suggestive of bony injury.

Vascular injury:
Any injury resulting in loss of distal pulses, changes in skin colour and temperature or drop in blood pressure.

Furthermore, the patient's previous and current medical history, drug history and general health should be taken into consideration to indicate if therapeutic intervention is contraindicated by current medication or health status. An injury management flowchart is included as **Appendix B**.

1.3 Alternative modalities

which may be used in the management of soft tissue injuries

Although this document provides guidelines for the management of soft tissue injuries using **P**rotection, **R**est, **I**ce, **C**ompression and **E**levation, it must be recognised that in conjunction with PRICE, other forms of intervention may be used. These may include **non-steroidal anti-inflammatory drugs, electrotherapeutic modalities, manual therapy, taping** and **rehabilitation**.
A table summarising alternative modalities and indications for use can be found in **Appendix C**.

The need for clinical guidelines

2

Injury to the soft tissues of the body is a major cause of pain and disability resulting in loss of function, often with socio-economic consequences due to lost working days. The psychological impact of inability to perform normal functional and recreational activities cannot be ignored.

2.1 Background

Although soft tissue injury can occur in any aspect of daily activity, the major thrust of investigations and research into the incidence and management of soft tissue injury has tended to concentrate on those injuries incurred as a result of sport and leisure activities. The health benefits of exercise are well documented (Royal College of Physicians, 1991) and this has led to encouragement by central government for increased participation in sport and exercise activities as part of its policy that 'prevention is everybody's business' (DHSS, 1976). Similarly, the medical world has directed more and more attention to the relationship between sport and exercise and health, in terms of both physiology and pathology.

- 'The economic costs of ill health which could be attributable to lack of endurance fitness have been studied extensively in the United States and West Germany but not, as yet, in this country, although there is no reason to believe our situation is very different. It is undoubtably true that in some cases, appropriate exercise could avoid hospitalisation and the cost of other services, as well as retaining the services of many individuals as active members of the community' (Sports Council, 1971, cited Williams and Sperryn, 1981)
- The American College of Sports Medicine has put forward position statements providing advice on the duration and intensity of exercise necessary to provide a protective effect.

With the general population increasingly participating in a more active lifestyle and with more demanding and intensive training regimens by sportsmen and women, soft tissue injuries appear to be occurring more frequently and receiving more publicity in the lay press (Kellet, 1985). The danger of injury occurs not only in the top levels of competitive sport but in popular leisure-time activities as well (Sports Council, 1976, cited Williams and Sperryn, 1981)

Little scientific interest has been displayed in the management of such injuries until the last 20–25 years. Even so, although a few soft tissue injury and sports injury clinics are beginning to emerge in some NHS Trusts, the Department of Health has made no firm commitment towards sports medicine in the UK. Indeed, the antisports lobby has in the past regarded injury in sport as 'essentially self-inflicted' (Williams, 1976) and, even more strongly, 'Sports medicine [is] a pseudospeciality which [is] dangerous, meddlesome and wasteful...NHS resources [are] being diverted towards treating and rehabilitating sportsmen, at the expense, indirectly at least, of the remainder of the population' (Pringle, 1980, cited Davies, 1981)

2.2 Epidemiology of soft tissue (sports) injury

Since there has been no unifying medical speciality under which soft tissue injury, from whatever cause, has been managed, it is difficult to ascertain the overall incidence of injury. To gain some insight into the extent of the problem, sports medicine literature has in the past provided some figures.

- Approximately five per cent of all cases seen in A/E departments of hospitals in the UK are due to participation in sport / exercise - an estimated 2,000,000 sports injuries per annum, of which ten per cent involve time off work. (Williams and Sperryn, 1981).
- Attendances at sports injury/sports medicine clinics:
  Cambridge - 281 (1978); 520 (1979); 290 (1980–Jan-April)
  St James Hospital (Leeds) - over 2,000 (Sept 1972–July 1976)
  Portsmouth - 14–16 new patients each week.
- A study by Groh and Groh (1975, cited Kuprian, 1981) investigated the socioeconomic aspects of sports injuries in West Germany. They investigated 2,739 injuries, of which:
  637 missed one weeks work
  702 missed two weeks work
  392 missed up to three weeks work
  258 missed up to four weeks work
  186 missed up to six weeks work
  110 missed up to eight weeks work.
  Time off by the remainder ranged from three to 12 months. Average time off work was three weeks.

These figures indicate that in the late 1970s and early 1980s, soft tissue injury due to participation in sport and leisure activities was becoming an increasing problem, both from medical and socio-economic points of view. More recently, the Sports Council recognised that although the health benefits of exercise are well established and documented, the costs in terms of injuries and the resources needed to treat them are not. In order to present a balanced and complete picture of the benefits of exercise, the Sports Council commissioned the Medical Care Research Unit of the University of Sheffield to undertake a study of the risks and costs of sport and exercise related injury in England and Wales during the year 1989-90 (Nichols et al, 1991).

Questionnaires were sent to 28,000 persons, aged 16–45 years, in 16 of the 90 Family Health Service Associations in England and Wales, asking about participation in sport or exercise during the previous four weeks and any injury incidents which occurred during that time. From the results of this study, national estimates were made.

- 19.3 million incidents resulted in new injuries.
- 9.8 million were 'substantive', potentially serious, in need of treatment or prevented the injured from participating in their usual activities.
- 1.4 million resulted in participants taking time off work.
- Average duration of each episode of time off work was six days.
- Time off work equated to up to eight million days each year as a result of new injuries, at an estimated cost of £405 million.
- 6.4 million new injury episodes resulted in contact with treatment providers.
- 1.3 million new injury episodes were seen at A/E departments.
- Of the sample studied, 56 per cent of incidents resulted in recurrent injuries.
- Direct and indirect costs of sport- and exercise-related injuries is £500 million per year.

The US department of Labour statistics also show that chronic soft-tissue injuries of tendon, ligament and fascia account for the majority of prolonged instability, and time lost from work (US Department of Labour, 1995), reinforcing the importance of optimal early management.

2.3 Long-term sequelae of soft tissue (sports) injury

All the evidence therefore seems to point to the desirability of ensuring the most effective early (immediate) management of these injuries, which will ensure more complete recovery of function, and reduce the socio-economic costs of lost work-days and prolonged morbidity.

Although it is difficult to assess the potential cost benefits of effective early treatment, there is evidence to suggest that poor management of these injuries may lead to long-term adverse sequelae, such as early onset degenerative joint disease, leading to disability and impairment, and expensive joint replacement surgery.

3 The importance of early management

The early management of soft tissue injuries can be either extremely effective or, if inappropriately applied, may be damaging. The course of injury can be modified by the effective and timely use of therapeutic techniques and modalities. For example, chartered physiotherapists, who are frequently the first of the health care team to see an injured athlete, are in an excellent position to prevent the development of chronic oedema which can markedly interfere with the later stages of treatment, lead to a poor rehabilitation outcome and increase the potential for recurrence of injury. Application of the appropriate modality at a particular stage in the healing process can act to prevent undue complications and can help save much time that might otherwise be spent unnecessarily in a prolonged period of convalescence.

3.1 Tissue response to injury

In order to develop an appropriate early management programme, it is necessary to have an understanding of the concepts of the response to injury, the mechanisms of healing and those processes that may be affected by what is, or is not, included in the management programme. Once the concepts of tissue healing and repair are appreciated, it is easier to establish sound, principled management programmes. These programmes must be based on biochemical time-scales and must also consider the healing tissue's ability to withstand specific stresses and how it optimally responds to these stresses.

When the body sustains an injury, it undergoes an organised and consistent process at the site of injury in its attempts to heal the area. Injury is the medical term for cellular damage. In a sprain, strain, bruise or crush, the local network of blood vessels is damaged, and oxygenated blood can no longer reach the tissues, causing some cells to die. The damaged blood vessels bleed, so the injured tissue contains dead cells, extracellular substance and extravasated blood (Evans, 1980). Although there may be some differences among the various structures, due to differences in vascularity, the overall process is essentially the same whether the injury is to ligament, tendon or muscle tissue. The primary differences in acute trauma are determined by the size and severity of injury and whether the injury must heal by primary or secondary intention.

There are three phases in the healing process:

- the inflammatory phase
- the proliferative phase
- the maturation or remodelling phase.

Although these phases are defined separately in the literature in terms of the type of cellular activity occurring at that time (Evans, 1980; Houglum, 1992), they are not totally discrete and there is of necessity a degree of overlap between them. The essential period of concern for these guidelines is the inflammatory phase, although the events occurring in the early part of the proliferative phase are also of interest.

The inflammatory phase may last anything up to six days; different researchers have suggested different durations of this phase, and although the duration will of necessity be related to the severity of the injury, the lack of consensus on the precise duration of this phase is more a reflection of the overlap and gradation of the phases of the healing process than imprecise research investigations (Houglum, 1992).

The cardinal signs of inflammation are **Calor** (heat), **Rubor** (redness), **Dolor** (pain) and **Tumor** (swelling).

Calor and Rubor
caused by the opening up of thousands of tiny local blood vessels in response to the interaction between cellular and chemical components. Inside the dilated capillaries, the rate of blood flow slows, and by four hours after injury, white blood cells are beginning to pass through the vessel walls. The heat and redness take a few hours to develop. The increase in local tissue temperature increases the metabolic demands of the area that also results in vasodilation.

Dolor
pain is caused by chemicals released at the site of injury by the dead and dying cells acting on the bare nerve endings of pain fibres. As swelling begins to develop, pain will also result from increased tissue pressure.

Tumor
swelling occurs through increased permeability of the blood vessel walls, caused by the release of chemicals by the damaged cells. The swelling of inflammation is mostly fluid, called the inflammatory exudate, which contains a large number of inflammatory cells and a high concentration of protein. The large amount of protein in the inflammatory exudate has two major consequences. Firstly, it contains fibrinogen, which forms fibrin that is a necessary part of the body's defence mechanism against infection. However, a large amount of inflammatory exudate results in excessive formation of fibrin that eventually becomes organised into scar tissue. Secondly, the presence of protein in the inflammatory exudate increases the osmotic pressure of the tissue fluid in the damaged area, thus drawing more fluid out of the local capillaries and into the tissues. Inflammatory swelling starts to develop approximately two hours after injury and may continue for up to four days. In cases of severe injury to joint structures, swelling may occur immediately, indicating bleeding into the joint (haemarthrosis).

3.2 The aims of early management

The management of soft tissue injury during the first 72 hours has **eight** aims:

- to reduce local tissue temperature
- to reduce pain
- to limit and reduce inflammatory exudate
- to reduce metabolic demands of the tissues
- to protect the damaged tissue from further injury
- to protect the newly-formed fibrin bonds from disruption
- to promote collagen fibre growth and realignment
- to maintain general levels of cardio-respiratory and musculoskeletal fitness/activity.

3.3 Responsibility for early management

In an ideal world, the patient with an acute soft tissue injury would have immediate access to a chartered physiotherapist or a medical practitioner (GP, sports physician or A/E doctor) who has the prerequisite knowledge to apply the appropriate management procedures. However, the wide range of activities and locations in which soft tissue injury may occur means that immediate access to such a practitioner is usually not possible.

Thus, these clinical guidelines should have a much wider remit than physiotherapy and medical practitioners. They should be accessible, in an appropriate format, to all those who are involved in the promotion and practice of physical activity, whether it be at a purely leisure/health promotion level or at the highest levels of competitive sport. Personnel involved might therefore be coaches, trainers, teachers and leisure centre staff who can then provide the necessary early advice on appropriate management, or indeed athletes themselves. Under guidance, the patient can then continue with his/her own management.

3.4 Some words of caution

If a severe injury is suspected, the patient should be referred immediately to either an A/E department or an experienced practitioner in the management of soft tissue injuries (In practice, this usually means a chartered physiotherapist with experience in the treatment of sports injuries or a sports medicine practitioner). Signs of severe injury include:

- severe pain which does not subside
- immediate and profuse swelling
- deformity
- extreme loss of function
- guarding, or unusual or false motion
- noises (grating / cracking) at injury site.

The following guidelines should be applied only after the patient has been examined and the possibility of severe injury has been ruled out. It is important that any indications of severe injury which may require specialist treatment are not masked by the injudicious application of modalities such as ice and compression, since this may allow the patient to continue his activity with resulting increased damage. **If in doubt, consult an expert!**

4 Statement of the problem

The use of the **RICE** (**R**est, **I**ce, **C**ompression and **E**levation) regime, together with the more recent addition of a **P**rotection element is widely accepted in the approach to the management of acute soft tissue injuries (Quillen and Rouillier, 1982; Pincivero et al, 1993). However, within this concept, there are wide variations, particularly with respect to the application of ice (or other cold applications) (Knight, 1989) and the argument of rest versus early mobilisation (Eiff et al, 1994; Jarvinen and Lehto, 1993).

