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LOCKING THE STABLE DOOR:
PREVENTING EQUESTRIAN INJURIES

by

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Graeme Watt

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This report is dedicated to the memory of Graeme Watt

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Abstract:

The medical and sports literature databases were searched for equestrian sports-related injury published in English since 1980, together with conference abstracts, and discussions with equestrian sporting bodies. This literature was critically reviewed, with emphasis on countermeasures. While there is considerable literature available on the epidemiology of injury incurred in most equestrian sports, there is little on the prevention of these injuries. Case-control or other studies evaluating the effectiveness of the countermeasures suggested by authors do not seem to exist. There is a good body of epidemiology that supports the proper use of approved helmets as a means of preventing injury in these sports. However, protective helmets do not always prevent injury as expected, and many riders do not choose to wear them because of perceived poor design. The search for the ideal equestrian helmet should continue. Ideally the effectiveness of helmets should be assessed scientifically. The use of rules and regulations for conduct of events, knowledge of horse behaviour, well-conducted lessons, contraindicated medical conditions, public education, rider education, appropriate equipment and clothing, the riding environment, rider experience, safety stirrups, body protectors, falling techniques, and first aid measures are among the other countermeasures discussed. Even though the injury rate for equestrians is relatively low by comparison with other sports, the injuries that are incurred are usually severe. In large part, prevention is difficult because the behaviour of the horse is unpredictable. Countermeasures used for prevention should be evaluated for effectiveness to reduce the frequency and severity of injuries to equestrians.

Key Words:

equestrian, horse riding, injury prevention, countermeasures, evaluation

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EXECUTIVE SUMMARY

The medical and sports literature databases were searched for equestrian sports-related injury published in English since 1980, together with conference abstracts, and discussions with equestrian sporting bodies. This literature was critically reviewed, with emphasis on countermeasures.

While there is considerable literature available on the epidemiology of injury incurred in most equestrian sports, there is little on the prevention of these injuries. Case-control or other studies evaluating the effectiveness of the countermeasures suggested by authors do not seem to exist.

There is a good body of epidemiology that supports the proper use of approved helmets as a means of preventing injury in these sports. However, protective helmets do not always prevent injury as expected, and many riders do not choose to wear them because of perceived poor design. The search for the ideal equestrian helmet should continue. Ideally the effectiveness of helmets should be assessed scientifically.

The use of rules and regulations for conduct of events, knowledge of horse behaviour, well-conducted lessons, contraindicated medical conditions, public education, rider education, appropriate equipment and clothing, the riding environment, rider experience, safety stirrups, body protectors, falling techniques, and first aid measures are among the other countermeasures discussed.

Even though the injury rate for equestrians is relatively low by comparison with other sports, the injuries that are incurred are usually severe. In large part, prevention is difficult because the behaviour of the horse is unpredictable. Countermeasures used for prevention should be evaluated for effectiveness to reduce the frequency and severity of injuries to equestrians.

Ideally, the effectiveness of all equestrian injury countermeasures should be demonstrated before they are implemented or widely promoted. However, where there is good reason to believe that a particular countermeasure is highly effective, despite a lack of direct scientific evidence for its effectiveness, then the use of that countermeasure should continue, provided there are no known negative effects or disbenefits associated with the particular countermeasure. This would particularly apply to the use of protective helmets. Although there is evidence from the field and the laboratory that helmets may not be capable of preventing all head injuries, they have been shown to be effective in reducing injuries to bicyclists. With the emergence of new materials, the search continues to design the ideal helmet which will satisfy riders involved many equestrian sports.

There is ample epidemiology that demonstrates equestrian injuries, although relatively infrequent, are generally severe, disabling and too often, fatal. Information needs to be collected on the extent of the implementation of, and attitudinal barriers against the use of existing equestrian countermeasures to inform the development of new and improved countermeasures.

With a high injury frequency during lessons having been reported, it would seem that an assessment of the quality of rider education programs and facilities is needed. Standards and practices of riding schools should be subject to accreditation and inspection by an external body, where accreditation is not in place.

Where countermeasures are aimed at primarily preventing injury, such as modification of the environment, and increasing skills and knowledge, they should be evaluated and then fully implemented. Where countermeasures are aimed at reducing injury severity, but for which there are doubts concerning their effectiveness, such as the use of safety stirrups or body protectors, formal evaluation should be conducted, preferably by case-control studies. Little work seems to have been done on evaluating the teaching and use of falling techniques. These could present a cheap and effective avenue of reducing a wide range of injuries, including those to the head, neck and upper extremities.

Many equestrian sports bodies actively promote safety in their sport. Sometimes this promotion is formal, where internal or external official rules and regulations are applicable and enforced, at other times it consists of informal verbal advice and the supply of safety literature. There is scope for considerable variation in the advice and enforcement of safety issues, with a consequent possible variation in the frequency of injury to riders.

No single equestrian organisation would have sufficient funds nor the expertise to properly assess the effectiveness of countermeasures. It may require coalitions of umbrella sports bodies, equestrian sports groups and researchers to conduct appropriate investigations. However, while there is so little knowledge of the effectiveness of countermeasures, equestrian injuries will continue to occur. It is not sufficient to claim the injury rate amongst equestrians is low, when the severity of the injuries which do occur is so high.

The range of countermeasures considered in this review and the specific recommendations for further research, development and implementation are given below.

RULES AND REGULATIONS

- Rules and regulations for rider safety in equestrian sports should continue to be enforced.
- The extent to which these rules and regulations are actually enforced should be established. If found to be lacking, efforts should be made to improve their enforcement.
- Equestrian sports without regulations for safety should consider developing these.
- Guidelines for rider safety aimed at informal or unsupervised riding need to be prepared and disseminated to the general riding and farm communities.

RIDER EXPERIENCE AND KNOWLEDGE

- Riders should develop their riding skills progressively and thoroughly and have a good knowledge of horse behaviour.
- Over time, riders and horse handlers should develop a bond with their horse.
- Handlers of horses should be aware of the significance of the horse's movements, safe ways to approach a horse and the relative position of the horse in relation to the surroundings and themselves.
- Riders and handlers should exercise extreme caution when riding in the presence of objects or animals that could frighten the horse (eg other horses, dogs, vehicles). This is particularly applicable to children.
- Extreme caution should be taken when riding in situations that could upset the horse and cause unexpected behaviour.

- Small children should be separated from horses. Safety precautions around horses should be taught from an early age under close supervision.
- Further research on identifying the injury risk factors amongst horse handlers (as distinct from horse riding) is needed.
- Horse handlers should avoid the back legs of horses at all times.
- The standards and practices of riding schools should be subject to mandatory accreditation and inspection by an external body.
- Riding instructors should be certified, experienced and have a good knowledge of horses and horsemanship.
- The choice of instructor should not be solely based on salesmanship or convenience (eg, the accessibility to the riding school or the availability of instructors).
- Education of parents in the general principles of horse riding and handling safety should be included in public education programs.
- The extent to which public education programs are effective in reaching their target groups, eg recreational riders, farmers, parents, etc should be determined.
- The effectiveness of public education campaigns in reducing horse-related injuries should be evaluated. Results from such evaluation should be fed back to improve the education campaigns.
- In rural areas, where much of the supervision of child riders is done by parents, training of parents in riding safety should be considered.
- Educational programmes need to be targeted at recreational riders, encouraging them to have lessons with accredited instructors.
- The teaching and use of appropriate falling techniques to prevent injury should be evaluated.

APPROPRIATE EQUIPMENT AND CLOTHING

- Horse riders should conduct routine checks of their tack (or saddlery) before mounting. All equipment should be checked for signs of fatigue and correct adjustment of fit.
- Regular maintenance checks of all equipment should be undertaken.
- Riders should avoid wearing loose clothing that could catch on trees, etc.
- Riders with long hair should ensure that it is tied back.
- It is strongly recommended that stirrups are matched to the size of smooth heeled and soled boots with elastic sides.
- Non-slip gloves may help to prevent friction burns associated with holding the rein.
- Effective hand, particularly finger, protection for rope handling needs to be further investigated.
- Sturdy boots should be worn when undertaking horse handling activities.

ENVIRONMENTAL FACTORS

- Where possible, riders should avoid excessively soft/muddy ground and ditches, holes and uneven terrain with rocks and exercise caution if these surfaces are unavoidable.
- Riding in outside paddocks should be limited to experienced riders.
- During horse handling activities, the horse should be isolated from all other horses, if possible.

PROTECTIVE EQUIPMENT

- All horse riders should wear a standards approved helmet.
- Children in the vicinity of a horse should always wear a helmet, whether or not they are mounted.
- There should be further standards development and improvement for helmets.
- More developmental research needs to be undertaken to improve the design of helmets must be improved that are low cost and versatile.
- Educational campaigns to increase helmet wearing rates need to be very well planned and implemented. Such campaigns should also be formally evaluated.
- Attitudinal barriers towards helmet wearing need to be assessed and addressed in education campaigns.
- Manufacturers should consider developing a helmet which meets both safety requirements and the aesthetics of different equestrian activities.
- Consideration should be given to conducting formal evaluation of the effectiveness of equestrian helmets in the field.
- The preventive effectiveness of the different types of safety stirrups needs to be formally evaluated.
- The circumstances under which body padding is likely to be effective needs to be determined.
- The effectiveness of such body padding needs to be formally evaluated in the field.

FIRST AID

- Organisers of equestrian events should ensure that adequate first aid and medical services are provided.
- Recommendations for the minium level of first aid equipment and personnel at all events should be prepared and disseminated to equestrian sports bodies.
- All horse riders should receive basic training in first-aid principles as part of their rider education.

OTHER COUNTERMEASURES

- Choose a horse of appropriate size, temperament, character and age for the rider's size and skill level, in conjunction with a trained and experienced hosreperson.
- No beginner or child should have a horse aged less than five years. Older horses are better for beginners.

- Inexperienced riders, especially children, should always be supervised when riding.
- Alcohol use before riding should be avoided as this could impair coordination and judgement, lengthen reaction time, and reduce the ability to adjust to the movements of the horse

1. INTRODUCTION

Equestrian sporting activities encompass competitive sport and the active recreation and activities that involve riding a horse. Horse riding is integral to the sports of horse racing, cross-country riding, dressage, hacking, point-to-point racing, harness racing, polo, gymkhana, working, jumping and fox hunting. Both horses and riders are involved in competition and training. Hence there is ample opportunity for injury to occur in what has been described as the most dangerous sporting activity in terms of frequency and severity of injuries (Firth, 1985).