Thus, the problem can be summarised in terms of the incidence and sequelae of soft tissue injuries and the variations and uncertainties apparent in their early management.

- There is a high incidence of injuries occurring in sports and recreational activities (Anderson and Hall, 1995; Nichols et al, 1991)
- There is a high socioeconomic cost to these injuries (Groh and Groh, 1975, cited Kuprian, 1981; Tolpin and Bentkover, 1986; Nichols et al,1991)
- Although there is general acceptance of the **PRICE** approach to the management of these injuries (Quillen and Rouillier, 1982; Pincevero, 1993), there is wide variation in practice (Knight, 1989; Jarvinen and Lehto, 1993; Eiff et al, 1994) and uncertainty about the most effective application (Knight, 1989).

The ultimate recommendations for practice presented in this document, and in the summary documents/leaflets, may apply to all individuals who sustain soft tissue injury as a result of physical activity.

Thus, individuals of all age groups, of all levels of fitness, and who participate in all levels of physical activity, from everyday functional activities to international athletic competition, should benefit from adhering to the recommendations for management in the immediate (up to 72 hours) post-injury management.

Objectives of the guidelines

- To provide a comprehensive clinical guideline document with recommendations for the management of soft tissue injury in patients of all ages, who have incurred injury to soft tissue as a result of participation in physical activity, using **P**rotection, **R**est, **I**ce, **C**ompression and **E**levation during the first 72 hours
- To provide evidence to support the recommended guidelines for practice
- To provide summary documentation in appropriate forms to reach the target populations, consisting of those involved in the organisation and supervision of physical activity, and patients as described above.

6 Development of guidelines - the process

Validity of clinical guidelines has been related to three principal factors in guideline development, namely the composition of the guideline development panel and its processes, the identification and synthesis of evidence, and the method of guideline construction (Eccles et al, 1996).

There were several stages in the development of these guidelines:

- identification of the topic
- constitution of the group responsible for developing the guidelines
- the process of developing the guidelines
- the presentation of the guidelines.

The first stage in the development is the identification of a topic or subject. Thomson et al (1995) outlined key questions on the choice of topic which will be addressed in the context of the development of these guidelines.

In deciding the composition of the development group, several factors need to be considered. Thomson et al (1995) noted that the group should have skills in the relevant topic area, including specialist experience, to ensure the guidelines produced have professional credibility. The group may also need skills in conducting a literature review and in collecting and analysing data. Finally, the group needs a leader with the organisational and communication skills to take them through the development of the guidelines and on to implementation and review.

Again, Thomson et al (1995) provides a list of questions which create a useful framework upon which to make decisions on the composition of the development group, and go on to suggest that the internal workings of the group should be addressed. When the nature of the task is clearly defined, it is relatively easy to assess the requirements of the task in terms of a proposed time-scale. Although the group had clearly defined the need for a survey to determine current practice and for an extensive review of the literature to provide evidence for practice, it was difficult to ascertain just what was required in the guideline documentation. This was compounded by the fact that we were starting ‘from scratch’ and, until fairly late in the process, had no structure provided within which to work.

Inevitably, as all members of the group are involved in full-time demanding occupations, it has been difficult to devote time to the project and have regular meetings. All of this has created a situation whereby it was impossible to determine a specific programme to which the group could adhere. In retrospect, and for the assistance of future development groups, it is essential that, at the outset, the development group not only has clearly defined the topic/subject of the guidelines but also has a clear indication as to what to include in the guideline documentation. Without this, there is a tendency to feel that the group is working in a vacuum with no clear idea as to how to focus its efforts. As increasing numbers of guidelines are published and become available for scrutiny, many of these problems will be resolved.

Finally, in the developmental stage, Thomson et al (1995) posed more key questions. These involved not only the actual process of identifying the evidence, but also consideration of the end users of the document. As there is a very wide range of potential users of these guidelines, we decided to provide a detailed reference document for physiotherapists and other professionals involved in the immediate management of soft tissue injuries, and to provide summary documents/leaflets which would be specifically targeted at other end users.

The decisions regarding the final presentation of the guidelines need to address several issues including both the nature of the documentation, the visual impact of the summary documents, and the most effective medium. Guidance will be sought on these matters, particularly with respect to the summary documentation, as the potential distribution of these is great.

Detailed consideration of the questions posed by Thomson et al (1995) can be seen in **Appendix A**

7 Overview of the development of clinical guidelines for acute soft tissue injuries during the first 72 hours

The development progressed through a number of phases:

1 Clear definition and delimitation of the problem
2 The literature search
3 Review and appraisal of the literature
4 Definition of the guideline statements
5 Pilot/peer review of the guidelines
6 Amendment of the guidelines

The literature search

7.1 Search strategy

7.1.1 The aim of the search was to identify those papers in the published literature that provided evidence on the application of the individual elements of the PRICE regimen. The major focus was to find studies in which the specific mode of application of the elements of PRICE had been investigated.

The original search was carried out through the CSP Information Resource Centre, and searched the following indices and databases from 1982–February 1996.

- Physiotherapy Index
- Rehabilitation Index
- Complementary Medicine Index
- CSP Research Database
- CSP Documents Database
- MEDLINE
- CINAHL.

An additional search was carried out on the EMBASE database (1988–February 1996)
The following keywords were entered into the search:

- Soft tissue injury
- Athletic injury
- Sports injury
- Ligament injury
- Muscle injury
- Tendon injury
- Acute injury
- Musculoskeletal injury.

These were combined with:

1 Compression, elevation, oedema, edema, swelling

2 Rest, movement, mobilisation, immobilisation, early mobilisation

3 Ice, cold, cold therapy, cryotherapy, cooling.

From the search, 109 papers were read, of which 57 were critically reviewed.

A second search was undertaken in June 1998, using the following databases, and the same keywords and combinations.

- BIDS/EMBASE
- MEDLINE
- The Cochrane library.

This search produced 11 additional papers, of which seven were ultimately critically reviewed.

7.2 Reviewing the literature

Where possible, the papers were divided into topic areas according to the individual elements of **PRICE,** and each group of papers was reviewed by two members of the development group.Those studies which reported research findings were evaluated according to the guidelines set out by Domholdt and Malone (1985). Where papers covered more than one element of **PRICE,** they were reviewed by more than one pair of reviewers, each pair concentrating on specific elements. The conclusions drawn by each pair of reviewers was then presented to the development group as a whole, and discussed fully before the guideline statements were created from the evidence. Where evidence was unclear, or lacking, the group created proposed guideline statements, which then were put forward for discussion by the **consensus panel**.

7.3 Assessing the evidence

On initial reading of the literature, it was immediately apparent that unlike research into the effectiveness of a specific intervention for a specific problem, the literature pertaining to the mode of application of the individual elements of the **PRICE** regimen was not in the form of the traditional “gold standard” of the randomised controlled trial. Consequently, it has not been possible to grade the evidence on the categories based on either the Canadian Task Force Classifications (1979), or those proposed by the Agency for Health Care Policy and Research (Grisham et al, 1994), both of which are based around the randomised controlled trial.

7.3.1 Categorising the evidence

Much of the literature reviewed has tended to make assumptions about the mode of application of the elements of **PRICE** in terms of duration and frequency, without providing evidence for the specified mode. For example, although many studies have used ice as an intervention, the duration of application has varied among studies, with authors rarely justifying their selection. In view of the nature of the literature, it was decided to appraise the evidence according to categories suggested by Bogduk and Mercer (1995) who suggest that any form of treatment, be it in medicine at large, in musculoskeletal medicine or in musculoskeletal physiotherapy, can be appraised against three distinct but complementary axes. These are **biological bases, convention** and **empirical proof.**

Biological bases

provide the rationale for treatment which is based on the identification of the mechanism of a symptom and the application of a therapy which is known to reverse that mechanism. Thus, under this axis, the subject under consideration is not whether the therapy 'works' but whether or not the therapy has a reliably-proven biological basis which allows it to be applied in a generic manner. This axis can be applied to animal studies, and to laboratory based studies, which can demonstrate efficacy of a specific intervention on either a biochemical or physiological bases, or on an animal model, but cannot directly infer the same in a human subject.

Convention

is a 'socially powerful but intellectually weak' dimension (Bogduk and Mercer, 1995). The power of this dimension lies in the perceived established and authoritative views of senior members of a profession who 'have always used this' and whose practice is unlikely to be disputed by younger and less experienced members. Convention is also a resort when there is no other legitimate basis for a therapy. Although not necessarily based in a strong proven basis, **consensus** might be regarded as providing a stronger argument for application of a form of treatment than **convention.** Grisham et al (1994) define **strong consensus** as having agreement among 90 per cent or more of panel members and expert reviewers, and **consensus** as having agreement amongst 75–89 per cent of panel members and expert reviewers.

Empirical proof

relates to valid clinical evidence of the efficacy of a treatment. This axis specifically addresses the concept that, irrespective of whether the mechanism of a therapy is known and irrespective of how 'popular' a treatment is amongst therapists, a therapy becomes legitimate only when its clinical efficacy is proven. Conversely, even if a particular therapy is popular amongst therapists, it can be outrightly condemmed if it fails to be vindicated in a properly controlled trial (Bogduk and Mercer, 1995). This category was applied to clinical studies, both experimental and observational.

7.3.2 Gaining consensus

The **convention** axis proposed by Bogduk and Mercer (1995) was modified slightly to encompass more of a **consensus** view which was be derived from an **expert panel** comprising the group involved in the development of these guidelines, the Executive Committee of the ACPSM and regional representatives of ACPSM, who represent each of the Sports Council regions. All members are chartered physiotherapists, with considerable and varied experience in sports medicine, and the management of soft tissue injuries. The executive committee consists of eight sitting members plus vice-presidents, and meets twice each year. The complete ACPSM committee has, in addition to the Executive Committee, potentially an additional 14 members, representing the regions, and also meets twice each year. As the guidelines were developed, they were presented at all meetings of the ACPSM committees, where those statements proposed by the development group, which had little or no supporting evidence, were discussed until agreement on the guideline statement was reached. Evidence of current practice from a questionnaire was also considered in reaching consensus (7.4).

The composition of the panel is shown in **Appendix D**.

7.3.3 The quality of the evidence

While recognising the limitations of the nature of the literature, with a limited number of randomised controlled trials (RCTS) which specifically investigate the mode of application of the elements of **PRICE,** a modification of the Canadian Task Force Classifications (1979) has been developed, in an attempt to acknowledge those studies which have a sound scientific basis, whether they are animal, laboratory or clinically based,

- **I** Evidence supported by RCTs that specifically investigate the mode of application of elements of PRICE
- **II** Evidence supported by RCTs which assume a specific mode of application of element/s of PRICE, or by studies (animal, laboratory or clinical) which stand up to scientific scrutiny
- **III** Evidence supported by a single study, by observational studies, or by studies that do not stand up to scientific scrutiny
- **C** Consensus - Agreement by an expert panel, in the absence of scientific evidence in the literature, based on experience and/or assumptions in the literature.

7.4 Current practice

Current practice with regard to the application of PRICE during the first 72 hours following injury has been determined through the analysis of a questionnaire distributed to 500 ACPSM members. A brief summary of the results of the questionnaire are shown in Appendix E and summaries of the findings of the questionnaire with respect to each of the elements of PRICE are provided at the end of each guideline. Thus the recommendations from the guidelines can be compared with current practice. In the long term, evaluation of implementation of the guidelines will be possible by carrying out a second survey to determine if they have influenced practice.

7.5 Guideline statements

For each statement on each element of the regimen involving **P**rotection, **R**est, **I**ce, **C**ompression and **E**levation an indication will be given regarding the nature and quality of evidence supporting the application of that element; in some cases some of the elements will be combined to reflect the nature of the supporting evidence.

7.6 Peer review / pilot

On completion, the guidelines document was sent to six professionals involved in sports medicine, who were asked for comments on clarity, content, usefulness and comprehensiveness. The names and designations of these “reviewers” are noted in the acknowledgements at the beginning of this document. All comments from these reviewers were taken into consideration, and amendments made to the document where deemed appropriate by the development group. Most of these involved minor points of clarification, particularly with respect to a clear statement as to for whom the guidelines were written. Specific comments from these reviewers can be seen in Appendix F, together with the responses from the guideline development panel.

The guidelines were also made available to members of the committee of ACPSM (see 7.3.2) at regular stages of development, and comments sought and implemented.

7.7 Factors to be considered in applying the guideline

7.7.1 Initial examination

Take account of

- history - current medication, pre-existing problems, allergies, previous treatment
- mechanism of injury
- pain
- swelling
- function - range of motion, muscle performance, quality of movement
- deformity
- temperature
- colour.

Indications for immediate referral

- immediate gross swelling - indicates extensive bleeding from injured tissues
- deformity - may indicate complete rupture of muscle/ligament or fracture of bone
- severe loss of function - may indicate any of the above, plus nerve lesion
- head injury
- spinal injury
- loss of pulse - indicates circulatory involvement
- blanching or rapid gross discoloration - indicates circulatory impairment or gross bleeding
- severe abdominal pain
- severe shortness of breath.

7.7.2 Early (immediate) management

Protection

Required to protect the injured tissues from undue stress which may disrupt the healing process and delay rather than promote healing. A further obvious function of protection is to remove the athlete from the location of injury.

Protection may be applied by:

- plaster cast
- taping
- bandaging
- splints
- slings
- crutches (protection from weight-bearing)
- bedrest.

Rest

Required to reduce the metabolic demands of the injured area and thus avoid increased blood flow. Also needed to avoid placing undue stress on the injured tissues that may disrupt the fragile fibrin bond which is the first element of the process of repair. Rest may be applied selectively, to allow some general activity, but the patient must avoid any activity involving the injured area which may compromise the healing process.

Rest may be achieved by:

- advice - the patient is advised not to participate in any activity which might place undue stress on the injured tissues
- avoidance of movements which replicate the mechanism of the injury and / or which cause / increase pain
- the use of crutches, slings etc., which provide a means by which the injured area can be rested from participation in normal functional activity.

Total rest is rarely required - this is difficult to achieve and advice to avoid all activity rarely meets with good compliance, particularly from athletes!

Although the injured structures should be rested during the early stages of the healing process, adjacent structures should be exercised. However, general activity should be reduced during this period to reduce metabolic rate and tissue demand for oxygen, decrease heart rate and blood pressure and consequently reduce blood flow. The concept of rest to promote the early part of the healing process and protect the newly formed repair tissue, together with controlled exercise / movement of the injured part to provide the stresses necessary for the correct alignment of the healing tissues, must be carefully balanced.

Ice

Ice is the most common means by which **cryotherapy** (or cold therapy) is applied. At this point, therefore, ice will be used to represent the application of cryotherapy in general, with the different means by which this may be applied being considered in more detail later. Ice is used in an attempt to limit the damage caused by the injury, by reducing the temperature of the tissues at the site of injury and consequently reducing metabolic demand, inducing vasoconstriction and limiting the bleeding. Ice may also reduce pain by increasing threshold levels in the free nerve endings and at synapses, and by increasing nerve conduction latency to promote analgesia.

Considerations in the application of ice:

- duration of application (ranges from five minutes to 40 minutes) - consider the evidence for the most effective duration of application
- frequency of application - consider duration of effects
- the area to be covered
- nature of underlying structures
- the most effective means of application.

Compression

Compression is applied to limit the amount of oedema caused by the exudation of fluid from the damaged capillaries into the tissue. Controlling the amount of inflammatory exudate reduces the amount of fibrin (and ultimately the production of scar tissue) and helps to control the osmotic pressure of the tissue fluid in the injured area.

Considerations in the application of compression:

- the most effective methods of application
- duration of application
- area of application
- mode of application - intermittent or continuous, with or without ice
- how long do you continue to apply compression?

Elevation

Elevation of the injured part lowers the pressure in local blood vessels and helps to limit the bleeding. It will also increase drainage of the inflammatory exudate through the lymph vessels, thus reducing/limiting oedema and its resultant complications.

Considerations in the application of elevation:

- mode of elevation
- duration of elevation
- frequency of elevation.

8 Evidence for the guidelines

Here follows a summary of the guidelines for the management of soft tissue injury during the first 72 hours, together with an evaluation of the supporting evidence. Each section will conclude with a brief summary of current practice with respect to each of the elements of **PRICE,** as extracted from a questionnaire distributed to 500 members of the ACPSM. A summary of the questionnaire response can be seen in **Appendix E**.

The guidelines are for the application of PRICE; they are based on the assumption that an accurate diagnosis has been made, and that PRICE is the appropriate intervention of choice.

Individuals may decide to apply alternative modalities, as identified in Appendix C. Individual consultation and agreement may be required to ensure adherence to the guidelines.

Situations in which caution should be observed have been identified in sections 1.2, 3.4 and 7.7.1. Specific contraindications are identified in individual statements relating to each of the elements of PRICE. A summary of precautions and contraindications are presented in Appendix G.

8.1 Protection (and prevention of further injury)

Injury results in a sudden drop in the tissue's ability to withstand tensile stress. Immediately following injury there is little or no drop in tensile strength but within the first few days, as the inflammatory process evolves, a significant loss of tensile strength is observed (Houglum, 1992). The extent of this loss is proportional to the degree of tissue damage.

Protection against further tension to the area of tissue damage is essential until an accurate diagnosis of the extent of the lesion is established (Hunter, 1994). In the early days following injury (up to four to six days), tension to the site of injury may disrupt the fragile fibrin bond which forms a network of 'scaffolding' which provides the link between the margins of the injured tissue (Hunter, 1994).

Protection may vary from the initial moving of the injured athlete from the location in which further injury may occur, through provision for general support to avoid using the injured part (eg crutches), to the application of specific means of limiting movement (eg braces/splints).

Various modes of protection have been advocated:

- crutches (Pincivero et al, 1993; Reider et al, 1993)
- slings (Levin, 1993)
- taping (Pincivero et al, 1993)
- hinged brace (Reider et al, 1993; Cross et al, 1990)
- plaster of Paris/splints.

Protection does not form the focus of any of the papers reviewed. However, it is mentioned as an element in the total early management of soft tissue injuries (including following surgery) but specific recommendations are not provided.

However, taking into consideration the nature and timing of the healing process and the evidence of the effect of excessive early stress on healing tissue, the following recommendations are made.

Guideline 1 - Protection

1 Protection should be applied during the early stages of the healing process (at least up to day three) **(II)**.

2 The duration of application should be dictated by the severity of pain and the extent of injury. Animal studies suggest that a moderate (second degree) injury requires three to five days protection. Mild (first degree) injuries may require a shorter period and severe (third degree) longer **(II)**.

3 The mode of application of protection will depend on the site and nature of injury. This may range from protection from full weight-bearing (crutches), to general support (slings), to specific support for the injured structure/s (braces, splints, taping) **(C)**.

4 Whilst supporting/protecting the injured structure/s, the mode of protection should avoid complete immobilisation of the part whenever possible **(C)**.

5 The mode of protection must be capable of accommodating oedema **(C)**.

Evidence

Animal studies provide a sound **biological base** to support the use of some form of protection to avoid excessive stress on healing tissue during the first three to five days of the healing process (Jarvinen and Lehto, 1993; Burrough and Dahners, 1990; Buckwalter, 1995).

Although several clinical studies have investigated the concept of rest/immobilisation versus exercise/mobilisation following soft tissue injury, no reports of clinical trials investigating the efficacy of different modes and duration of application of protection were found. Consequently, **empirical evidence** on the efficacy of protection is lacking.

In a RCT to compare the effectiveness of early functional and conventional treatment for acute ankle ligament injuries, the use of some form of protection in both groups was advocated by Karlsson et al (1996). The "functional" group wore compression pads with elastic bandage followed by ankle tape, while the control ("conventional") group had elastic bandage with crutches. The "functional" group had shorter sick leave and earlier return to sports, but there was no difference in the final outcomes between the two approaches, both of which demonstrated good results.

Recommendations for guidelines

There is general acceptance of the use of some form of protection during the early stages following soft tissue injury (Paessler et al, 1992; Pincivero et al, 1993; Levin, 1993; Reider et al, 1993; Karlsson et al, 1996); evidence for its specific use tends to be by consensus.

Current practice - results of questionnaire

When asked if they would prescribe protection to a **second degree soft tissue injury** during the first 72 hours following injury, 96 per cent of those who returned the questionnaire responded to this question. Of these, 94 per cent stated that they would prescribe protection whilst six per cent stated they would not. Crutches and slings were the most common mode of protection prescribed with 89 per cent (82 per cent of the total returned) stating they usually or sometimes prescribed crutches and 70 per cent (56 per cent of total) stating they usually or sometimes used slings. Inflatable and non-inflatable splints were less commonly prescribed, with only 17 per cent of the total prescribing inflatable and 38 per cent prescribing non-inflatable splints. This may reflect the availability of the splints and their cost.

8.2 Rest

The appropriate role of activity in the management of injuries has been a subject of considerable controversy. The long-accepted concept that physical activity through loading and movement alters the structure of the musculoskeletal structures has prompted supporters of early post-injury activity to advocate early controlled activity to promote healing and accelerate restoration of function. The opponents of this view argued that absolute rest allows healing to proceed at maximum pace and that early use of injured musculoskeletal structures increases inflammation and disrupts repair tissue, thus delaying or preventing healing (Buckwalter, 1995).

Although the structure and vascularity of different soft tissues (muscle, ligament, tendon) differs and the mechanism of injury may differ, the overall process which occurs at the site of injury in an attempt to heal the area, is essentially the same (Houglum, 1992). Following injury, the connective tissue is either partially or totally disrupted and a gap appears between the ruptured fibres that are retracted. The rupture gap is soon filled by a haematoma and later by proliferating granulation tissue (Jarvinen and Lehto, 1993).

Immobilisation has previously been the method of choice used in the treatment of soft tissue injuries, but due to various complaints and complications after prolonged immobilisation, early mobilisation has become more favoured as a form of treatment. Immobilisation following injury basically means complete rest until pain-free activity is feasible and can mean anything up to two to six weeks (O'Donaghue, 1976; Reider et al, 1993). Jarvinen and Lehto (1993) cited Corrigan (1967) in defining early mobilisation for muscle injuries as 'gradually increasing physical activity involving the injured muscle within the limits of pain tolerance'. Immediate mobilisation (following muscle injury) may result in dense scar formation in the area that inhibits muscle regeneration. Immobilisation limits the area of connective tissue scarring thus allowing muscle fibre regeneration, but the orientation of the muscle fibres is haphazard and not parallel to the uninjured fibres (Jarvinen and Lehto, 1993). The same situation has been found in healing ligaments and tendons (Bair et al, 1980 and Gelberman et al, 1982, cited Buckwalter, 1995).

For those patients (particularly competitive athletes) who are reluctant to rest, some element of agreement for "relative rest" may be required to ensure compliance. Consultation will be required to ensure that healing of the injured tissues is not compromised, while "controlled activity" may be carried out.

Guideline 2 - Rest

1 Rest should be applied to the injured part immediately following injury. **(II)**.

2 Stress on the injured tissue should be avoided during the early (inflammatory) phase of the healing process, as the tensile strength of the injured tissue is greatly reduced at this time **(II)**.

3 The optimum period of rest appears to be one to five days, depending on the severity of injury. Moderate (second degree) muscle injuries require three to five days "immobilisation". Mild (first degree) may require only 24 hours rest and severe (third degree) injuries may require at least one week's rest **(II)**.

4 Early mobilisation following the period of rest should initially avoid undue stress on the healing tissue **(III)**.

5 Isometric work may be performed during the period of rest, within the limits of pain tolerance **(C)**.

6 Overall general activity should be reduced to avoid increasing metabolic rate and producing a generalised increase in blood flow **(III)**.

Evidence

Animal studies have shown that controlled loading applied at the optimal time can promote healing of dense fibrous tissue (Gelberman et al, 1982, cited Buckwalter, 1995) and muscle tissue (Jarvinen and Lehto, 1993). Excessive early loading may increase joint instability (Burrough and Dahners, 1990) and result in excessive scarring and inhibition of muscle regeneration (Jarvinen and Lehto, 1993). A short period of immobilisation (three to five days for a second degree injury in rats) accelerates formation of a granulation tissue matrix, followed by mobilisation which promotes penetration of the connective tissue scar by muscle fibre and the orientation of regenerated muscle fibres in alignment with the uninjured fibres. Although restricted to animal studies, the results may be extrapolated to human subjects to provide a sound **biological base** for practice.