Compared to other sports horse riding has one of the lowest rates of hospitalisation for injury whether rates are calculated on a general population basis or by participation (Berhang and Winslett, 1983; Watt, 1995). This should be of little comfort to the participants in equestrian sports as their numbers are low when compared with participation in other sporting activity and injuries often occur regardless of the experience of the rider. Notwithstanding this comparatively low rate of hospitalisation, horse riders have been estimated to be at higher risk of serious injury than participants in most other sports, including motorcycle and auto-mobile racing (Firth, 1985; Silver and Lloyd Parry, 1991).

The unique characteristic of equestrian sports that contributes to injury is that the vehicle (ie. the horse) and rider are of different animal species. The vehicle is capable of acting unpredictably and independently of the rider, both when it is being ridden and not ridden. This is a major contributor to the aetiology of equestrian injuries. Furthermore, the rider's head can be up to three metres above the ground. This contributes to the severity of head injuries that occur when a rider falls from a horse. It is not surprising that head injuries constitute a considerable proportion of the injuries sustained by horse riders. For example, Pounder's (1984) study of 18 fatal horse-related injuries in South Australia from 1973 to 1983, found that 13 of the deaths were the result of head injury after a fall. Similarly, a Canadian study found that of 38 horse-related fatalities, 22 were the result of head injury (Aronson and Tough, 1993). In Sweden, 57 horse-related deaths were examined; of the 38 deaths from head injury, 28 were the result of a fall from a horse (Ingemarson et al, 1989).

Data obtained from hospital admissions paints a similar picture. Over 14 years (1973-1987), 136 patients aged 19 years or younger were admitted for horse riding injuries to a group of hospitals in Virginia (Barone and Rodgers, 1989). The most common injury was head and facial trauma (55%), followed by fractures to the extremities (28%). The events most likely to lead to injury were being thrown from the horse (75%), followed by being kicked (15%). Females outnumbered males in this study (76% compared to 24%). This ratio or female to males (3:1) appears to reverse when older age groups of hospitalised injured horse riders are studied. In the study by Bixby-Hammett and Brooks (1990), there were three times as many males aged over 45 years as females in the same age group hospitalised for horse riding injuries.

In a report on the epidemiology of horse-related injury in Victoria, Williams and Ashby (1995) found that 284 of 1068 presentations to hospital emergency departments (27%) were admitted to hospital and a further 48% required significant treatment (referral or review), indicating the high degree of severity of these injuries. The mechanisms of injury were most commonly falls (77%), crushing injuries inflicted by a horse (7%) and kicks (4%). The body parts affected differed between adults and children, but generally the upper limbs, lower limbs, head and face and soft tissues were the parts most frequently injured. Head injuries were over-represented in the cases admitted to hospital.

The injury prevention section in *Better Health Outcomes for Australians National Goals and Targets* for Better Health strategy document (Commonwealth Department of Health and Community Services, 1994), includes strategies for the reduction of sporting and recreational injury. The Victorian injury reduction strategy (*Taking Injury Prevention Forward - Strategic Directions for Victoria Victorian Department of Health and Community Services 1994*), contains specific goals and targets for the reduction of equestrian sports injuries. The national document contains a call for a general review of the effectiveness of injury countermeasures. Therefore, this review of equestrian sports injury countermeasures is timely.

2. AIMS

Given the popularity of equestrian sports, and the significant incidence of severe injury, the implementation of efficient means of prevention is vital (Firth, 1985; Ingemarson, 1989). This review is designed to the stimulate evaluation of currently advocated ways of preventing or reducing the number and severity of equestrian injuries.

The overall aim of this report is to critically review both the formal literature and informal sources that describe injury prevention measures, or countermeasures, for equestrian sports. In doing so, it provides an evaluation of the extent to which these countermeasures have been demonstrated to be effective.

Unlike other literature describing equestrian injuries, this report does not specifically focus on the epidemiology of horse riding injuries and neither does it provide a description of their aetiology in detail. Rather, this report presents a detailed examination of the range of countermeasures promoted to prevent equestrian injuries. Nevertheless, a brief overview of the epidemiology of horse riding injuries is given to set the scene for the subsequent discussion of countermeasures.

3. METHODOLOGY

The sources of information used to compile this report were:

- Medline CD-ROM for published medical literature (covering the past 10-15 years)
- Sport discus CD-ROM search for published sports literature (covering the past 10 years)
- scans of injury conference proceedings
- discussions with key Australian researchers
- correspondence with relevant state and national sporting organisations
- a posting to the Injury List on the Internet
- Standards Australia
- world-wide standards index on CD-ROM 1995/96 issue. US Database: key words of helmet, sport, recreation
- scanning of other Internet and world wide web sites.

This review is based on English-language material only. Since most of the studies have been done in the USA or UK this is unlikely to have led to major reports being overlooked.

The literature gathered for this review was critically assessed to determine the extent to which the various countermeasures had been fully evaluated and demonstrated to be effective in preventing injuries. A grading scale for the strength of the evidence presented in the literature was developed. This is shown in Figure 1.

Figure 1: Grading scale for assessing the extent to which countermeasures have been fully evaluated

STRENGTH OF THE SCIENTIFIC EVIDENCE	TYPE OF SCIENTIFIC EVIDENCE
least ↑	anecdotal or informed/expert opinion
	laboratory-based/equipment testing
	data-based evidence (uncontrolled)
↓ **most**	controlled evaluations

This scale reflects an epidemiological and rigorous scientific approach to injury prevention that considers controlled demonstration of the effectiveness of a countermeasure's performance in the field to be the highest level of 'proof'. This is particularly important for sports injury

countermeasures where any change to the nature of the sport is an important factor to be considered in their implementation. In general, changes to factors such as how the sport is undertaken/performed, the behaviour of the participants and the level of enjoyment can only be measured during 'in-the-field' evaluations.

At the lowest level of proof (ie the 'least' evidence end of the scale) are anecdotal reports of injuries and their prevention and comments based on informed or expert opinion. This category would include, for example, statements like "I treated five cases of head injury last year and all would have been prevented if they were wearing a helmet at the time" or "none of the people I treated with soft tissue injuries to the torso was wearing body padding at the time of injury". Of course, some expert or informed opinion carries more weight than other, particularly when it is based on a critical review of available information.

Laboratory-based evidence is a very important source of information about sports injury countermeasures. This category includes reports on equipment design and testing, development of standard testing procedures and biomechanical research, including that performed on animals, cadavers and simulated body tissue such as crash-test dummies. Such information provides detail about the extent to which countermeasures such as protective equipment and properly designed horse riding equipment (eg. safety stirrups) perform under certain stress and/or impact conditions. This research is generally performed under laboratory conditions which are often controlled. However, such conditions may not be a good representation of actual environment or horse riding conditions.

Data-based evidence can take a number of forms and vary in strength. Case-series studies or routine surveillance systems document the incidence of new injury cases over periods of time. Patterns in data can then be examined over time to draw conclusions about the impact that countermeasures may have on injury rates. Cross-sectional epidemiological studies provide some information about injury prevalence at a given point of time but are unable to assess the influence of countermeasures on injury rates. Quasi-experimental studies are not controlled evaluations but do enable a comparison of pre-intervention and post-intervention data to examine the effects of some countermeasures.

Controlled evaluations provide the most definitive evidence for the impact of countermeasures. Case-control studies and longitudinal (cohort) studies are common forms of controlled studies. Neither study type allows random assignment of people (or injuries) to test and control groups, though they are examples of natural experiments. A randomised controlled trial is considered to provide the best evidence. In such studies, the units of interest (ie the horse riders, helmet wearers, types of equipment, etc) are randomly assigned to test and control groups.

Another important aspect of countermeasure implementation is the extent to which they are accepted or adopted by the users for whom they were intended. Countermeasures should be acceptable to those they were designed to protect. Community consultation and awareness programs must therefore be considered in any implementation process. It is also important to assess barriers towards use of injury countermeasures such as helmets and examination of attitudes, knowledge and behaviours are crucial to this. Studies looking at these factors are generally conducted after implementation of a countermeasure and can highlight the need for behavioural or educational change at either the individual or organisational level. Because of the importance of this sort of research, the literature describing these studies is also included in this review.

Another measure of the success of countermeasures is a demonstration of their cost/benefit ratios. This information is often need by regulatory bodies and those involved in policy or rule

making to inform their decisions about countermeasures. Unfortunately, studies of the economic benefits of sports injury countermeasures are rare.

The evidence included in this review is categorised according to the scale in figure 1. For each countermeasure individually, the relevant literature has been critically reviewed. Appendix 1 provides an overall summary of each of the countermeasures considered in this report. This summary includes the background to the uses of the countermeasure, the mechanism of injury it is relevant for, the rationale for its use and the strength of the evidence for its effectiveness. A detailed matrix has also been prepared for some of the countermeasures and these can be found in the Appendices to this report.

4. AN OVERVIEW OF THE EPIDEMIOLOGY OF EQUESTRIAN INJURIES

There have been numerous studies describing the epidemiology of horse riding related injuries across all levels of severity, mainly from the USA (Edixhoven et al, 1980; Berhang and Winslett, 1983; Ilgren et al, 1984; Pounder, 1984; Bixby-Hammett, 1985; Muwanga and Dove, 1985; Bixby-Hammett, 1987; Lloyd, 1987; McGhee et al, 1987; Whitlock et al, 1987; Barone and Rodgers, 1989; Ingemarson et al, 1989; Mills and Whitlock, 1989; Hammett, 1990; Bixby-Hammett and Brooks, 1990; Silver and Lloyd Parry, 1991; Bixby-Hammett, 1992; Hammett et al, 1992; North West Farmsafe Committee, 1992; Aronson and Tough, 1993; Hamilton and Tranmer, 1993; Niskanen et al, 1994; Bond et al, 1995; Lantis, 1995; Lower and Wolfenden, 1995; Press et al, 1995; Williams and Ashby, 1995).

Fatal equestrian injuries (Pounder, 1984; Hammett et al, 1990), and many requiring hospitalisation (Barone and Rodgers, 1989; Bixby-Hammett and Brooks, 1990) usually arise from head injury as a result of a fall from a horse. In one study, for instance, the most common injury was head and facial trauma (55%), followed by fractures to the extremities (28%) (Bixby-Hammett and Brooks, 1990)

Head injuries are responsible for the majority of serious equestrian injuries (Barone and Rodgers, 1989; Bixby-Hammett and Brooks, 1990; Silver and Lloyd Parry, 1991; Williams and Ashby, 1995) and deaths (Pounder, 1984; Ingemarson et al, 1989;. ; Nelson and Bixby-Hammett, 1992). Injuries to the thorax, abdomen and extremities are also often severe and account for a smaller, but still substantial, number of hospitalisations (Bixby-Hammett, 1992, Amongst cases treated in an emergency department, but not subsequently hospitalised, injuries are mainly to the extremities, particularly upper (clavicle to wrist), and are predominantly soft tissue injuries and fractures (Nelson and Bixby-Hammett, 1992).

Equestrian activities have a low ranking in the twenty most frequent sport and recreation activities leading to presentation at an Australian hospital emergency department for treatment (Finch et al, 1995) They rank third as the most frequent activity requiring hospital admission following presentation to an emergency department for children where 34% of cases are subsequently admitted, and as the fourth most frequent for adults with 20% being admitted (Finch et al, 1995)

In a report on the epidemiology of equestrian injury in Victoria (Williams and Ashby, 1995), 27% of presentations to hospital emergency departments were found to be subsequently admitted to hospital, while a further 48% required significant ongoing treatment. The mechanism of injury was most commonly falls (77%), crushing injuries inflicted by a horse (7%) or kicks (4%). The most frequently injured body parts were the upper limbs, lower limbs, head, face, and soft tissues. Head injuries were over-represented in the hospitalised cases.

The morbidity and mortality associated with equestrian activities varies according to factors such as age, sex, type of activity, experience, use of helmet and type of helmet used. Many studies have found the highest frequency of equestrian injuries in people aged less than 20 years of age (McGhee et al, 1987; Ingemarson et al, 1989; Bixby-Hammett and Brooks, 1990; Silver and Lloyd Parry, 1991; Bixby-Hammett, 1992; Nelson and Bixby-Hammett, 1992; Williams and Ashby, 1995). In Victoria, the age groups reported to have the greatest numbers of injury were 10-14 year olds (24% of cases of equestrian injuries reported at two emergency departments collecting all-age data), and 15-19 year olds (an average of 21% at two emergency departments collecting mainly child injury data) (Williams and Ashby, 1995). This contrasts with the US National Electronic Injury Surveillance System (NEISS) data where the

highest frequency of equestrian injuries during 1979-1982 was in the 15-24 year age group (33.5%), and during 1987-1988, it was in the 25-44 year age group (38.9%) (Bixby-Hammett and Brooks, 1990). The 1995 NEISS equestrian injury summary showed that, in the years 1993-1994, the frequency in 15-24 year olds had decreased to 19.7%, with that in 25-44 year olds increasing to 40.9% (AMEA, 1995).

Other studies have indicated that equestrian injuries tend to occur whilst the rider is mounted (Barone and Rodgers, 1989; Barone and Rodgers, 1989; Ingemarson et al, 1989; Nelson and Bixby-Hammett, 1992; Bixby-Hammett and Brooks, 1990), during lessons or leisure (Bixby-Hammett and Brooks, 1990; Barone and Rodgers, 1989; Williams and Ashby, 1995), on farms or in paddocks Williams and Ashby, 1995), during warm weather and school holidays (Barone and Rodgers, 1989; Silver and Lloyd Parry, 1991; Williams and Ashby, 1995), on weekends (Williams and Ashby, 1995), among young females, (Barone and Rodgers, 1987; McGhee et al, 1987; Barone and Rodgers, 1989; Bixby-Hammett, 1992; Nelson and Bixby-Hammett, 1992; Niskanen et al, 1994; Williams and Ashby, 1995) and to a lesser extent, in males aged over 44 years (Bixby-Hammett and Brooks, 1990). Many injuries are associated with not wearing a helmet, the wearing of an inadequate helmet or a helmet that dislodges from the head during a fall. (Barone and Rodgers, 1989; Ingemarson et al, 1989; Nelson and Bixby-Hammett, 1992; Hobbs et al, 1994; Williams and Ashby, 1995)

A smaller, but significant, proportion of equestrian injuries are incurred by people involved in non-riding activity. (Barone and Rodgers, 1989; Bixby-Hammett and Brooks, 1990; Williams and Ashby, 1995) Figures range from 17% of traumatic brain injuries (Injury Prevention Service, undated) , to 20% of emergency department cases (Williams and Ashby, 1995) to 41% in the National Farm Medicine Centre study (Marshfield Clinic, undated). In such instances, children are often involved (Aronson and Tough, 1993; Williams and Ashby, 1995), injuries are most likely to occur in confined spaces such as stables (Hobbs et al, 1994), and serious injury is most likely to result from kicking by the horse (Hobbs et al, 1994; Williams and Ashby, 1995).

5. AN OVERVIEW OF HORSE RIDING INJURY COUNTERMEASURES

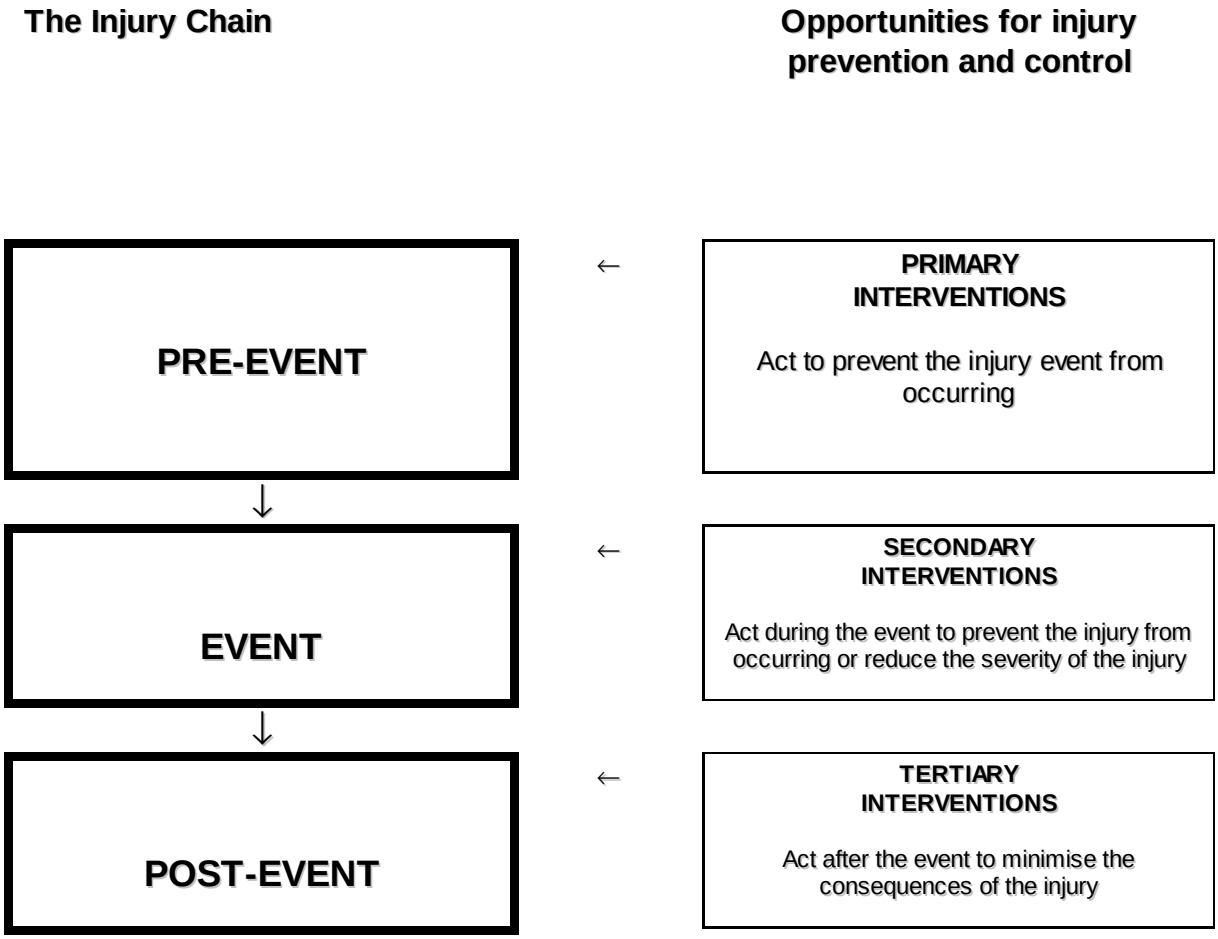
Injuries are considered to result from a culmination of a set of circumstances and pre-existing conditions that may best be understood as a chain of events: pre-event, event and post-event (Robertson, 1983). Measures to prevent or control injury, ie, countermeasures, should be targeted at the links in this chain, equating to primary (pre-event), secondary (event) and tertiary (post-event) prevention (Ozanne-Smith and Vulcan, 1990; Watt and Finch, 1996).

Figure 2 provides a summary of this chain of events and shows the points of potential intervention to prevent injuries. Primary countermeasures for equestrian injuries include rules and regulations, knowledge of horse behaviour, well-conducted lessons, attention to contraindicated medical conditions, public and rider education, appropriate equipment and the riding environment. Secondary countermeasures include the use of protective helmets, rider experience, safety stirrups, body protectors, and the use of appropriate ways of falling from a horse. Quick response times for the assessment and treatment of injuries, prompt referral to an appropriate specialist for treatment, and improved rehabilitation are examples of tertiary countermeasures.

The literature reveals that many countermeasures for preventing equestrian injuries have been considered. These include: wearing headgear and other body protection; learning proper fall techniques; acquiring knowledge and experience of horse behaviour; the necessity of properly-conducted riding lessons; discouraging people with contraindicated medical conditions from participating in equestrian sports; public and rider education on the dangers of horse riding; the necessity for rider experience; using safety stirrups; checking the condition of tack before riding; the development of better/more appropriate riding surfaces; and the use of appropriate riding boots.

For equestrian sports countermeasures, primary prevention methods include: education to increase knowledge of horse behaviour; rider skills education; trainer education; contraindicated medical conditions; public education; modification of the environment; improving general horse and rider physical fitness; adequate supervision of children; controlling onlookers at equestrian events; and training riders and handlers in appropriate horse handing, stabling and transport techniques.

Figure 2: The injury chain and opportunities for injury prevention and control



Secondary measures include the proper use of well-designed headgear; planned program to broaden rider experience; use of safety stirrups; use of body protection; training in falling techniques; and wearing of appropriate equipment.

Tertiary countermeasures include ready access to medical attention for injured riders, first aid knowledge and equipment, and appropriate rehabilitation of injured rider before allowing further riding.

Many of these countermeasures will be discussed below.