Clinical studies have concentrated on the mobilisation / immobilisation debate and on comparison between surgical and non-surgical methods. Few studies have given a precise indication of the duration (if any) of a period of rest following injury. Generally, clinical studies have found that immobilisation results in significant weakness and muscle atrophy, even up to five years following injury (Rutherford et al, 1990). Early mobilisation resulted in decreased need for pain medication (McCarthy et al, 1993), fewer days off work (Brooks et al, 1981), minimal treatment morbidity (Reider et al, 1993), and an earlier return to functional and sport related activity (Reider et al, 1993). Thus, clinical studies provide **empirical support** for early mobilisation but have yet to determine the optimal period of rest to precede mobilisation.

Recommendations for guidelines

In the absence of evidence from clinical trials regarding the precise timing of early (active) rehabilitation, evidence from animal trials, which indicates that activity during a period of up to five days following soft tissue injury may disrupt the healing process (Jarvinen and Lehto, 1993; Burrough and Dahners, 1990) forms the basis of recommendations for rest of the injured area for up to five days following injury, depending on the severity of injury.

Current practice - results of questionnaire

Of those who responded to this question (95 per cent of the total), 96 per cent stated that they prescribed rest, whilst four per cent stated that they did not. Although most of the respondents usually or sometimes prescribed complete rest of the injured part (89 per cent), 11 per cent rarely prescribe complete rest and 95 per cent prescribed activity within the limits of pain. In view of the findings by Jarvinen and Lehto (1993) that second degree injuries require three to five days' rest, it appears that this is one area of practice that needs to be changed.

8.3 Ice

Ice (or other applications of cryotherapy) has been recognised as one of the least expensive and widely used therapeutic modalities employed in the management of acute musculoskeletal injuries (Knight, 1989). This same author further notes that the confusion surrounding cryotherapy is almost as extensive as its popularity, with different opinions existing concerning its theoretical base, techniques of application and the physiological responses of the body to its application.

Claims for the effects of cryotherapy include decrease in pain, decrease in metabolism, decrease in swelling, decrease in muscle spasm, decrease in circulation (but also cold-induced vasodilation) and effects on the inflammatory process. In spite of the fact that some of these claims are unsubstantiated, it appears that they still form the basis for the application of ice during the rehabilitation process.

Some studies demonstrate an initial increase in pain upon application of ice, followed by decrease in pain and numbness (Wolf and Hardy, 1941, cited Knight, 1989), and a cyclical course of pain and numbness (Kunkle, 1949, cited Knight, 1989). Clinical as well as experimental research on pain and the pain threshold indicates that pain reduction occurs after cooling to temperatures around 10-15°C, although uncertainty exists as to the duration of the analgesic effect (Meeusen and Lievens, 1986). Lee et al (1978) found reduction in both motor and sensory nerve conduction velocity in the ulnar nerve during application of ice.Knight and Londeree (1980) showed decreased blood flow during cold applications. However, they also found that exercise appeared to supersede the effects of cold on blood flow, indicating that even in the presence of cold application, exercise will increase blood flow. Taber et al (1992) demonstrated a reduction in the normal increase in local blood volume during venous occlusion, when a cold gel pack was applied to the ankle, with no apparent reactive cold-induced vasodilation.

Decreased metabolism is the primary reason for using cryotherapy during the immediate care of acute musculoskeletal injury (Knight, 1989; McLean, 1989; Rivenburgh, 1992). Hypothermia reduces cellular energy needs, thereby reducing the need for and conserving limited supplies of oxygen (Knight, 1989).

Research into the effect of application of cold on oedema has produced conflicting reports. This was summarised by Kowal (1983), who stated that 'the right kind of cold can be effective in decreasing swelling...the wrong kind of cold can exacerbate swelling.' Results from clinical studies are complicated by the fact that in first aid, cold is usually combined with compression (Meeusen and Lievens, 1986).

Clinically it is suggested that appropriate application of therapeutic heat and cold encourages rehabilitation (Kaul and Herring, 1994), minimises the acute response to soft tissue injury and maximises recovery from chronic sequelae (Halvorson, 1990).

Perhaps because of its easy accessibility and general acceptance as a treatment modality, it is easy to assume that the application of therapeutic cold has few dangers. Clinical observations by some authors suggest that care must be taken when applying cold over superficial nerves (Covington and Basset, 1993; Basset et al, 1992; Green et al, 1989). Although not supported in the literature, clinical observations suggest that the static application of cold (in the form of ice or commercial cold packs) may result in what is commonly termed an 'ice burn'. This may be regarded as a form of superficial frostbite, in which tissue destruction results from exposure to low environmental temperature. The signs and symptoms are similar to a thermal burn, with pain, swelling, redness and blistering.

Guideline 3 - Ice

1 Ice should be applied immediately following acute musculoskeletal injury **(C)**.

2 Chipped/crushed ice in a damp towel appears to be the most effective application of cold (**II)** followed by ice in a plastic bag, and then frozen gel packs **(II)**.

3 A damp towel should be placed between the cooling agent and the skin to avoid "ice burn". A maximum safe period for icing of 30 minutes is recommended, to avoid skin and tissue damage and nerve palsy **(C)**.

4 The most effective duration of application of ice appears to be 20–30 minutes, applied every two hours, although there are no specific recommendations **(II)**.

5 Areas with >2cm subcutaneous fat may require longer applications (30 mins) since it has been found that ten minutes of application produces no muscular cooling effect in these circumstances. **(III)**.

6 Cold application should cover the entire area affected by the injury **(III)**.

7 The athlete should not return to participation immediately following application of ice (or other types of cold application), as nerve conduction velocity, sensation and connective tissue flexibility are likely to be reduced by cold application **(C)**.

8 Care should be taken in the application of ice to patients with little subcutaneous fat and in the region of superficial nerves, e.g. common peroneal nerve at the knee, ulnar nerve at the elbow, since cold-induced nerve injury may result. To compensate for this, the duration of application should be reduced (no more than ten minutes) or an insulating material should be applied between the source of cooling and the patient's skin **(III)**.

9 Application of cold is contraindicated for patients who have previously developed cold-induced hypertension during cold treatment, who have allergy to cold (urticaria, joint pain) or who have Raynaud's syndrome, peripheral vascular disease or sickle cell anaemia **(C)**.

10 If nerve damage as a result of the injury is suspected or if there is a history of reduced skin sensation, application of cold should not exceed 20 minutes and the skin condition should be checked every five minutes **(C)**.

Evidence

The local application of cold (cryotherapy) was mentioned by Hippocrates (460–370 BC), who advised the use of ice and snow as a therapeutic modality. Meeusen and Lievens (1986) and Ogilvie-Harris and Gilbert (1995) list some of the effects attributed to cryotherapy, i.e. limiting the inflammatory response, reduction of oedema, reduced haematoma formation and pain relief. Physiological responses such as vasoconstriction, decrease of blood flow, reduction of muscle spasm and decrease in nerve conduction velocity have also been attributed to cryotherapy.

The use of cold modalities to decrease the effects of a local inflammatory response is widely accepted. Tissue cooling produces an initial vasoconstriction in the cutaneous blood vessels, resulting in a decrease in local blood volume. Controversy has surrounded the subsequent responses, since Lewis (1930, cited Kowal, 1983) first described cyclic phases of skin cooling and rewarming (the 'hunting response') when tissue temperature reached 15ºC when a subject's finger was immersed in ice water. Knight and Londeree (1980) measured blood flow using strain gauge plethysmography in 12 normal subjects during therapeutic applications of heat, cold and exercise. They found that total blood flow was greater ($p<0.002$) during a combination of cold and exercise than during application of heat. However, there was neither cold-induced vasodilation nor a reflex vasodilation following 25 minutes of cold application, suggesting that during cryotherapy it is exercise that causes the increased blood flow rather than the application of cold.

Taber et al (1992) measured blood flow in 13 normal subjects, under three experimental conditions of rest, application of a room temperature gel pack and application of a cold gel pack. A significant reduction in local blood volume was found for the cold gel pack, with the maximum decrease occurring 13.5 minutes after application. No reactive vasodilation was observed. Kowal (1983) and Meeusen and Lievens (1986) report inconsistent findings from a number of studies on the effects of cold application on blood flow, suggesting that the differences in outcome are a result of the variation in methodologies used. However, it appears that reactive vasodilation with resultant increase in blood flow occurs at skin temperatures below 14ºC, whereas at skin temperatures between 14ºC and 42ºC, vasoconstriction and decreased blood flow occurred. Thus **empirical evidence** seems to support vasoconstriction and decrease in blood flow at temperatures between 14ºC and 42ºC.

It is difficult to find definitive recommendations on the frequency and duration of cold application in the literature. Ho et al (1994) noted that few studies had examined the effects of cold on blood flow over time, and that those which had were performed on arms and fingers, and had produced no consensus. These researchers found decreases in soft tissue blood flow and skeletal blood flow with as little as five minutes ice application, which effects were enhanced three- to four-fold by increasing the duration of application to 25 minutes. This study supported earlier work by Knight and Londeree (1980), who also applied ice for 25 minutes. Belitsky et al (1987) found skin cooling of up to 12ºC after 15 minutes application, with skin temperatures rising towards their pre-ice levels 15 minutes following removal of the ice. The effect of longer durations of application has not been established. Recommended frequency of application varies between 20 minutes in every hour (McMaster et al, 1978) to 30 minutes every two hours (Knight, 1989).

Contrary to commonly held beliefs, it appears that cold application does not reduce oedema but may indeed result in increased swelling. Farry and Prentice (1980) studied the effects of ice treatment on experimentally induced ligament injury in the domestic pig. They found that there was greater swelling in the ice-treated injured limbs, but even in uninjured animals, there was greater swelling in those having ice application, than in the controls (no injury, no ice). The temperature of the ice was not identified in this study. Other studies cited by Meeusen and Lievens (1986) report inconsistent findings. However, those studies in which temperature was quoted suggest that lower temperatures (<15ºC) seem to result in increased oedema when compared with limbs exposed to temperatures of >30ºC. Prolonged exposure to less intense cold may also be implicated (McMaster et al, 1978). Meeusen and Lievens (1986) suggest that the reasons for the increased oedema is increased permeability of the lymph vessels, with resulting extravascular protein accumulation and increased extravasated fluid. Laba (1989) found no difference in swelling between an experimental group with ankle injuries who received ice pack treatment, and a control group which did not. Thus **empirical** and **biological evidence** from animal and human studies seem to refute the notion that cold application reduces oedema. The same evidence is not widely apparent from **clinical** studies, but this may be because cold application is usually combined with compression and elevation (Farry and Prentice, 1980).

Kowal (1983) outlined several reports that have demonstrated the pain-relieving capacity of treatments involving cold application. He cited a study by Chambers (1969), who applied cold in the form of towels soaked in ice water to 23 patients with a variety of musculoskeletal and neurological conditions. He found that pain was sufficiently decreased or eliminated in 74 per cent of those patients with pain. Meeusen and Lievens (1986) also stated that clinical, as well as experimental, research on pain and the pain threshold indicates that pain reduction occurs after cooling to temperatures around 10–15^{0}C, although uncertainty exists as to the duration of the analgesic effect. Nevertheless, Lee et al (1978) found that application of ice for between 16 and 24 minutes resulted in a significant reduction in both sensory ($p<0.005$) and motor ($p<0.005$) nerve conduction velocity which may explain the reduction in pain. Most of the findings on the pain-relieving ability of cold application are based on **empirical, clinical evidence** but there is a lack of evidence from controlled trials comparing the mode or duration of application, the ideal temperature, and the duration of the analgesic effects. This lack of evidence regarding the mode of application of ice (or cryotherapy) has been noted in the literature (Ho et al*,* 1994; McDowell et al, 1994).

Although the application of cold is regarded as a readily accessible, inexpensive and safe modality, case reports indicate that there is a risk of nerve damage if the application is prolonged, or over superficial nerve trunks, or in athletes who have little subcutaneous fat. Covington and Basset (1993) and Basset et al (1992) reported six case studies in which peripheral nerve injury followed application of ice, and Green et al (1989) also reported a case study involving peripheral nerve injury following ice application. The nerve most commonly affected was the common peroneal nerve following ice application over the lateral aspect of the knee (four cases), although the lateral femoral cutaneous nerve was implicated in two cases when ice had been applied over the anterior superior iliac spine. The supraclavicular nerve was affected in one case following ice application over the shoulder. Durations of application varied between 20 minutes and one hour. The precise mode of application of ice was noted in only two cases (plastic ice bag and ice bag over a towel). This evidence, obtained from **clinical observations,** suggest that caution is required when applying ice in close proximity to superficial nerves.