It may be implied from the epidemiology of equestrian injuries that measures to reduce the injuries to riders and handlers should concentrate on falls from horses, and controlling the unpredictable nature of the horse itself. However, while falls constitute the major mechanism of injury, others mechanism include being dragged when a foot or leg becomes caught in the stirrup, crushing and compression injuries when the horse falls on a fallen rider or handler and being kicked, trampled on, butted, or bitten by a horse (Firth, 1985). For participants in some equestrian sports there is also the possibility of being hit by tree branches. For all riders, there is also the risk of general lacerations and abrasions which may require minor treatment.

Despite the long history of horse riding, it has only been since the mid to late half of this century that serious measures have been taken to prevent horse-related injuries. In contrast the desirability of wearing helmets in motor racing, for instance, was recognised around the

end of World War Two. When standards for motor racing helmets were developed in Britain and later the US (Fisher, 1992). Standards for helmets for other sports where the likelihood of head injury existed, such as bicycling, skiing, and equestrian sports, were developed subsequently. The first standard for horse rider helmets was published in Britain in 1963.

Appendix 1 provides an overall summary of horse riding injury countermeasures and the strength of the evidence for their effectiveness. A detailed discussion of these studies is given in the section below.

6. DETAILED REVIEW OF EQUESTRIAN INJURY COUNTERMEASURES

6.1 RULES AND REGULATIONS

Most organisations for equestrian sports have rules and regulations for the conduct of their sport, including rules relating to safety issues. Possibly because horse racing has such a long history as an organised equestrian sport, its public nature, or because it is professional, Jockey (or race) Clubs, are rigorously regulated with respect to safety. For instance, the *UK Jockey Clubs* have requirements for licensing of jockeys, trainers and stable hands - which depends in part on medical condition; keeping a log of accidents; construction of courses, slopes, fences and rails; procedures for saddling up and returning from the finish; video recording of races, archived for future examination; the use of protective headgear; and the use of spine protection (Firth, 1985).

The Victoria Racing Club, which controls all public horse racing in Victoria, Australia, has similar requirements (Kinna, 1995). Regular meetings of senior officers of the state horse racing clubs ensure that all Australian states have very similar standards. Jockeys are licensed annually on the production of a medical certificate. A register of injuries is kept by the Club which details every injury sustained by the jockey throughout his/her career. Jockeys are required to wear Australian Standards protective headgear, and should the jockey fall, these caps must be replaced. There are no requirements for spine protection, but jump jockeys generally wear a body protector. Race courses are inspected for safety prior to every meeting, All races are video-taped, partly for enforcement of rules infringement by jockeys during races.

Australian and Victorian equestrian sports organisations, such as the *Equestrian Federation of Australia*, Victorian pony clubs, Riding for the Disabled Association of Australia and others, mirror their counterparts overseas in having extensive rules and regulations for the events they organise. All of these organisations, include requirements for riders and handlers of horses to abide by their safety standards.

The effectiveness of rules and regulations as primary safety requirements depends on whether they are enforced. There is some evidence hat self-regulation may be less efficient than externally enforced regulation.

Because informal or unsupervised riding lies outside regulation, riders in these situations may be at most risk of injury. This could account for the high rate of horse-related injury on farms (North West Farmsafe Committee, 1992). Riders in sports where even self-regulation does not apply are at equally high risk.

6.1.1 Recommendations for further research, development and implementation

- Rules and regulations for rider safety in equestrian sports should continue to be enforced.
- The extent to which these rules and regulations are actually enforced should be established. If found to be lacking, efforts should be made to improve their enforcement.
- Equestrian sports without regulations for safety should consider developing these.
- Guidelines for rider safety aimed at informal or unsupervised riding need to be prepared and disseminated to the general riding and farm communities.

6.2 RIDER EXPERIENCE AND KNOWLEDGE

6.2.1 Knowledge of horse behaviour

Horse behaviour is a major factor in many equestrian injuries. The horse is not a very intelligent animal (Firth, 1985, Woods, 1995). He is less intelligent than the dog, has a simple mind, a good memory but no reasoning ability. He is basically a wild animal whose primary means of defence is flight. The eyes on the side of a horse's head apparently evolved in response to the need to see possible distant predators. The horse has cones of blindness of about two metres directly in front and behind. He also has no conscience, so will not feel guilty about stepping on or kicking a human, despite what many horse owners might like to believe. As a consequence, a rider or handler never has complete control of the animal, although strong bonds, between horse and handler/rider may be established.

In a five-year study of injuries to United States Pony Club (USPC) members aged 6 to 21 years (Bixby-Hammett, 1987), it was reported that 76% of accidents were caused by the action of the horse. In another study of injuries to members of the American Horse Shows Association, the figure was about 90% (Berhang and Winslett, 1983). In a British study of spinal injuries to horse riders, 70% of accidents were considered to be attributable to the horse's behaviour (Silver and Lloyd-Parry, 1991).

The type of injuries resulting from the unpredictable nature of the horse are different depending on whether the horse is being ridden or not. While being ridden, the most likely cause of injury is falling or being thrown. This results most frequently in soft tissue injuries (Bixby-Hammett and Brooks, 1990), although upper extremity fractures and concussion are common. When the horse is not being ridden, the most common injury causes are bites, kicks from either the front or hind feet and being stepped on (Woods, 1995).

Since the event leading to an equestrian injury is often unpredictable, primary countermeasures should be aimed at reducing that unpredictability to as low a level as possible. For riders, it is mostly suggested that this is achieved by comprehensive training (Bixby-Hammett and Brooks, 1990; Bixby-Hammett, 1992; Aronson and Tough, 1993), or by carrying out a warming-up procedure for the horse (Pawley, 1995). For handlers of horses, the emphasis is on being aware of the significance of the horse's movements, adopting a safe manner of approach to the horse and being totally aware of the relative position of the horse in relation to the surroundings and the handler (Woods, 1995). Horses can be easily frightened by other animals or vehicles. Extreme caution should be taken when riding in situations that could upset the horse and cause unexpected behaviour (Williams and Ashby 1995).

6.2.2 Well-conducted lessons

There is an unexpectedly high frequency of injury to horse riders whilst taking lessons or schooling the horse (Bixby-Hammett, 1987; Bixby-Hammett and Brooks, 1990; Bixby-Hammett, 1992). In the five-year USPC study referred to above (Bixby-Hammett, 1987), there were 130 incidents leading to injury involving 212 injuries. Over one-third of the incidents occurred during lessons.

Although not common, fatalities have been reported during lessons (Pounder, 1984). In the USPC study (Bixby-Hammett, 1987), individuals taking lessons were most frequently involved in accidents (37%) than in those in riding activities. Falls were the most common mechanism of injury. The author suggests that the major method to prevent or reduce injuries sustained

during lessons for riding, or schooling of horses, is to ensure that riding instructors are certified, experienced, and have a good knowledge of horses and horsemanship. She further warns parents that the choice of instructor should not be based on salesmanship or convenience, ie., the accessibility to the riding school or the availability of instructors.

The major countermeasure recommended in this study was ensuring that riding instructors are certified, experienced and have a good knowledge of horses and horsemanship. As mentioned in 6.2.1 this is one of the major preventive measures for horse-related injuries (Bixby-Hammett, 1992; Bixby-Hammett, 1987).

6.2.3 Public education

The authors of a retrospective descriptive study of 38 horse-related fatalities between 1975 to 1990 in Alberta, Canada (Aronson and Tough, 1993), suggest, *inter alia*, that a campaign of public education to sensitise the public to the severe injuries which may result from horse riding activities and the necessity for wearing approved helmets, might lead to a reduction in injury frequency. They reasoned that when members of the public become involved in horse riding activity at a personal level they become more aware of the dangers. This may lead them to take a more cautious approach when involving themselves or their children in the sport. The concept of increasing public awareness as a preventive measure is supported by the authors of the 14-year Virginia review study of Barone and Rodgers (1989).

The American Academy of Paediatrics (American Academy of Paediatrics, 1992) recommends four means of preventing or reducing the severity of injuries related to horse riding. The first of these, which relates to public education, is:

> *Education programs, such as those offered by the USPC, should be presented to parents, riding instructors, horse show organisers, and managers. The programs should emphasise the risks involved in horseback riding and should present methods to minimise them.*

From anecdotal evidence, it has often been emphasised that while parents are keen to have their children riding or learning to ride, they themselves are totally ignorant of the hazards related to horses. The American Academy of Pediatrics has recognised the importance of parents as a subset of the public in public education programs, but there is little evidence that parental education is as widespread as it ought to be. The effectiveness of such education campaigns in reducing horse-related injuries has yet to be demonstrated.

6.2.4 Rider education

Many studies have found the greatest frequency of horse riding injuries occurs in persons up to 20 years of age, and that the highest proportion of the injured are females (Bixby-Hammett, 1987; McGhee et al, 1987; Barone and Rodgers, 1989; Nelson and Bixby-Hammett, 1992; Niskanen et al, 1994; Williams and Ashby, 1995). For example in Victoria, the age groups with the greatest case numbers of horse riding injury were the 10-14 year olds (24% of cases of horse-related injuries reported at each of two surveillance hospital emergency departments collecting all-age data), and the 15-19 year olds (24% and 18% respectively at two surveillance hospital emergency departments that mainly collected data on child injuries) (Williams and Ashby, 1995). However data from the National Electronic Injury Surveillance System (US) emergency department presentations showed that for the period 1979 to 1982, the highest frequency of horse-related injuries was in the 15-24 years age group (33.5%). For

the period 1987 to 1988, the highest frequency was seen in the 25-44 years age group (38.9%) (Bixby-Hammett and Brooks, 1990).

While there is some disparity in the evidence on the age group most likely to incur horse-related injuries, there is general consensus that there is a direct correlation between youth and a high frequency of injury. This suggests that injury frequency will decrease with increasing knowledge and experience of horsemanship

Possibly the best evidence which relates knowledge and skills with injury frequency available at this time comes from the USPC 10-year prospective study (Bixby-Hammett, 1992). In this study, members with lower ratings of knowledge and skill, regardless of experience, had more incidents leading to injury than those with higher ratings. A member with five years experience but without a high level rating of knowledge and skill, was found to be at the greatest risk of injury. This demonstrates that horse riding experience, per se, does not prevent injury.

In a review of the literature, Masters found that 90% of injuries occurred to those riders less than 21 years of age and that 70% of these occurred to amateur riders during recreational riding without supervision. He concluded that able horse people are trained, not born, and that active safety measures begin with sound basic training and ongoing specialist training of both horse and rider. This opinion is supported by a number of other authors (Aronson and Tough, 1993; Barone and Rodgers, 1989; Nelson and Bixby-Hammett, 1992; Niskanen et al, 1994).

A pilot educational program to reduce horse-related child injury was conducted in 1992 in a rural area of New South Wales, Australia (Lower and Wolfenden, 1995). In this study, educational material on rider safety for children 10 to 12 years was developed, and children's existing knowledge and attitude to safe riding behaviour was assessed before and after the intervention program. A total of 650 students were involved in four test areas.

Despite some methodological problems, it was found that there were statistical improvements in the children's knowledge of appropriate footwear, leading a horse, and awareness of the local pony club. There were also improvements in the attitudes towards helmet wearing, but this was not reflected in increases in local sales of helmets. Because the outlets for safety information was limited, it was concluded that a broad range of approaches are needed to increase rider education to reduce injury frequency. It was therefore suggested that schools, parents, equine organisations and the local media should be involved.

Many unsafe riding practices are considered to be associated with a lack of formal instruction and with high levels of opportunistic riding (Lower and Wolfenden 1995). In rural areas, where much of the supervision of child riders is done by parents, training of parents in riding safety should be considered. (Williams and Ashby 1995).

6.2.5 Rider experience

There appears to be a difference of opinion in the literature about the importance of rider experience as distinct from rider skills and knowledge in the prevention of equestrian injury. In analyses of USPC data for different periods of time, more experienced members were found to be involved in more accidents than the less experienced (Bixby-Hammett, 1992, AMEA, 1995).

On the other hand, in two retrospective studies, one of horse-related fatalities in Sweden (Ilgren et al, 1984), the other of horse-related spinal injuries in England (Silver and Lloyd-Parry, 1991), inexperience of the rider was considered to be a factor in the occurrence of injuries.

The divergent findings are difficult to reconcile. It may be that riders with more experience of riding are able to avoid injury because of this experience. Conversely riders with more experience may take greater risks, and so have increased numbers of injuries.

The role of experience may be confounded by the type of equestrian activity being undertaken since the more experienced riders may participate in events requiring more equestrian skill. A study of fox hunting injuries found that serious injuries were more likely to occur to experienced riders on inexperienced horses (Harrison, 1984).

6.2.6 Falling techniques

In sports such as skiing, one of the injury countermeasures used is to teach a falling technique which is likely to lead to least injury. Suprisingly in horse riding, where falls constitute the major mechanism of injury, this countermeasure is rarely mentioned in the literature.

Bliss (1988) suggested that learning and using a "tuck and roll" falling technique will lead to fewer injuries. However, it is recommended that falling techniques should be taught at an early age so that they will be adopted as a reflex action (Firth, 1985). Many riders have a sense of being about to fall and in these circumstances they should be prepared to use a safe falling technique or emergency dismount. The “tuck and roll” is probably a major factor in the low injury rates amongst professional jockeys.

6.2.7 Recommendations for further research, development and implementation

- Riders should develop their riding skills progressively and thoroughly and have a good knowledge of horse behaviour.
- Over time, riders and horse handlers should develop a bond with their horse.
- Handlers of horses should be aware of the significance of the horse's movements, safe ways to approach a horse and the relative position of the horse in relation to the surroundings and themselves.
- Riders and handlers should exercise extreme caution when riding in the presence of objects or animals that could frighten the horse (eg other horses, dogs, vehicles). This is particularly applicable to children.
- Extreme caution should be taken when riding in situations that could upset the horse and cause unexpected behaviour.
- Small children should be separated from horses. Safety precautions around horses should be taught from an early age under close supervision.
- Further research on identifying the injury risk factors amongst horse handlers (as distinct from horse riding) is needed.
- Horse handlers should avoid the back legs of horses at all times.
- The standards and practices of riding schools should be subject to mandatory accreditation and inspection by an external body.

- Riding instructors should be certified, experienced and have a good knowledge of horses and horsemanship.

- The choice of instructor should not be solely based on salesmanship or convenience (eg, the accessibility to the riding school or the availability of instructors).

- Education of parents in the general principles of horse riding and handling safety should be included in public education programs.

- The extent to which public education programs are effective in reaching their target groups, eg recreational riders, farmers, parents, etc should be determined.

- The effectiveness of public education campaigns in reducing horse-related injuries should be evaluated. Results from such evaluation should be fed back to improve the education campaigns.

- In rural areas, where much of the supervision of child riders is done by parents, training of parents in riding safety should be considered.

- Educational programmes need to be targeted at recreational riders, encouraging them to have lessons with accredited instructors.

- The teaching and use of appropriate falling techniques to prevent injury should be evaluated.

6.3 APPROPRIATE EQUIPMENT AND CLOTHING

6.3.1 Appropriate equipment

Attention to tack (or saddlery) is one of the major means of primary prevention. Yet there seems to be little reference in the literature to the use of equipment of good quality and design which is appropriate for the horse and rider, as a preventive measure for injury. However, it is apparent that some injuries result from the use of old, worn or ill-designed tack (Barone and Rodgers, 1989), or riders wearing unsuitable clothing (Hamilton and Tranmer, 1993). A casual walk around a saddlery reveals wide variations in the cost of equestrian sports equipment. This may suggest that standards of materials and workmanship are variable.

There are many mechanisms of injury which arise from the use of inappropriate equipment. Falls can occur if the tack (or saddlery) is old or worn or doesn't fit the rider or is not suited to the rider. Unsuitable tack can also slip or otherwise become detached from the horse, causing the rider to become dismounted.

6.3.2 Appropriate clothing, personal grooming and boots

If a rider has long unrestrained hair or hair protruding from a helmet which catches in tree branches falls and scalp injuries can result, particularly on cross-country events,. Loose clothing can be caught by obstacles on riding courses such as low hanging tree branches. The use of appropriate breeches not only reduces chafing to the rider and increases comfort, but increases abductor control and may reduce the incidence of falls.

Jockeys and steeplechase riders goggles to protect their eyes. Other riders would be advised to also wear goggles or spectacles, rather than contact lenses, to protect their eyes from injuries due to sun glare, wind, dirt and other foreign bodies.

Friction burns and blisters to the hands sometimes occur and can be prevented by wearing non-skid gloves (Firth, 1985; Hammett, 1990).

Riding boots are the preferred footwear, and should be heeled and smooth-soled, particularly at the instep. (Barone and Rodgers, 1989; Aronson and Tough, 1993; Bergman et al, 1993). Riding boots tend to protect the feet, ankles and shins, and also act as splints for the lower legs in the event of a fall (Bixby-Hammett, 1987; Hammett, 1990; Masters, 1991).

6.3.3 Recommendations for further research, development and implementation

- Horse riders should conduct routine checks of their tack (or saddlery) before mounting. All equipment should be checked for signs of fatigue and correct adjustment of fit.
- Regular maintenance checks of all equipment should be undertaken.
- Riders should avoid wearing loose clothing that could catch on trees, etc.
- Riders with long hair should ensure that it is tied back.
- It is strongly recommended that stirrups are matched to the size of smooth heeled and soled boots with elastic sides.
- Non-slip gloves may help to prevent friction burns associated with holding the rein.
- Effective hand, particularly finger, protection for rope handling needs to be further investigated.
- Sturdy boots should be worn when undertaking horse handling activities.

6.4 ENVIRONMENTAL FACTORS

The riding environment, particularly the riding surface, has a significant role in equestrian injuries. For example, a review of fox-hunting injuries concluded that there is more risk when horses are taken across paved roads than through forests (Harrison, 1984). For many types of equestrian sports it is not possible to modify the environment. In cross-country riding, modification is also likely to be undesirable (from the point of view of the riders and organisers), since overcoming natural hazards is an integral part of the activity.

Where modification to the environment is possible the riding surface should be as energy-absorbent as possible. Turf is preferred to harder surfaces such as consolidated earth or tarmac. In a study by Hunt and Mills (1989) in which impact and compression tests on materials used in horse riding helmets were performed, it was found that some existing helmets used in the UK would not have protected the fallen rider's head if they had fallen 2.4 metres onto tarmac. However, they would have provided adequate protection if the fall had been onto soft earth or turf.

That relatively less serious injuries are likely to occur should a rider fall onto grass has been recognised in the proposed new Australian Road Rules, which, for the first time, allow horses

to be ridden on a nature strip (Austroads, 1995). Also under these proposed rules, a horse may be ridden on a footpath, which separates it from vehicular traffic. The horse must give way to pedestrians in these circumstances.

By their very nature horse racing and steeplechase events, potentially provide the most opportunities for riders (and horses) to sustain injuries. These equestrian sports have been controlled the longest, although the control in relation to injury prevention is largely through self-regulation. However there have been few formal published studies of injuries in this industry.

In a retrospective study conducted by the American Medical Equestrian Association (Press et al, 1995) a self-administered questionnaire was given to all active jockeys competing at US racetracks from July to October 1990. This study identified multiple causes of injury. These included weather and track conditions (poor track conditions may cause the horse to fall and unseat the jockey), equipment failure, and both jockey- and horse-related factors. The track equipment implicated in causes of injury included the starting gates, rails, and posts.

Significant advances have been made in modifying the environment for horse racing. In the UK, wooden rails enclosed in plastic materials and supported by metal gooseneck posts, appear to be less dangerous than other fences, particularly wooden ones (Firth, 1985). This new design throws the falling rider outside the track, rather than into the field of on-coming horses. In courses operated by the Victoria Racing Club in Australia, flexible, lightweight aluminium rails are often used (Kinna, 1996). These appear less likely to cause severe injuries to jockeys (and horses) when compared to the traditional wooden rails. In general, it is recommended that riders should avoid excessively muddy or soft ground and ditches, holes and uneven terrain with rocks (Williams and Ashby 1995).

6.4.1 Recommendations for further research, development and implementation

- Where possible, riders should avoid excessively soft/muddy ground and ditches, holes and uneven terrain with rocks and exercise caution if these surfaces are unavoidable.
- Riding in outside paddocks should be limited to experienced riders.
- During horse handling activities, the horse should be isolated from all other horses, if possible.

6.5 PROTECTIVE EQUIPMENT

6.5.1 Protective helmets

The most severe injuries to horse riders across all equestrian sports are to the head and face resulting from falls or kicks from horses. It was recognised as early as the 1950s that protective headgear would lead to a reduction in these disabling and often fatal injuries. This countermeasure has received the most attention in the literature.

The head is a rather delicate structure, with the thin bone of the skull enclosing the soft brain tissue inside a relatively small envelope of cushioning fluid. It requires little force to crack the bone and disturb the contents. The force of a simple fall from a height of two to three metres onto a hard surface is sufficient to cause severe damage. When a horse and rider are in motion, the rider is often catapulted from the animal, giving the head added momentum and

increasing the probability of damage. A kick to the head of a horse-handler from the shod foot of a stationary horse is delivered with an impulse well beyond the breaking strain of most skulls (Firth, 1985).