In subjects with large subcutaneous deposits of fat, cooling may be impaired (Wolf and Basmajian, 1973). In a study in which deep muscle temperatures were recorded in the gastrocnemius muscle in ten subjects over a period of five minutes, the subject who was described as being ‘of a muscular body type’ demonstrated the greatest temperature change, whilst the subject who was described as ‘obese’ demonstrated the smallest temperature change. Although the sample size in this study was not large enough to draw definitive conclusions regarding the influence of obesity on cooling, it appears that longer periods of cooling may be required in obese individuals to achieve a therapeutic effect.

Meeusen and Lievens (1986) have identified several modes of application of cold. The most common therapeutic application is usually with ice packs, ice towels or ice massage to the injured part (Kalenak et al, 1975 and Kern, 1980, cited Meeusen and Lievens, 1986). Another application technique, mostly used in research because of the ability to control temperature, is immersion in cold water. Local cryotherapy can also be applied by frozen gel packs, vapocoolant sprays, chemical ice and refrigerant inflated bladders/splints. Skin temperature has been reduced by between 6ºC (ice pack) and 29.5ºC (water immersion at 4ºC) using different applications, applied for between ten seconds (vapocoolant spray) and 193 minutes (water immersion at 4ºC). Intramuscular temperatures show a delayed fall in temperature that continues after the cold application has been removed (Meeusen and Lievens, 1986).

Few comparative studies have been carried out to evaluate the efficacy of different cold applications. However, McMaster et al (1978) compared chipped ice, frozen gel packs, chemical ice pack and an inflatable envelope containing a gaseous refrigerant, measuring deep intramuscular temperatures over a period of one hour, in canine thighs. The iced gel packs performed best of the artificial ice techniques but the chipped ice performed best overall, producing a temperature drop of 11.3ºC. Belitsky et al (1987) also found crushed ice in a damp towel (wet ice) to be the most effective application, performing better than crushed ice in a plastic bag (dry ice) or cryogen packs, both in the actual temperature drop, and the duration of effect. These authors also found that the direct effects of the cold application were restricted to the area of application. Botte (1982, cited Meeusen and Lievens, 1986) found no depth effect with ethyl chloride sprays. Thus, although limited, **empirical evidence** tends to support chipped ice as the most effective form of cold application.

Scheffler et al (1992) support our findings that no specific conclusions have been reached regarding the optimum duration of cold applications, possibly due to different outcome measures being used.

Recommendations for guidelines

However, although the evidence is not conclusive, there is general agreement that the application of ice (or cold) for 20–30 minutes results in decreased pain, blood flow and metabolism (Taber et al, 1992, Ho et al, 1994, McMaster et al, 1978; Knight, 1989). Duration of application should be reduced over superficial nerve trunks, or in patients with little subcutaneous fat (Covington and Basset, 1993; Basset et al, 1992), but increased in individuals with large subcutaneous deposits of fat (Wolf and Basmajian, 1973). The most effective mode of application of cold appears to be chipped ice in a damp towel (McMaster et al, 1978; Belitsky et al, 1987).

Current practice - results of questionnaire

Crushed ice was the most common mode of application of cold in the hospital/clinic setting (92 per cent of respondents usually or sometimes using this application), with gel packs and cryocuff usually or sometimes being used by 76 per cent and 65 per cent of respondents respectively. Only 21 per cent usually or sometimes used cold sprays in this setting. Crushed ice, gel packs and ice cubes were the most common modes of application in the sporting environment, with 86 per cent of respondents usually or sometimes using these applications. Cold sprays were more popular in this environment with 75 per cent usually or sometimes using these. Damp towels were the most popular mode of application of ice in the hospital/clinic setting, whereas in the sporting environment, plastic bags, damp towels and a combination of plastic bags + damp towels were used with equal frequency. Most respondents applied ice/cold for between 11 and 20 minutes (47 per cent), with a frequency of three to five times per day. However, 41 per cent applied ice/cold for more than 20 minutes and 28 per cent suggested its application hourly when awake.

8.4 Compression

Poor management of acute musculoskeletal injuries can lead to excessive swelling, which in turn may develop into chronic oedema. Following knee arthroplasty, it has been found that discomfort and oedema can lead to inhibition of the extensor mechanism, with delayed resumption of motion, strength and leg control (Whitelaw et al, 1995). Although the application of compression has long been accepted as a means of limiting and reducing oedema, most of the support for the use of compression dressings has arisen from observation and convention. Ice, compression and elevation are widely recognised as the standard intervention in acute soft tissue injuries, and it is difficult to find studies in which the effects of compression alone have been investigated.

External compression through the application of an elastic wrap can stop bleeding, inhibit seepage into underlying tissue spaces and help disperse excess fluid (Thorsson et al, 1997). As the compression increases the hydrostatic pressure of the interstitial fluid, this fluid is pushed back into the capillaries and lymph vessels in the region of the trauma or into the tissue spaces away from the traumatised area (Rucinski et al, 1991). The presence of external compression increases the effectiveness of the muscle pump in influencing venous return.

Several modes of application of compression are available, ranging from non-adhesive and adhesive elastic bandages and tubigrip to adjustable neoprene supports and inflatable splints.

Guideline 4 - Compression

1 Always apply compression in a direction from distal to proximal, irrespective of the type of bandage/compression agent **(C)**.

2 Pressure must **not** be greater proximally than distally. Application of pressure should be uniform throughout the compression **(II)**.

3 Apply compression a minimum of six inches below and above the site of injury. At distal sites (e.g. ankle, wrist) apply from heads of metatarsals/metacarpals to the joint proximal to the site of the injury **(C)**.

4 Apply as per manufacturer's instructions when these are available **(C)**.

5 Compression must be capable of accommodating oedema immediately following injury, and of continuing to apply pressure with diminishing effusion **(II)**. Therefore:
- do not apply compression with the material at full stretch
- ensure overlap of half to two-thirds of previous turn of compressive material
- apply turns in a spiral fashion - **never** apply circumferential turns
- protective padding (gauze, underwrap, foam, cotton wool, gamgee) or gapping of the compressive material may be necessary over vulnerable areas such as the popliteal fossa, superficial tendons and bony prominences.

6 Compression using an elastic legging (or equivalent) should not be applied in the recumbent (lying) position, or in association with elevation **(I)**.

7 Remove and reapply if uniform and constant pressure is not maintained, or to administer other treatment modalities. Otherwise, reapplication is recommended within 24 hours **(C)**.

8 Compression should be applied as soon as possible following injury **(C)**.

9 Intermittent compression may be applied (30 mins daily at a compression of 60mmHg, 30 seconds on, 30 seconds off) in addition to compression during the first five days **(II)**.

10 Continue compression for first 72 hours following injury, when not lying down **(II)**.

11 Distal areas should be checked immediately following application of compression for signs of diminished circulation (cold, pallor) and then regularly checked throughout the continued application of compression **(C)**.

12 The following materials may be considered for purposes of application of compression:
- cohesive / tensor bandages
- tubigrip
- elastic adhesive bandage
- adjustable neoprene supports
- inflatable pressure devices.

Elastic bandages and tubigrip appear to be most effective **(II)**.

Evidence

Few studies exist which examine the effects of compression alone on oedema or in the management of acute soft tissue injuries, as most seem to investigate the influence of a combination of cold application with compression (Schroder and Passler, 1994).

A study by Rucinski et al, (1991) compared three treatment protocols in the management of post-traumatic oedema in 30 subjects following lateral ligament ankle sprains. Subjects were divided into three groups. One group had the limb elevated at 45°C for 30 minutes, the second had the limb elevated at 45°C and an elastic wrap applied from the heads of the metatarsals to 12.7 centimetres above the malleoli for 30 minutes, and the third group had the limb elevated to 45°C and an intermittent pressure device applied at 40–50mmHg for 30 minutes. Both of the compression protocols resulted in slightly increased limb volume when measured by water displacement and the elevation alone resulted in a significantly decreased limb volume, suggesting that elevation alone is the treatment of choice. However, although elevation alone produced the most favourable results, in reality this is difficult to maintain over prolonged periods of time and it may be that compression has its most beneficial effect when the limb is not elevated. Furthermore, the degree of compression (40–50mmHg in the intermittant compression device) may have caused arteriolar dilatation under the area of compression (Neilsen, 1983b), which on removal of the compressive device caused increased blood flow and increase in limb volume.

Airaksinen et al (1990) compared the effectiveness of elastic bandages and intermittent compression for the treatment of acute ankle sprains. Subjects who had sustained an inversion injury to the ankle were randomised into two groups, the control group wore elastic bandages and the experimental group hade intermittant compression therapy for once per day for five days in addition to wearing elastic bandages. At one week and four week follow-up measurements, both groups demonstrated improvements in all measures, but the compression group had significantly less oedema, less pain, greater range of movement and improved function than the control group. This suggests that a combination of elastic bandage and intermittent compression is better than an elastic bandage alone. Although the study was in the form of a randomised controlled trial, no information was given about advice on elevation, weight-bearing or the position in which the compression treatment was given (recumbent or elevated), potentially reducing the scientific rigour of the report.

Murthy et al (1994) provided both support and a possible explanation for Rucinski et al's (1991) findings; they found that in the recumbent position, elastic leggings created intramuscular pressures of a magnitude which had the potential to compromise microcirculation, and suggested that patients should be discouraged from lying down with elastic leggings for long periods of time. The authors did not identify the period of time, but as the reported pressures in the study were recorded at 30 seconds, it might be assumed that lying down with elastic leggings should be avoided completely. Lower "safe" intramuscular pressures were recorded during sitting, standing, walking and running.

Thorsson et al (1997) in a prospective non-randomised trial of 40 athletes, found no difference in range of motion, serum creatine kinase and ultrasonic scan following muscle injuries between two groups, one of which had immediate (within five minutes) compression and the other which had rest and elevation only. The lack of difference between the two groups may be explained by the fact that the compression group appeared to have continuous compression, which other studies have suggested may be undesirable, until symptom-free.

Neilsen (1983b) applied external compression at levels of 10mmHg up to the level of diastolic pressure of 66-74mmHg. At external pressures of greater than 10mmHg, blood flow in both subcutaneous and muscle tissue was significantly reduced ($p<0.05$). However, Neilsen (1983b) suggested that increased tissue pressure provides a stimulus for arteriolar dilatation as a means of autoregulation of blood flow, but that this compensatory dilatation is masked by a general increase in local vascular resistance caused by the external pressure. This study provided **empirical evidence** for reduction of blood flow during compression and the **biological basis** for the increase in limb volume when compression is removed.

Furthermore, Neilsen (1983b) showed that when proximal pressure was applied at a level of 66-70mmHg, distal external pressures of 10-40mmHg resulted in significant ($p<0.005$) increases in subcutaneous blood flow and small but insignificant ($p>0.01$) increases in muscular blood flow. This provides **empirical evidence** to support avoidance of high proximal-distal pressure gradients.

Matsen and Krugmire (1974, cited Brodell et al, 1986) studied tibial fractures in the rabbit and concluded that although external pressure decreased post-fracture swelling, the pressure must be uniform and controlled so that it does not result in adverse haemodynamic effects. They observed that most pressure dressings currently in use tend to apply more pressure as the volume of the limb increases, with undesirable consequences. This provides empirical support for careful grading of applied compression which must accommodate increases in limb volume brought about by oedema. Precise pressure levels were not quoted.

Brodell et al, (1986) showed that the application of compression in the form of a Robert Jones bandage, with a distal to proximal pressure gradient resulted in reduced antero-lateral compartment pressure which was reversed upon removal of the bandage. Tufft and Leaman (1994) found that immediately following application, a wool and crepe bandage produced more pressure than an elastic tubular bandage at the ankle of both normal and ankle-injured subjects, but suggested that over time the tubular bandage had greater effect.

Numerous studies have evaluated the effectiveness of a combination of ice/cold and compression on pain and oedema in a variety of clinical situations (Starkey, 1976; Quillen and Rouillier, 1982; Scheffler et al, 1992; Levy and Marmar, 1993; Healy et al, 1994; Whitelaw et al, 1995; Barlas et al, 1996). Due to considerable variation in study design and outcome measures, direct comparison across studies is not possible. However, general conclusions are that the combination of ice and compression reduces pain and swelling. Thus these studies provide **empirical evidence** for the efficacy of a combination of ice and compression but do not distinguish between the two.

Recommendations for guidelines

The findings from these studies indicate that the application of compression can effectively reduce oedema and pain, and improve range of motion and function following soft tissue injury (Rucinski et al, 1991; Airaksinen et al, 1990). Evidence also suggests that compression should be removed when the limb is elevated, but should be applied at all times when the limb is in the dependent position (Rucinski et al, 1991; Murthy et al, 1994). Additionally, intermittant compression may be of value in the early stages (Airaksinen et al, 1990), but not in the elevated position. Applied pressure should be controlled with a distal to proximal pressure gradient (Brodell et al, 1986).