Many studies describe the epidemiology of equestrian injuries and conclude that most injuries would have been less severe or prevented by the wearing of helmets (Berhang and Winslett; 1983, Bixby-Hammett, 1985; Bixby-Hammett, 1987; Gullan et al, 1987; Johnston et al, 1987; Lloyd, 1987; Bliss, 1988; Barone and Rodgers 1989; Bixby-Hammett and Brooks, 1990; Masters, 1991; Bixby-Hammett, 1992; Aronson and Tough, 1993; Buckley et al, 1993; Hamilton and Tranmer 1993; Hobbs et al, 1994; Austroads, 1995; Bond et al, 1995; Davis et al, 1995; Lantis, 1995).

As far as could be determined from this literature review, the use of equestrian helmets to prevent head and face injuries has not been formally evaluated by a good prospective or case control study, such as those confirming the efficacy of bicycle helmets (Rivara et al, 1989; Cameron et al, 1994). On the other hand, there has not been any evidence to the contrary. On the other hand, there has not been a valid study showing that American Society for Testing and Materials (ASTM) standard/Safety Equipment Institute (SEI) certified, fitted, secured helmets, have not reduced all equestrian accidents, not just brain/head/face injuries. Taken together, the available evidence suggests that any helmet/hat is better than no helmet/hat in the event of a head injury.

A number of authors have noted that protective headgear is highly desirable but its design and use by riders needs further study. For example Barone and Rodgers (1989) suggest there is sufficient evidence of poor design and improper use in riding to quantify the support given to helmet use. McGhee et al (1987) agree, stating that protective headgear for horse riding should be improved, particularly to enhance the protection afforded the rider from scalp and skull injury in the region. In a retrospective review of 17 patients admitted to an emergency department of a Nottingham hospital, Muwanga and Dove (1988) concluded there was no correlation between protective headgear and skull fracture. All 17 riders were wearing protective helmets of some type. The value of helmets as a countermeasure for other injuries such as central nervous system and spinal injuries is also controversial. The availability of ASTM/SEI helmets has done much to address these early inadequacies of equestrian helmets reported in these two studies.

The inadequacy of equestrian helmets available in the late 1980's was also supported by laboratory tests that criticise the testing methods in official standards for helmets (Mills and Whitlock, 1989; Masters, 1991). These laboratory tests concluded that many helmet designs were inadequate, and that helmets may never be able to be designed to offer complete protection to horse riders. In one of these laboratory test which simulated actual cases of head injury to equestrians, the authors point out that British Standard tests on helmets do not test the effect of impact on the head, but on the helmet (Mills and Whitlock 1989). This study, concluded that bicycle and motorcycle helmets manufactured to approved standards provided better protection for their users than equestrian helmets did to theirs. Bicycle helmets in 1996 do not provide better protection than ASTM or PAS015 (English standard) equestrian helmets.

While all authors agree that helmet use for equestrians should reduce the frequency and severity of most head injuries, there remains controversy about their value as a countermeasure for other injuries. In a prospective observational study of 32 children less than 15 years old presenting to an emergency department with horse-related injuries over a two-year period in Virginia, 20 were wearing helmets at the time of the injury (Hamilton and Tranmer, 1993). The authors concluded that helmet-less riders had more severe injuries on all measures, and that helmet use was associated with decreased frequency and severity of

central nervous system injury. However, helmet use was unlikely to explain the difference in other types of injury between those wearing and those not wearing helmets. They concluded that helmets would not protect against spinal injuries.

It is often stressed in the literature that helmets must be properly fastened to be effective (Muwanga and Dove, 1985). In the Nottingham study referred to above (Muwanga and Dove, 1985), all but one rider had been wearing a helmet which was strapped on. Six helmets were dislodged by the fall and three of the patients receiving skull fractures. Two further skull fractures were caused by horse kicks. The authors advise that a helmet will offer no protection if it does not stay on. As the British Standard for horse rider helmets has been altered since this report, it is possible that fewer helmets might now be dislodged during a fall, if riders ensure that their helmets are properly fastened.

Another British study of 103 injured horse riders, including 32 professional jockeys, presenting to an emergency department in Berkshire, found a different pattern of injuries amongst the professionals and the amateurs. Amateurs had more head and facial injuries, compared with jockeys who mainly incurred injuries to the upper limbs (Whitlock et al, 1987). While the better protective clothing, especially headgear, worn by jockeys could account for this difference, the grass surface onto which jockeys fall or their falling techniques, may also provide part of the explanation. Of the 42 amateur riders questioned later, 31 did not have the helmet's safety strap attached.

In 1990, a helmet complying with the American Society for Testing and Materials (ASTM) standard and certified by the Safety Equipment Institute (SEI) replaced the former (American National Standards Institute) ANSI-approved one. This new helmet then became the helmet which Pony Club members were required to wear. The USPC has compared the results of injury frequency during the eight years of USPC helmet use with the two years of ASTM/ SEI helmet use. Injuries to the head decreased by 26%, face by 62%, clavicle by 57%, concussion by 3% and closed fractures by 10%. Neck injuries showed no change in frequency. This study provides a strong indication that helmets are likely to be effective in preventing many injuries. However, neither this study, nor any other reported in the literature, can be considered to be the optimal formal evaluation of the effectiveness of equestrian helmets.

It is tempting to conclude from the USPC study that the decreases in injury frequency were due to the ASTM/ SEI helmet, or perhaps to helmet-wearing generally. As the number of riders in each of the two time periods is not known, rates of injury cannot be calculated. Additionally, without a control group, it is not possible to state definitely that this constitutes proof of the effectiveness of helmets against injuries. However, the study does provide a strong indication that helmets are likely to be effective in reducing many injuries, particularly to the head.

Official Standards for horse riding helmets in the UK, Europe and the US are similar to the Australian Standard, AS2063.3. It is therefore likely that the equestrian sports injury scene in Australia will mirror that in the US and UK. In Australia, the same helmet standard is applicable for all equestrian sports.

When the first standards for equestrian helmets were devised, they often included peaks at the front and, sometimes, at the back of the helmet. New standards do not include peaks,(or visors) since they have been shown to be responsible for a small number of nose fractures. Optional collapsible peaks are often now used, apparently without the incidence of associated injuries (Firth, 1985).

Attitudinal barriers to the use of protective helmets have been investigated in Canada (Condie et al, 1993) and the USA (Nelson et al, 1994). Reported barriers include discomfort, expense,

the fact that they are quickly outgrown their appearance and the fact that they are perceived as inappropriate for some riding styles where a brimmed hat is traditionally worn, such as in Western and trail riding (Condie et al 1993). Of major concern is the distorted risk perception of adolescents that helmets are only for inexperienced riders and that risk is most closely associated with the particular horse being ridden (Condie et al 1993). Firth (1985) suggests that attitudes to helmet-wearing vary with horse-riding activity. In polo and dressage, helmet-wearing is accepted, but it is disdained in jumping and hunting. However, such helmets are not necessarily protective but rather form part of the standard dress for the sport, eg. the top hat in dressage. Jumping and hunting require a hard hat, but requirements to wear the protective ASTM/SEI helmets varies with the hunt and the event/activity. Means of overcoming barriers to wearing protective helmets need to be multi-faceted and should include attention to factors such as design and risk perception.

While the evidence for wearing protective headgear to reduce head injuries is compelling, many riders persist in not using any form of headgear. One study examined, by written questionnaire and in focus groups, the attitude of 837 horse riders belonging to clubs in three Washington counties (Hunt and Mills, 1989). Only 20% wore helmets every time they rode, while 40% claimed to never wear a helmet. The major reason for non-wearing the helmet was design. In the six focus group sessions, most felt that the helmets were uncomfortable, hot, heavy and looked silly. However, 56% stated they felt safer when wearing a helmet.

In a cross-sectional mail survey of 900 English-style and 684 Western-style riders, it was found that 517 of the first group wore helmets on their last ride, compared with only 81 of the latter group (Nelson et al 1984), Among 564 riders who did not own helmets, their reasons for not doing so included their beliefs that helmets were unnecessary and uncomfortable.

The authors of both of these papers (Hunt and Mills, 1989; Nelson et al, 1994) conclude that the design of helmets must be improved, they must be low cost and versatile. and educational campaigns to increase wearing rates need to be very well planned.

The European Consumer Safety Association (ECOSA) recently decided its main target will be to have a high level of helmet wearing for all activities with a high risk of head injuries by the year 2010 in all EC and EFTA member states (ECOSA, 1993). Equestrian sports are not specifically mentioned in this decision, although high risk sports are to be targeted. ECOSA seems to be aware of the problem of the lack of broad rider acceptance of helmets, for it declares that reasonable acceptance and a wearing rate of about 30% should be achieved before introducing mandatory helmet-wearing.

Skin cancer rates are very high in Australia compared with other countries. Anti-Cancer Councils across the country have been highly successful in promoting the use of protective clothing, headgear and sunscreens to the public, especially during summer. This presents a problem for helmet designers. Brimmed equestrian headgear does not offer adequate protection from falls, therefore brimmed hats are not recommended. Anecdotal evidence suggests that there is some resistance from Australian riders to helmets which do not afford sun protection.

6.5.2 Safety stirrups

Very severe injuries result from the rider being dragged along the ground because the foot is not released from the stirrup after to a fall (Barone and Rodgers, 1989; Bixby-Hammett, 1990). One way to prevent this is to ensure that the stirrups and the footwear are well-matched (Firth, 1985; Bixby-Hammett and Nelson 1992). It is recommended that the stirrup size should be only

two to three centimetres wider than the boot. This is sufficient to allow emergency dismounts and to prevent the boot from sliding forward, so that the foot and ankle are not caught in the stirrup (Brooks and Bixby-Hammett, 1988). In Western riding, it is recommended that the Western boot be designed/fitted so that it slides from the foot in the event that the boot is caught in the stirrup.

Another way to prevent injuries resulting from a rider's foot being caught in the stirrup after falling is to modify the stirrups. Safety stirrups allow quick release of the stirrup with increased foot pressure (Bixby-Hammett, 1992). One style of safety stirrup incorporates a release mechanism that allows the stirrup to be pulled from the stirrup leathers when placed under tension. The use of safety stirrups has not gained universal acceptance as a preventive measure because the release mechanism does not always work. For child riders and jockeys, the body weight may be too low to provide sufficient tension to release the stirrup. Furthermore, not all types of saddles can be fitted with stirrups with release catches. The Peacock safety stirrup, which has a rubber band replacing the iron on the outside of the stirrup, may be useful for children as it requires less force to dislodge the rubber band in emergency situations. However, the condition of the rubber band should be regularly checked (Williams and Ashby, 1995). Many English saddles have a release safety bar for the stirrup leather located near the pommel of the saddle which should be open (down) so that the stirrup leather will slide off the bar.