Current practice - results of questionnaire

Ninety-eight percent of the total sample stated that they prescribed compression , which was 100 per cent of those who responded to this question. Tubigrip and taping / strapping were the most popular modes of application in both the clinical and sporting environments, with stretch bandages being the third most popular in both locations. Crepe bandages were used (usually or sometimes) by 36 per cent (clinic) and 33 per cent (sporting environment) of the total sample. This perhaps gives some cause for concern due to the material’s limited ability to accommodate to increasing limb volume. Similarly, one might question the small number (11 per cent in the clinic and 12 per cent in the sporting environment) who stated they used non-stretch bandages.

The majority of respondents always or sometimes advocated removal of compression for application of ice / cold (94 per cent), other treatment (96 per cent) and at night, whilst 66 per cent advocated the permanent application of compression. Apparent discrepancies in numbers are because the total sample did not respond to all questions.

8.5 Elevation

Kellet (1986) noted that it is common practice to combine cryotherapy with both compression and elevation of the injured limb to reduce the effects of the local inflammatory response. He further suggested that, although specific data are not available to support these elements of treatment, logic suggested that elevation assists in overcoming the gravitational influence on the accumulation of oedema.

Guideline 5 - Elevation

1 Elevate the injured part above the level of the heart as much as possible during the first 72 hours following injury **(III)**.

2 Ensure that the elevated part is adequately supported (e.g. by pillows, slings) **(C)**.

3 Elevate the injured part as soon as possible following injury **(C)**.

4 Avoid placing the limb in the dependent position immediately following elevation as the 'rebound phenomenon' will tend to increase oedema **(II)**.

5 If the limb can be maintained in elevation, do not apply compression simultaneously **(I)**.

Evidence

Neilsen (1983a) found that intra-arterial pressure reduction was achieved by limb elevation above heart level in subjects placed in a horizontal position. This pressure reduction has the further effect of providing a stimulus for arteriolar dilatation, similar to that resulting from increased tissue pressure produced by external compression. Baumert (1995) noted that elevation of the injured part above the level of the heart enhances draining of extravascular fluid away from the injured area, but does not support this observation with evidence. From the Neilsen (1983a) study, reduction in intra-arterial pressure resulting from elevation of the limb might cause a reduction in extravasation of fluid into the interstitial tissues, suggesting but not confirming a **biological base** to support elevation of the injured part.

Empirical evidence to support the use of elevation was produced by Rucinski et al (1991), who found that elevation alone was more effective in reducing oedema following ankle injury than elevation plus intermittant compression or elevation plus elastic wrap. As the measurement of oedema was by volumetric displacement, the superior effects of elevation alone may be explained by greater arteriolar dilatation when the tissues were also compressed which resulted in an increase in limb volume once the compression had been removed (Neilson, 1983b). It may also be explained by the 'rebound phenomenon', which is caused by a sudden shift of vascular or lymphatic fluid when the limb is moved from an elevated position to a dependent position. This does not occur with elevation alone, but only when elevation is combined with compression. Furthermore, it might be suggested that if compression is applied to an elevated limb, arterial supply and venous drainage may be compromised.

Recommendations for guidelines

This evidence tends to suggest that when an injured limb / part can be maintained in elevation above the level of the heart, compression should not be applied simultaneously (Rucinski et al, 1991). However, when elevation cannot be maintained, evidence suggests that compression reduces intra-arterial pressure and increases tissue pressure, thus reducing extravasation of fluid into the tissues (Neilsen, 1983b).

Current practice - results of questionnaire

Ninety-eight per cent of the total sample stated that they prescribed elevation, and of these, 91 per cent advocated elevation ‘as much as possible’ and 59 per cent suggested continual elevation. Fifty-six per cent of the total sample prescribed elevation of the injured part above the proximal joint, 53 per cent prescribed elevation above the heart and 48 per cent prescribed supine lying with elevation above the level of the heart.

9 Summary of Guidelines

Guideline 1 - Protection

Guideline	Evidence
1 Protection should be applied during the early stages of the healing process (at least up to day three).	Biological **(II)**
2 The duration of application should be dictated by the severity of pain and the extent of injury. Animal studies suggest that a moderate (second degree) injury requires three to five days protection; mild (first degree) injuries may require a shorter period and severe (third degree) longer.	Biological **(II)** + consensus (literature + panel)
3 The mode of application of protection will depend on the site and nature of injury and its severity. This may range from protection from full weight-bearing (crutches) or general support (slings) to specific support for the injured structure/s (braces, splints, taping).	Consensus (literature + panel) **(C)**
4 Whilst supporting / protecting the injured structure/s, the mode of protection should avoid complete immobilisation of the part whenever possible.	Consensus (literature + panel) **(C)**
5 The mode of protection must be capable of accommodating oedema.	Consensus (literature + panel) **(C)**

Guideline 2 - Rest

Guideline	Evidence
1 Rest should be applied to the injured part immediately following injury.	Biological **(II)**
2 Stress on the injured tissue should be avoided during the early (inflammatory) phase of the healing process, as the tensile strength of the injured tissue is greatly reduced at this time.	Biological **(II)**
3 The optimum period of rest appears to be one to five days, depending on the severity of injury. Moderate (second degree) muscle injuries require three to five days 'immobilisation'. Mild (first degree) injuries may require only 24 hours rest and severe (third degree) injuries may require at least a week's rest.	Biological **(II)** + panel consensus (based on biological and empirical evidence)
4 Early mobilisation following the period of rest should initially avoid undue stress on the healing tissue.	Empirical **(III)**
5 Isometric work may be performed during the period of rest, within the limits of pain tolerance.	Consensus (literature + panel) **(C)**
6 Overall general activity should be reduced to avoid increasing metabolic rate and producing a generalised increase in blood flow.	Empirical **(III)** (+ consensus based on physiological principles).

Guideline 3 - Ice

Guideline	Evidence
1 Ice should be applied immediately following acute musculoskeletal injury	Consensus (panel) **(C)**
2 Chipped/crushed ice in a damp towel appears to be the most effective application of cold, followed by ice in a plastic bag, and then frozen gel packs	Empirical **(II)**
3 Damp towels should always be applied directly to the skin before using crushed ice and commercial cold packs, to avoid an 'ice burn'. A maximum period of 30 minutes is recommended	Consensus (panel) **(C)**
4 The most effective duration of application of ice appears to be 20 to 30 minutes, applied every two hours, with a recommended maximum of 30 minutes to avoid tissue damage	Biological + empirical **(II)**
5 Areas with >2cm subcutaneous fat may require longer applications (30 minutes), since it has been found that ten minutes of application produces no muscular cooling effect in these circumstances	Empirical **(III)**
6 Cold application should cover the entire area affected by the injury	Empirical **(III)**
7 The athlete should not return to participation immediately following application of ice (or other types of cold application), as nerve conduction velocity, sensation and connective tissue flexibility are likely to be reduced by cold application	Consensus (panel) **(C)**
8 Care should be taken in the application of ice to patients with little subcutaneous fat since cold-induced nerve injury may result. To compensate for this, the duration of application should be reduced (no more than ten minutes) or an insulating material placed between the skin and ice application	Empirical (based on case-study observations) **(III)**
9 Application of cold is contraindicated for patients who have previously developed cold-induced hypertension during cold treatment, who have allergy to cold (urticaria, joint pain), or who have Raynaud's syndrome, peripheral vascular disease or sickle cell anaemia	Consensus (literature + panel) **(C)**
10 If nerve damage as a result of the injury is suspected or if there is a history of reduced skin sensation, application of cold should not exceed 20 minutes and skin condition should be checked every five minutes.	Consensus (panel) **(C)**

Guideline 4 - Compression

Guideline	Evidence
1 Always apply in a direction from distal to proximal, irrespective of the type of bandage/compression agent	Consensus (panel) **(C)**
2 Pressure must **not** be greater proximally than distally. Application of pressure should be uniform throughout the compression	Empirical **(II)**
3 Apply compression a minimum of six inches above and below the site of injury. At distal sites (e.g. ankle, wrist) apply from heads of metatarsals/metacarpals to the joint proximal to the site of injury	Consensus (literature + panel) **(C)**
4 Apply as per manufacturer's instructions, when available	Consensus (panel) **(C)**
5 Compression must be capable of accommodating oedema immediately following injury, and of continuing to apply pressure when the swelling is diminishing. Therefore: • do not apply compression with the material at full stretch • ensure overlap of half to two-thirds of previous turn of compressive material • apply turns in a spiral fashion - **never** apply circum ferentially • protective padding (gauze, underwrap, foam, cotton wool, gamgee) or gapping of the compressive material may be necessary over vulnerable areas such as the popliteal fossa, superficial tendons and bony prominences	Empirical + Consensus (literature + panel) **(II)**
6 Compression using an elastic legging (or equivalent) should not be applied in the recumbent (lying) position, or in association with elevation	Empirical **(I)**
7 Remove and reapply if uniform and constant pressure is not maintained, or to administer other treatment modalities. Otherwise, reapplication is recommended within 24 hours	Consensus (panel) **(C)**
8 Compression should be applied as soon as possible following injury	Consensus (literature) **(C)**
9 Intermittent compression may be applied (30 minutes daily at a compression of 60mmHg, 30 seconds on, 30 seconds off) in addition to compression, during the first five days	Empirical **(II)**
10 Continue compression for the first 72 hours following injury, when not lying down	Empirical **(II)**

Guideline 4 - Compression

Guideline	Evidence
11 Distal areas should be checked immediately following application of compression for signs of reduced circulation (cold, pallor) and then regularly checked throughout the continued application of compression	Consensus (panel) **(C)**
12 The following materials may be considered for purposes of application of compression: cohesive bandage, tubigrip, elastic adhesive bandage, adjustable neoprene supports, inflatable pressure devices. Elastic bandages and tubigrip are the most effective mode of continuous compression.	Empirical **(II)**

Guideline 5 - Elevation

Guideline	Evidence
1 Elevate the injured part above the level of the heart as much as possible during the first 72 hours following injury	Empirical +Consensus (literature + panel) **(III)**
2 Ensure that the elevated part/limb is adequately supported (e.g. by pillows, slings)	Consensus (panel) **(C)**
3 Elevate the injured part as soon as possible following injury	Consensus (literature + panel) **(C)**
4 Avoid placing the limb in the dependent position immediately following elevation as the ‘rebound phenomenon’ will tend to increase oedema	Empirical **(II)**
5 If the limb can be maintained in elevation, do not apply compression simultaneously.	Empirical **(I)**

10 Conclusions and future developments

In conclusion, it may be stated that the first two of the objectives identified in section 3 have been achieved. A guidelines document has been developed, and the biological bases, empirical evidence and consensus view has been provided to support the guideline statements. From this definitive document, which may be used as a reference text, alternative modes of presentation will be developed to target the identified populations, in order to achieve the third objective.

Following dissemination of the guidelines in appropriate format to the target populations, the degree of implementation of the guidelines will be evaluated through audit. This will document the flow of information to the practitioners, and the degree to which the guidelines have been incorporated in current practice.

As an intervention, **PRICE**, as a total package and in terms of its individual components, is cheap and readily available. It is simple to apply, and if correct advice is given, does not require the presence of an experienced practitioner. These guidelines, and the summary documents to be developed for wider dissemination, will provide the best evidence-based advice for both practitioner and patients. However, in view of the surprisingly limited amount of evidence in the literature to support definitive guidelines for the application of the PRICE regimen, it is apparent that further research is necessary to provide that evidence. Thus, there will be a need to review these guidelines as further evidence becomes available.

10.1 Review of the guidelines

It is proposed that these guidelines should be reviewed in three years, when it is hoped that new evidence on the mode of application of **PRICE** will have emerged. To ensure continuity, and also with a view to taking these guidlines forward, it is suggested that the review panel should consist of the present development group, with additional members from the current (at the time of review) committee of ACPSM - the Chair, Vice-Chair and Education Chair. End-users will be included where appropriate.

10.2 Monitoring of guidelines

Because of the potential scope of these guidelines, conventional methods of monitoring compliance through clinic attendance, assessment, goal attainment etc may not possible. The process of auditing the guidelines might take the following suggestions into consideration.