The preventive effectiveness of safety stirrups has yet to be formally evaluated. In general, safety stirrups are not favoured over the use of heeled riding boots with smooth soles, matched to the stirrups (Firth, 1985; Barone and Rodgers, 1989; Bixby-Hammett and Brooks, 1990,). It is considered that this precaution, would normally prevent the foot becoming entangled in the stirrup and prevent dragging injuries.

Safety stirrups are not used by horse racing jockeys riding in Victoria (Kinna, 1996). The current designs are considered to be too cumbersome and unreliable, and the weight of the jockey of about 50 kg may be insufficient to activate the release mechanism.

6.5.3 Body protectors

Body and body part protectors are used in many sports and presumably reduce injury. The shoulder padding of baseballers and grid-iron footballers are familiar sights on television, and skateboarders and in-line skaters wearing elbow and knee protection seem to be more common.

In equestrian sports such as cross country events where so many injuries are to soft tissues and upper extremities, (Davis et al, 1987; Bixby-Hammett and Brooks, 1990) it is not surprising that body protection is becoming popular. Body protection is mandatory in some countries, but only for jockeys in some horse racing events, such as jumps.

Padded jackets have been suggested as a means of providing some protection to the trunk, but have yet to be evaluated (Firth, 1985). It is known however, that they will not protect against spinal or crushing chest injuries nor organs in the abdominal region (Bixby-Hammett and Brooks, 1990). Spinal injuries are usually caused by rotation or flexion of the spine and the currently-available braces are not effective in preventing these movements (Feit, 1990). They may be useful in reducing the severity of soft tissue injuries and rib fractures, and for protecting the acromioclavicular joint of the shoulder (Nelson et al, 1994).

A major problem with body protection is that riders find it uncomfortable to wear since they must be bulky to absorb the force of falling from a horse. After comparing the injuries from horse riding to those sustained by BMX bicyclists and skateboarders. Kennedy and Fitzgerald (undated) have suggested that child horse riders would be advised to wear elbow and knee pads. However, elbow and knee pads may be too restrictive for riders who continually need to control their horse through movements of the arms and legs.

Standards as elbow and knee pads and vests for riders have yet to be developed.

6.5.4 Recommendations for further research, development and implementation

- All horse riders should wear a standards approved helmet.
- Children in the vicinity of a horse should always wear a helmet, whether or not they are mounted.
- There should be further standards development and improvement for helmets.
- More developmental research needs to be undertaken to improve the design of helmets must be improved that are low cost and versatile.
- Educational campaigns to increase helmet wearing rates need to be very well planned and implemented. Such campaigns should also be formally evaluated.
- Attitudinal barriers towards helmet wearing need to be assessed and addressed in education campaigns.
- Manufacturers should consider developing a helmet which meets both safety requirements and the aesthetics of different equestrian activities.
- Consideration should be given to conducting formal evaluation of the effectiveness of equestrian helmets in the field.
- The preventive effectiveness of the different types of safety stirrups needs to be formally evaluated.
- The circumstances under which body padding is likely to be effective needs to be determined.
- The effectiveness of such body padding needs to be formally evaluated in the field.

6.6 MEDICAL CONTRAINDICATIONS

Horse riding requires a keen sense of balance, agility, reasonable physical fitness, and mental acuity. Yet few authors mention that, certain medical conditions should be contraindications for horse riding. As injuries associated with equestrian sports are severe, relative to other sports, with head injuries comprising the most common neurological injuries (Brooks and Bixby-Hammett, 1988), reducing participation by those who appear to be at increased risk when taking part has the potential to be an effective countermeasure.

Brooks and Bixby-Hammett (1988) state the following medical conditions are contraindications for horse riding:

- any pain-producing or neurologic abnormalities or spine anomalies that are potentially unstable and could render the spinal cord vulnerable, eg., congenital absence of the odontoid process of the axis and previous cervical fracture or dislocation
- temporary paralysis from any cause
- permanent sequelae of any head injury, eg., visual disturbances, altered mental or intellectual capacity, or post-traumatic epilepsy
- repeated painful injury to the cervical and lumbar spine, particularly in persons with radiographic evidence of degenerative osteoarthritis or congenital narrowing of the spinal canal.

There are other medical conditions that do not necessarily preclude horse riding, for which it is recommended should be considered on a case-by-case basis (Nelson and Bixby-Hammett, 1992). These are repeated concussions, brachial injury, lumbar injury, herniated intervertebral disk and recurrent injury to cervical or lumbar ligaments or muscles.

Well-controlled idiopathic epilepsy or insulin-dependent diabetes mellitus are not considered indications for restrictions of horse riding (Nelson and Bixby-Hammett, 1992).

Re-injury is common among horse riders. It is important that riders who sustain an injury, but consider they are able to continue riding, either immediately or soon after the injury event, should receive thorough examination before proceeding (Hamilton and Tranmer, 1993). For instance, "repeated concussion’s may result in loss of attention, concentration, memory, judgement and speed of thinking, all of which may lower intelligence and thus must not be dealt with passively." (Brooks and Bixby-Hammett, 1988).

Disabled persons are not necessarily excluded from riding provided they comply with general equestrian safety rules and take specific precautions (Maplehouse ,1995).

6.7 FIRST AID

Despite the importance of tertiary countermeasures for minimising the medical consequences of injury, (such as the availability of first aid, and the presence of medical or paramedical personnel at events), there is very little discussion of this in the literature.

In Victoria, St John's Ambulance personnel or another person with a current first aid certificate from the Red Cross is required to be present at all one-day events (except gymkhanas) conducted by the Pony Club Association of Victoria (Corry, 1996). For Equestrian Federation of Australia are (EFA) events, one or more doctors are on duty and St John's Ambulance personnel are present as well. For larger EFA meetings, an ambulance is required to be on site, (which may be a St John's Ambulance) and a medical clinic is alerted to be on stand-by in case of serious injury (Canapini, 1996; Mccaulay, 1996). Veterinarians are also present.

Similarly, for events conducted by the Victoria Racing Club ambulances from the public ambulance brigades are present at every race meeting (Kinna, 1996). For races conducted in the Melbourne metropolitan area there is a minimum of two ambulances on the course, and a minimum of one for country events. These ambulances follow the race outside the rails and behind the field of horses. In addition, two or three doctors are required to be present.

In Australia, there is no training in sports injury for undergraduate general practitioners, in sports injury although physiotherapists receive some training. General practitioners,

physiotherapists, chiropractors, podiatrists and other health care personnel should ideally have specialist training in sports injury, but few courses are available. For equestrian sports, the presence at organised events of personnel trained to deal with head injuries would seem to be an obvious requirement. It is recommended that basic training in first aid, especially stabilising measures for head injuries, should be required for every rider.

The American Equestrian Association has published a booklet which gives recommendations for planning medical care coverage of equestrian events and this is quoted in many horse publications (Byrd, undated).

Rehabilitation from severe injury can be expensive. In Australia, professional jockeys are covered by occupational injury insurance (Kinna, 1996) but other riders may need to ensure they are adequately covered by health insurance either privately or through their equestrian association.

6.7.1 Recommendations for further research, development and implementation

- Organisers of equestrian events should ensure that adequate first aid and medical services are provided.
- Recommendations for the minium level of first aid equipment and personnel at all events should be prepared and disseminated to equestrian sports bodies.
- All horse riders should receive basic training in first-aid principles as part of their rider education.

6.8 OTHER

The choice of horse, suitably matched to the age and experience of the rider is an important safety precaution that should not be overlooked. It is generally recommended that older horses are safer for beginners (no learner or child should be given a horse under 5 years of age to ride) and that an experienced and trained horse person should be involved in the selection of horses for riding (Williams and Ashby 1995).

Supervision of riding, particularly for children is another safety precaution that is an effective primary countermeasure. only experienced riders should ride unsupervised (Williams and Ashby 1995).

Other primary countermeasures that have been mentioned in the literature include alcohol avoidance (Hammett, 1990. Lantis, 1995), mounting and dismounting techniques (Bixby-Hammett and Nelson 1992) and use of reflectors at night (Austroads, 1995).

As remarked in a previous section, horse riding requires a keen sense of balance, agility, reasonable physical fitness, and mental acuity. Consequently, alcohol use by equestrians may impair their coordination and judgement, lengthen their reaction time, and reduce their ability to adjust to the movements of the horse they are riding. Even though there seems to be no evidence that alcohol use is associated with an increased injury rate in equestrian sports compared with any other sporting activity (Lantis, 1995, Hammett et al, 1992). training courses for horse riders should include warnings relating to the possible hazards of the use of alcohol during riding.

One equestrian sport where alcohol use may be common is fox hunting (Hanson, 1984). This equestrian sport could be the most hazardous of all equestrian sports, are the risk factors usually include, in addition to alcohol use, rough terrain, a wide variety of rider experience, fitness and age, an inclination to disregard the usual cautions because of the exuberance of the chase, pride and the competitive nature of the sport.(Firth, 1985).

6.8.1 Recommendations for further research, development and implementation

- Choose a horse of appropriate size, temperament, character and age for the rider's size and skill level, in conjunction with a trained and experienced hosreperson.
- No beginner or child should have a horse aged less than five years. Older horses are better for beginners.
- Inexperienced riders, especially children, should always be supervised when riding.
- Alcohol use before riding should be avoided as this could impair coordination and judgement, lengthen reaction time, and reduce the ability to adjust to the movements of the horse

7. SUMMARY AND CONCLUSIONS

The literature relating to equestrian sports injury countermeasures is not extensive. There are, however, many good reports of the epidemiology of horse-related injury, particularly in the pony club sports. There seem to be few published studies in other equestrian sports, such as fox hunting, rodeo, horse racing and polo. As well there is a paucity of information about injuries to non-riders such as farriers, horse handlers and bystanders.

Ideally, the effectiveness of all equestrian injury countermeasures should be demonstrated before they are implemented or widely promoted. However, where there is good evidence to suggest that a particular countermeasure has the potential to be highly effective, (despite a lack of 'gold standard' scientific evidence for its effectiveness), then the use of that countermeasure should continue, provided there are no known negative effects or disbenefits associated with the particular countermeasure. This particularly applies to the use of protective helmets.

Very few of the countermeasures suggested or used for the prevention of horse-related injuries, have been scientifically evaluated by case-control or other studies. This may not necessarily be a concern, if epidemiological records consistently and strongly show a reduction in injury frequency after the introduction of the countermeasures.