1 Monitoring the dissemination of the guidelines reference document - this will be distributed to all ACPSM members, to all academic physiotherapy departments, and to regional Sports Councils. Already we have had requests for the document from several other interested parties. A record will be kept of the distribution

2 Monitoring the distribution of the summary leaflets

3 A follow-up questionnaire to members of ACPSM to determine what impact the guidelines have had on clinical practice

4 Targeting specific athlete/patient/user groups to determine if they have received leaflets/advice on the immediate management of their soft tissue injuries, and how closely their practice of **PRICE** conforms to the guidelines.

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Appendix A (I)

The development process - choice of topic

Is the topic high volume, high risk, high cost?

The incidence of sport-related injury has been highlighted in the introductory section of this document, providing evidence of **high volume**. Whilst not constituting **high risk** in the conventional sense, it is generally accepted that effective early management of soft tissue injury aimed at ameliorating the inflammatory response will reduce the risk of prolonged morbidity and recurrence of injury. The potential cost of sport-related injury related to time off work has been estimated at £405 million each year in England and Wales alone (Nichols et al, 1991), indicating the **high cost** of these injuries and emphasising the need for effective management.

Are there large or unexplained variations in practice?

The use of **PRICE** (**P**rotection, **R**est, **I**ce, **C**ompression and **E**levation) has been generally accepted, but there is great diversity of practice, particularly with respect to the frequency and duration of ice application and the degree of protection and rest as opposed to early mobilisation.

Is the topic important in terms of the process and outcome of patient care?

Soft tissue injuries are common, both in the context of sport- and non-sports-related activities, and occur in a variety of environments. Consequently, the first person to deliver some form of management in the critical period immediately following injury may be a chartered physiotherapist, a doctor, a coach, a team-mate, a work colleague or indeed the injured person himself. Clear guidelines will assist the practitioner, his colleague and/or the patient to make appropriate decisions and take effective action during this critical period, thus influencing the process of patient management and ultimately the outcome.

Is there potential for improvement?

When there is wide variation in practice, it is inevitable that some elements of practice will be convention rather than evidence-based. The identification of evidence for practice, where it exists, will provide potential for improvement.

Is the investment of time and money likely to be repaid?

If improvements in practice associated with these guidelines result in improved efficacy of treatment, length of time off work and/or sport should be reduced with consequent socio-economic benefits.

Is the topic likely to hold the interest of team members?

The selection of the topic involves an area of practice which is extensively used (and advised) by all chartered physiotherapists in sport. As such, all members of the development group were familiar with the topic, were aware of the diversity of practice and were aware of the need to provide evidence (where it exists) to support practice.

Is consensus likely?

Members of the initial development group were in agreement that where evidence exists, this should form the basis for practice. Where no evidence exists in the literature, the group agreed that consensus should form the basis for the guidelines.

Will change benefit patients?

Any move towards evidence-based practice should benefit our patients.

Can change be implemented?

The guidelines for practice as presented in this document are likely to result in a more focussed and consistent approach to the application of **PRICE**. With the dissemination of these guidelines, it should be possible to implement an alteration in the emphasis of current practice. Connections within ACPSM and in the wider context of those involved in the management of soft tissue injuries should provide a useful network for the dissemination and implementation of the guidelines.

Appendix A (II)

The development process - membership of the group

Do we have the right people in the group?

The original membership of the group consisted of members of the physiotherapy profession, all of whom are members of ACPSM. At a later stage, when the first draft of the guidelines is complete, representatives of other interested parties (chartered physiotherapists not involved with the development of the guidelines, medical practitioners, etc.) will be included to evaluate the guidelines for accuracy and 'user friendliness'.

Can we involve other appropriate people?

Due to the close working relationship and connections of practising members of the group with other professionals involved in sport and sports medicine, appropriate consultation with others can be assured. For the development of the supporting leaflets, the development group will be expanded to include potential users of the summarised guidelines. This will involve sports centre staff, athletes, coaches/trainers, and patients.

Do we have appropriate skills?

The group consisted of chartered physiotherapists with extensive experience of sports physiotherapy, some whom are currently in practice but also with recent academic experience, and others currently working in an academic environment. This provided the necessary mix of specialist experience in practice and experience in reviewing and analysing literature. The group leader has extensive experience in both clinical practice and academic work and is experienced in practicalities of research and the dissemination of findings.

Are there too many or too few of us?

The group identified key areas integral to the development of these guidelines and assigned individuals to take responsibility for each of the areas. Tasks therefore revolved around three major areas of literature, development, distribution and analysis of a questionnaire, management of finances and a co-ordinator to collate the information and take responsibility for producing the guidelines document. The original group had a membership of six, which has allowed dissemination of the load but which is small enough to facilitate ease of communication.

Have we included representatives of those expected to implement the guidelines?

All members of the group are members of ACPSM which is the major target group for implementation of the guidelines. However, as mentioned above, chartered physiotherapists not involved in the development of the guidelines and other appropriate people will be added to the group to advise on the final presentation and composition of the guidelines documentation.

Appendix A (III)

The development process - development of the guidelines

Have we clearly defined the subject of the guidelines?

The subject of the guidelines has been clearly defined as the management of soft tissue injury with **P**rotection, **R**est, **I**ce, **C**ompression and **E**levation during the first 72 hours.

Do we have access to guidelines already produced on this subject?

We are unaware of any existing guidelines on this subject.

Have we approached likely sources of advice?

As the initiator of the development of clinical practice guidelines in physiotherapy, the Chartered Society of Physiotherapy was approached for guidance and advice on the development of these guidelines.

Do we need to undertake a literature review?

It was agreed that a review of the literature was necessary to identify evidence for practice. A computerised review was undertaken, using the following data bases: Physiotherapy Index, Rehabilitation Index, Complementary Medicine Index, the CSP Research and Documents databases, Medline, CINAHL and BIDS/Embase.

Is the evidence for defining the components of the guidelines available for those responsible for their construction?

Although it was relatively easy to define the basic components of the guidelines as they constituted accepted practice, the amount of clear evidence to support the individual elements was inconsistent.

How shall we take this forward?

With the knowledge that the supporting evidence was either limited or inconclusive, and that the overall approach was widely accepted in current practice, it was decided to produce guidelines based on evidence (where this exists) and on consensus based on expert opinion.

What type of guidelines do we want to produce?

The guidelines should be clear and unambiguous but should avoid being totally prescriptive to preserve the autonomy of experienced clinicians who wish to exercise clinical judgement. As the guidelines are targeting groups with mixed knowledge bases, the summary documents will take this into consideration.

Have we clearly defined the end users of the guidelines?

The end users will be health professionals (chartered physiotherapists, doctors), sports professionals (coaches, trainers, athletes, sports centre staff) and patients.

Appendix A (IV)

The development process - presentation of the guidelines

Is the problem clearly defined?

The problem has been clearly stated in terms of the high incidence and socioeconomic cost of injury and the need to provide evidence-based guidelines to support practice.

Is our presentation clear and unambiguous?

The guidelines have been presented in the form of clear statements pertaining to each element of practice.

Is the evidence for the statements presented or readily available?

The evidence as it exists is discussed in general with respect to each of the elements of practice. The nature of the evidence is presented alongside each statement.

Is there a rationale for the guidelines?

- what is the estimated impact?

The guidelines (complete document or summary) will be distributed to all members of ACPSM (approximately 1,000), to all members of BASM (approximately 1,000), to sport and coaching bodies, and to sport/leisure venues.

- what are the current variations and uncertainties?

Current variations in practice have been identified through the literature and through the findings of the questionnaire.

If options are available, are the decision-making factors clear?

The critieria for options have been clearly presented in the document and in the appendices.

How should we present them? Which format will be most appropriate for their proposed use?

There will be three main means of presentation - the complete bound document which may be used for reference purposes, a durable leaflet which may be carried around for immediate reference and a simple instruction leaflet which may be given to the injured individual.

Will the chosen medium be sufficiently durable for its proposed use?

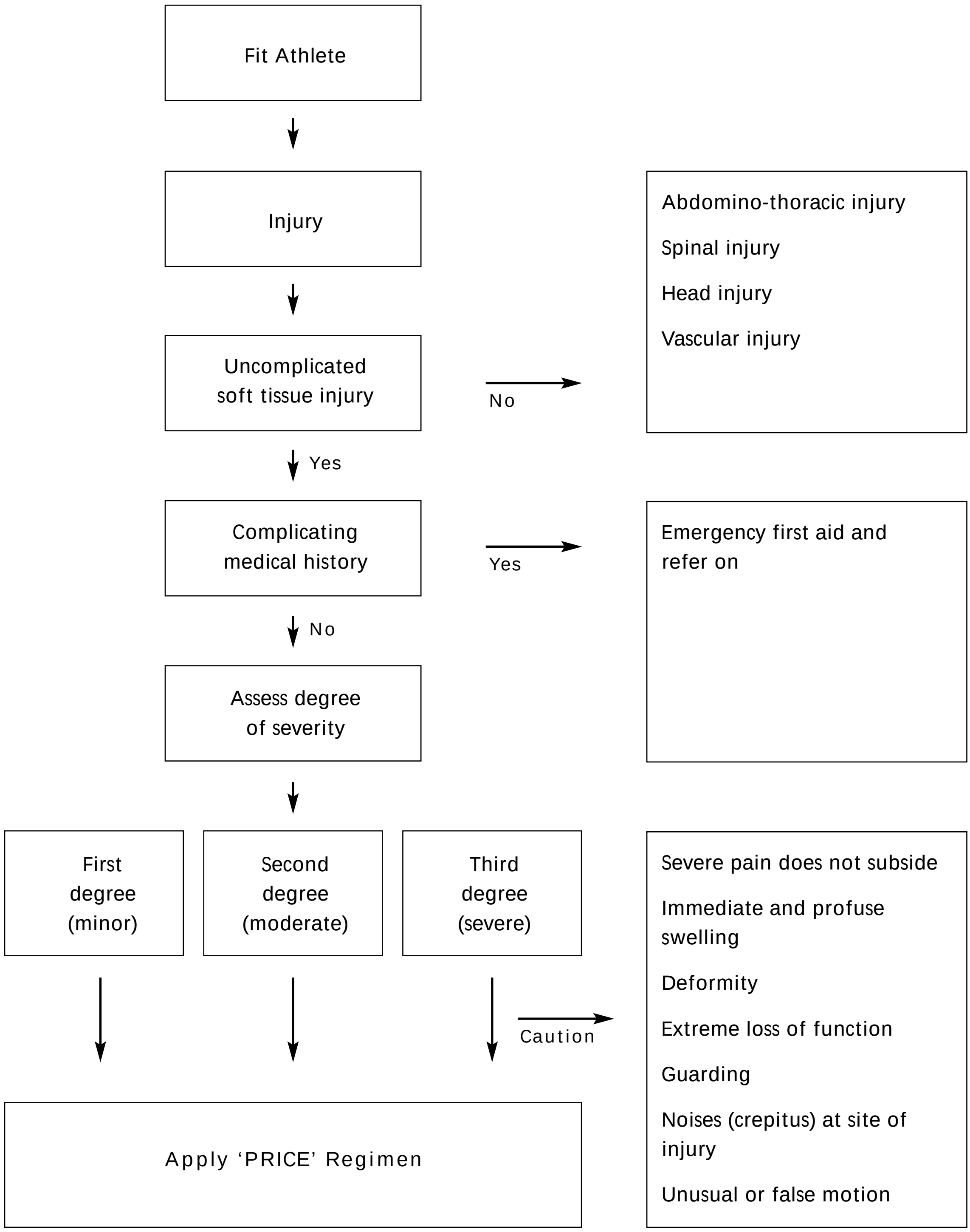
Guidance will be sought as to the most effective and durable medium/material for presentation / dissemination.

Are the authors acknowledged or stated?

The authors have been stated and acknowledgements made to other contributors.

Appendix B

Injury management flowchart



Appendix C

Alternative modalities which may be used in parallel with PRICE during the first 72 hours

First degree (mild)	**Second degree (moderate)**	**Third degree (severe)**
NSAIDs Oral NSAIDs. Topical NSAIDs.	**NSAIDs** Oral NSAIDs. Topical NSAIDs.	**NSAIDs** Oral NSAIDs. Topical NSAIDs.
Electrotherapy Interferential therapy. TENS. Ultrasound. PEME. Laser.	**Electrotherapy** Interferential therapy. TENS. Ultrasound. PEME. Laser.	**Electrotherapy** Usually not appropriate, as patient is referred on for further investigation.
Manual techniques e.g. joint mobilisation stretching PNF.	**Manual techniques** Not usually appropriate for injured area during first 72 hours.	**Manual techniques** Not appropriate - patient should be referred on for further investigation.
Taping Use to protect during activity.	**Taping** Use to protect during rest period of the injured part.	**Taping / bracing** Use to protect and stabilise during rest and to apply compression.
Rehabilitation May commence immediately following injury, providing the injured structure is protected.	**Rehabilitation** Not appropriate during the first 72 hours. Light activity of uninjured parts may commence.	**Rehabilitation** Not appropriate - patient should be referred on for further investigation.

Appendix D

Consensus Panel:

Executive Committee

Kate Kerr (Education Chairman, ACPSM) (Development Group).
Lynda Daley (Chairman, ACPSM) (Development Group).
Lynn Booth (Vice chairman, ACPSM) (Development Group).
Nikki Phillips (Secretary, ACPSM)
Liz Mendl (Treasurer, ACPSM)
Sharon Turl (Journal Editor, ACPSM)
Pete Evans (PRO, ACPSM)
Laura Hanna (Membership Secretary, ACPSM)
Rose Macdonald (Vice-president, ACPSM)

Regional Representatives

Judy Fessey (East Midlands)
Christine Wallace (Northern)
Jean O’Farrell (North Wales)
Helen Rocca (North West)
Sarah Ferguson (South West)
Lisa Graham (Scotland)
Sarah Cripps (Southern)
Clair Hickson (South East)
Jackie Zaslona (South Wales)
Lizzy Lane (West Midlands)
Caroline Clay (Yorkshire and Humberside)

Appendix E

Results of questionnaire

Summary of Questionnaire Response:

Five hundred questionnaires were randomly distributed to ACPSM members, of which 226 were returned, which was a response rate of 45.2 percent. Here follows a brief summary of the responses for each section of the questionnaire.

Not all of those who returned the questionnaire responded to each question, or to each part of each question. The figures quoted refer to the percentage of responses of the total who returned the questionnaire, not to the responses to each question, the assumption being that if an individual did not respond to a question/part of a question, the individual did not use/apply the modality in question. For ease of reporting, the 'usually' and 'sometimes' categories have been combined to indicate a positive response; the 'rarely' category has been interpreted as indicating a negative response.

Protection:

Eighty nine percent prescribed specific protection, with crutches (82%) and slings (56%) being used most commonly, non-inflatable splints used by under half the respondents (38%). Inflatable splints were rarely used (17%).

Rest:

A high percentage (92%) prescribed rest, although less than half (31%) prescribed general rest. Seventy eighty percent prescribed complete rest of the injured part, and 86% allowed activity within the limits of pain. Surprisingly, 8% allowed any activity, and 1% gave no instructions regarding rest/activity.

Ice:

In the hospital/clinic setting, crushed ice was the most popular means of applying cold, with 69% of respondents using this method. Other methods commonly employed were gel packs (54%), ice massage (40%), cryocuff (38%), ice cubes (38%), and contrast baths (33%). Less commonly used were cold water (17%), chemical packs (9%) and cold sprays (9%). For the application of ice in this setting, 67% used damp towels, 48% used plastic bags and damp towels, 40% used oil and 32% used plastic bags alone. Plastic bags and dry towels (9%) and dry towels (8%) were rarely used.

In the sporting environment the mode of application of cold was more evenly spread, with gel packs (56%), crushed ice (47%), ice cubes (43%), and cold sprays (42%) being most popular. Less commonly used were chemical packs (33%), cold water (30%), ice massage (29%) and contrast baths (12%). For the application of ice, 44% used damp towels, 43% used plastic bags, 39% used plastic bags and damp towels and 21% used oil. Again, plastic bags and dry towels (9%) and dry towels (6%) were rarely used.

Forty six percent applied ice/cold for between 11 and 20 minutes, 40% applied it for more than 20 minutes, and 12% applied it for less than 10 minutes. Sixty-seven percent recommended that ice/cold should be applied 3-5 times/day, 27% recommended hourly when awake, and four percent recommended one-to-two times/day.

Compression:

Ninety-eight percent of the total prescribed compression, with 84% using tubigrip and 74% using taping/strapping in the hospital/clinic environment. In this location, 49% used stretch bandages, 36% used crepe bandages, 33% used flowtron, and 12% used non-stretch bandages. In the sporting environment, 69% used taping/strapping, 66% used tubigrip, 51% used stretch bandages and 34% used crepe bandages. Only 11% used non-stretch bandages, and 7% used flowtron.

Seventy-nine percent removed compression for treatment purposes, and 78% removed it for application of ice/cold. Sixty-nine percent recommended that compression should be removed at night, but 37% advocated that it should be maintained permanently. Seventeen percent would remove compression for activity.

Elevation:

Ninety-six percent of the total prescribed elevation, with 97% advising 'as much as possible', and 23% continual elevation during the day. During the day, 56% suggested elevation above the level of the proximal joint, 53% above the level of the heart, and 48% supine, above the level of the heart. Fourteen percent advocated that the limb should be horizontal, and 13% suggested supine lying.

During the night, 75% suggested elevation 'as much as possible', and 44% suggested continual elevation. At night, 51% prescribed elevation in supine with the injury above the heart, 43% suggested elevation above the proximal joint, and 35% above the heart. 22% advised supine lying, and 17% suggested that the limb should be horizontal.

Appendix F

Comments from Peer review/pilot

“Few comments. It reads well, is very comprehensive and does the job. The summary tables of guidelines are an excellent idea. My only comment would be to define more clearly the purpose of the document and who it is for, and to comment on what happens in the future - what do you feel needs to be done”.

This has been addressed in the introductory statement and in the conclusions.

“Thank you for seeking my impressions of the “guidelines”. Please extend my congratulations to the panel for a tremendous effort in putting the developments of recent years into a more sensible reasoning behind the time-honoured acronym. I am not without experience of a similar venture and I fully appreciate the demands inflicted on time and effort. Apart from nit-picking comments in the margins, my only real concern is of a more general nature, concerning “**protection**”.

The term “first aid” is never used and “early management” is the statement of choice. I can’t decide whether the panel had in mind the chap/chapess who is running onto the pitch (ie the sharp end of sports medicine) or the one in a clinic at HQ or the physio in A&E on Monday morning”.

This has been addressed by adding “immediate” to qualify the phrase “early management”

“GREAT! WONDERFUL! BRILLIANT! Hows that then? I actually enjoyed it so much I’ve finished it already. Well presented and easy to read. I like the way you say what you’re going to say, say it again, summarise and then tabulate it. Couldn’t be clearer - my congratulations to you all. There are a few minor type errors, and I’ll point them out if you want when I see you next.

No comment! (The manuscript was sent for professional editing)

(verbal comments) “...add “haematuria” to abdomino-thoracic injury; redefine head injury/ unconsciousness to include “altered cerebral function, leading to disturbed consciousness, vomiting, drowsiness or amnesia”. Change the order to alphabetical, to avoid any sense of hierarchy (p2). Give examples of superficial nerves (p22). Change “grating” to “crepitus” in flow-chart. Otherwise, a comprehensive and well-written document”.

Changes made as suggested.

“Many thanks for asking me to review your guidelines. I thought they were extremely useful and provided a clear outline of the premises or evidence underlying PRICE. I only have a few suggestions.

- I would place objectives and the need for guidelines at the very beginning.
  We felt that the definition of terms and a clear statement on the parameters of the guidelines should come first
- The epidemiology is good and drawing attention to the Sheffield survey is excellent as are the other references
  No comment
- The process of the development of the guidelines is interesting, but might be better served in the appendix
  We have summarised this in the text, and put the detailed comments/responses in Appendix A
- The appendices are not labelled yet
  This has since been done
- Although the phrase biological bases is used in the opening statement 5.1, it is referred to thereafter as biological evidence. This is somewhat misleading, as empirical proof should itself be referred to as evidence-based, in line with current vogue. In turn, biological bases should be rephrased, something like scientific foundation or premis or even physiological foundation.
  We have based this on the terminology proposed by Bogduk and Mercer (1995), but have added some explanatory statements relating to the nature of biological and empirical evidence
- Section 6, each subheading should be numbered or started on separate pages for clarity.
  Subheadings have been numbered and underlined. Layout will be further considered before publication
- I found the totals and % of total responses confusing. It might be simpler to have one initial % and let people extrapolate back.
  The detailed information on the results of the questionnaire have been removed, and a summary included instead.

The summary of the guidelines is excellent, and I would round them off by saying that many can be considered as a continuum and can overlap. “As both our understanding of soft tissue inflammation and the modalities available for its modifcation continues to develop, these guidelines will obviously need revising with a view to the duration and timing of interventions...”.

Appendix G

Precautions and contraindications for the application of PRICE

Patients exhibiting any of the injuries listed below should receive immediate first aid and should be referred on immediately for further investigation.

Abdomino-thoracic injury:
Any injury which results in chest pain, shortness of breath, severe abdominal pain, haematuria

Blocked airway:
Any injury which causes respiratory arrest

Cuts/lacerations:
Any injury which results in open, bleeding wounds

Head injury/unconsciousness:
Any injury which results in altered cerebral function, leading to disturbed consciousness, vomiting, drowsiness or amnesia

Nerve injury:
Any injury causing changes in motor and/or sensory function

Spinal injury:
Any injury to the back or neck which causes changes in motor or sensory function
Any injury which is suggestive of bony injury

Vascular injury:
Any injury resulting in loss of distal pulses, changes in skin colour and temperature or drop in blood pressure

Furthermore, the patient's previous and current medical history, drug history and general health should be taken into consideration to indicate if therapeutic intervention is contraindicated by current medication or health status.

The following signs and symptoms indicate severe injury. The injured area should be supported and the patient referred on immediately for further investigation

- severe pain which does not subside
- immediate and profuse swelling
- deformity
- extreme loss of function
- guarding, or unusual or false motion
- noises (grating/cracking) at injury site.

Specific precautions and contraindications for application of PRICE

a The mode of protection must be capable of accommodating oedema

b A maximum safe period for icing of 30 minutes is recommended, to avoid skin and tissue damage and nerve palsy. A damp towel should be placed between the cooling agent and the skin to avoid "ice burn"

c The athlete should not return to participation immediately following application of ice (or other types of cold application), since nerve conduction velocity, sensation and connective tissue flexibility are likely to be reduced by cold application

d Care should be taken in the application of ice to patients with little subcutaneous fat and in the region of superficial nerves, e.g. common peroneal nerve at the knee, ulnar nerve at the elbow, since cold-induced nerve injury may result. To compensate for this, the duration of application should be reduced (no more than ten minutes) or an insulating material should be applied between the source of cooling and the patient's skin

e Application of cold is contraindicated for patients who have previously developed cold-induced hypertension during cold treatment, for patients who have allergy to cold (hives, joint pain) or for patients who have Raynaud's syndrome, peripheral vascular disease or sickle cell anaemia

f If nerve damage, as a result of the injury, is suspected or if there is a history of reduced skin sensation, application of cold should not exceed 20 minutes and the skin condition should be checked every five minutes

g Pressure must **not** be greater proximally than distally, therefore application of pressure should be uniform throughout the compression

h Compression must be capable of accommodating oedema immediately following injury, and of continuing to apply pressure with diminishing effusion. Therefore:

- do not apply compression with the material at full stretch
- ensure overlap of half to two-thirds of previous turn of compressive material
- apply turns in a spiral fashion - **never** apply circumferential turns
- protective padding (gauze, underwrap, foam, cotton wool, gamgee) or gapping of the compressive material may be necessary over vulnerable areas such as popliteal fossa, superficial tendons and bony prominences

i Distal areas should be checked immediately following application of compression for signs of diminished circulation (cold, pallor) and then regularly checked throughout the continued application.

Appendix H

Overview of application of PRICE regimen

First degree (mild)	Second degree (moderate)	Third degree (severe)
Protection May not be required. Use taping/support if early/immediate return to participation.	**Protection** Required to avoid further stress on injured structures. Use tape, bandage, splints.	**Protection** Necessary to avoid stress on injured part, and to provide protection and stability.
Rest Complete rest is not necessary. Avoid activity which causes pain. Participation may be possible with some form of protection.	**Rest** Necessary to avoid further injury and prevent further bleeding. Gentle exercise to uninjured parts is possible.	**Rest** Necessary to avoid further injury and prevent further bleeding. Complete rest is advised.
Ice Apply as in Guideline 3. Ten to 20 minutes on areas over superficial nerves; otherwise 30 minutes.	**Ice** Apply as in Guideline 3.	**Ice** Apply as in Guideline 3.
Compression Apply if swelling is apparent.	**Compression** Apply as in Guideline 4.	**Compression** Apply as in Guideline 4.
Elevation Necessary only if swelling is apparent.	**Elevation** Apply as in Guideline 5.	**Elevation** Apply as in Guideline 5.