There is ample epidemiological evidence that demonstrates equestrian injuries, although relatively infrequent, are generally severe, disabling and too often, fatal. Information needs to be collected on the extent of the implementation of, and attitudinal barriers to the use of, existing equestrian countermeasures this should be used to inform the development of new and improved countermeasures.

Where countermeasures are aimed at preventing injury, such as modification of the environment, and increasing skills and knowledge, they should be trialed and evaluated before full implementation. Where countermeasures are aimed at reducing injury severity, but for which there are doubts concerning their effectiveness, (as in the case of the use of safety stirrups or body protectors) formal evaluation should be conducted, preferably by case-control studies.

The equestrian injury countermeasure which has received the most attention is protective headgear. The desirability of using protective headgear is based on descriptive epidemiology which supports the scientific advice that protective headgear should reduce head injuries. On the other hand there are a number of researchers who are hesitant to give unqualified support to helmet use, on the grounds that there is evidence from injury data and the laboratory, that the helmets in current use have not, and are not able to prevent all head injuries. There is general agreement that the design of helmets has not been perfected. As new materials emerge the search to improve the equestrian helmet continues. The ideal helmet will need to protect and be acceptable to the wide variety of riders involved in the many different equestrian sports. Notwithstanding the reservations of some researchers, the data-based studies demonstrate that helmets should be worn.

None of the protective equipment recommended has been formally evaluated. While the available evidence suggest that some pieces of equipment such as safety stirrups have the potential to be effective in reducing injury, it is not at all clear that others such as protective body vests are likely to prove particularly useful.

Those countermeasures for which there is currently a lack of good evidence on their effectiveness in preventing injury, should be evaluated, preferably by case-control studies, or

retrospective case studies. Protective equipment such as safety stirrups and body protectors fall into this category.

Protective headgear has been shown to be effective in reducing injuries to bicyclists. Hence protective headgear should be effective in equestrian sports. What is needed for equestrian sport headgear is the continuation of the search for the ideal helmet. While the ideal may be unachievable, the current helmets in use require further development, modification, improved design, and improved rider acceptance.

There is some debate about whether knowledge and skills in riding and horse handling techniques, or practical experience is the more important factor in reducing equestrian injuries. This could be an academic argument. A rider with no formal training in riding but with years of experience in the saddle may have acquired knowledge and skills of a high order. On the other hand, it would appear to be desirable for a beginner rider of any age to be properly taught the basic skills of horsemanship before riding unsupervised.

The reportedly high injury frequency during lessons suggest that formal assessments of the quality of rider education programmes and facilities are needed. Standards and practices of all riding schools should be subject to accreditation inspection by an external body.

Education is a common countermeasure suggested for the prevention of most injuries. For equestrian sports lessons being recommended for riders. Other recommended means include education of the public and the parents of riders using brochures, and videos. Educational material should be evaluated.

Educational material in the form of brochures and videos may be of limited value. Equestrian organisations using this material should monitor its usefulness. Feedback evaluation by users should be sought as a simple means of determining the strengths and weaknesses of the material.

Little work seems to have been done on evaluating the effectiveness of teaching and using falling techniques. This countermeasure may offer a cheap and effective avenue of reducing a wide range of injuries, including those to the head, neck and upper extremities.

Many equestrian sports bodies actively promote safety in their sport. This is to be commended. Sometimes this promotion is formal, where internal or external official rules and regulations are applicable and enforced. At other times it consists of relatively informal verbal advice and the supply of safety literature produced by the sporting body. Clearly in the case where strategies are informally implemented there is scope for considerable variation in the advice and enforcement of safety issues.

No single equestrian organisations has sufficient funds or expertise to properly assess the effectiveness of countermeasures. It may require coalitions of equestrian sports bodies, and researchers to conduct the appropriate investigations. The lack of knowledge of the effectiveness of countermeasures means that equestrian sport related injuries will continue to occur. The injury rate amongst equestrians is low, but the severity of the injuries which do occur is high.

Every attempt possible should be made to reduce equestrian sports injuries. The evidence shows that these injuries predominantly affect female teenagers, and although relatively infrequent, can be severe, disabling or too often, fatal. Unlike injuries sustained in other contexts, equestrian sports injuries are often not preventable because of the unpredictability of the horse. There remains room for improvement of the means of reducing preventable injuries.

However the major effort in all equestrian sports must be on reducing the severity of the injuries which will inevitably occur. Evaluations of countermeasures in this regard are lacking and deserve considerably more attention than they have so far received.

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APPENDIX 1: SUMMARY OF THE EVIDENCE FOR THE EFFECTIVENESS OF HORSE RIDDING INJURY COUNTERMEASURES

Note: the numbers in the column headed STUDIES refer to the lsit of references at the end of this appendix

COUNTERMEASURE	BACKGROUND TO COUNTERMEASURE	MECHANISM OF INJURY	RATIONALE FOR COUNTERMEASURE	STUDIES	STRENGTH OF EVIDENCE
Helmets	Head protection for horseriders recognised historically, but science first applied to design in early 1950s. It was argued that head protection would reduce the head injuries sustained when riders fell from horses.	Helmets are highly associated with a reduction in fall injuries. They also seem to protect to some degree against kicks from horses not being ridden.	The skull is a relatively thin bone enclosing the brain. Hence additional protection is needed to protect the brain. Helmets should reduce the severity and frequency of head injuries related to horseriding by acting as a barrier.	1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14, 15, 17, 18, 20, 22, 24, 29, 31, 32, 33, 35, 36, 37, 38, 41, 45, 47	The epidemiological evidence is very strong that the use of helmets complying with official standards and properly worn will reduce the frequency and severity of head injuries. (1, 2, 4, 8, 24,15, 18, 22, 32, 33, 35, 36, 37, 38, 45) However most of the evidence is anecdotal and opinion. Some authors point out that helmet use does not guarantee head protection. (2, 3, 15, 29, 35). The head is not protected by the helmet in many impacts - the ideal design has not been found. (2, 3, 7, 24, 11, 17, 29, 35)
Knowledge of horse behaviour	The horse is less intelligent than the dog, has a simple mind, good memory, but no reasoning ability. A rider never has complete control.	When being ridden, falls are the most common. However other soft tissue, and fractures to the upper and lower extremities are also common. When not being ridden, kicks and other collisions occur.	Riders should be matched to horses as closely as possible. Injuries are just as likely to occur to experienced riders riding an inexperienced horse, as inexperienced riders riding a trained horse. The better the knowledge of horse behaviour the more likely potential injuries can be anticipated.	1, 3, 4, 14, 23	Largely anecdotal and informed opinion. This countermeasure often related to others such as the necessity for lessons, and rider experience.

COUNTERMEASURE	BACKGROUND TO COUNTERMEASURE	MECHANISM OF INJURY	RATIONALE FOR COUNTERMEASURE	STUDIES	STRENGTH OF EVIDENCE
Well-conducted lessons by a trained teacher	There is an high frequency of injury during lessons for horseriders.	Falls, and all other mechanisms.	Riding instructors who are certified, experienced, and have good knowledge may overcome potential faults developed by children and young adult riders. The choice of an instructor by parents should not be based on availability, easy accessibility and salesmanship.	3, 4, 37	Anecdotal and informed opinion.
Discouraging people from riding who have contraindicated medical conditions	Certain medical conditions, especially those requiring a sound sense of balance, would intrinsically contraindicate horseriding for some persons. Re-injury is frequent amongst horseriders.	Falls, and all other mechanisms.	Medical conditions which many contribute to injuries because of temporary loss of control of mental of physical function, would place the riders with the conditions at greater risk of injury. Some conditions which could be thought to be a contraindication, eg idiopathic epilepsy, are not, available evidence a contraindication.	6, 12	Anecdotal and informed opinion.
Public education		All mechanisms.	Public education of the hazards faced by horseriders may lead to responsible use of safety equipment and procedures by riders.	1	Informed opinion.
Rider education	Younger children (assumed to be inexperienced riders) have horseriding injuries more frequently than older.	All mechanisms	The frequency of injury of all riders should decrease as their experience of riding and knowledge of horses, particularly handling, mounting and dismounting increases.	1, 2, 3, 10, 12, 30, 31, 33, 20, 39, 45	Mostly informed opinion. One study (10) evaluated an education program on rider safety by pre- and post-intervention surveys. Some measures improved, but decreases in frequency of injury was not detected (sample may have been too small).

COUNTERMEASURE	BACKGROUND TO COUNTERMEASURE	MECHANISM OF INJURY	RATIONALE FOR COUNTERMEASURE	STUDIES	STRENGTH OF EVIDENCE
Rider experience	Those with more serious injuries were often found to be inexperienced riders (regardless of age).	All mechanisms.	The frequency of injury of all riders should decrease as their experience of riding and knowledge of horses increases.	10, 14, 26, 31, 33	Two retrospective studies (10, 14) suggest that rider experience is important for frequency and severity of injury. On the other hand, two US studies based on the same source of data (USPC) (26, 33) indicate that experience does not equate with skill and knowledge. In the later studies the more experienced riders had more accidents than the less experienced.
Safety stirrups	Multiple injuries were often found to be associated with non-release of the rider from the stirrups on falling. Victim is dragged along the ground.	All mechanisms.	Well-fitted riding tack, including stirrups of the correct size, smooth-soled heeled boots, and stirrups designed to release from the tack should the rider fall, should reduce injuries. (A child's weight may be insufficient to release the stirrups.)	2, 3	Some limited epidemiological evidence. Mostly informed opinion.
Body protection	Body protectors in other sports, such as shoulder pads in baseball, appear to protect the participants from serious injury.	Falls.	Suitably designed body protectors should protect against soft tissue injuries particularly. Knee and elbow padding should reduce fractures to these body parts.	3, 5, 19, 35	Informed opinion. Body protection often bulky leading to rider resistance.

COUNTERMEASURE	BACKGROUND TO COUNTERMEASURE	MECHANISM OF INJURY	RATIONALE FOR COUNTERMEASURE	STUDIES	STRENGTH OF EVIDENCE
Falling techniques	Learned falling techniques in other sports, such as in football codes, seem to reduce the frequency of injuries.	Falls.	Teaching the "tuck and roll" technique, together with the use of protective gear, especially helmets, should reduce head injuries arising from falls.`	5	Informed opinion and anecdote.
Modifying the environment	From a jockey's survey, racetracks where course safety measures were in place, appear to produce fewer injuries. New road rules to be introduced in Australia allow horses to be ridden on nature strips.	All mechanisms, mainly falls.	The severity of injuries should be reduced where the surfaces impacting on the rider are modified to reduce the impact. Falls onto grass are less severe than onto tarmac.	17, 35, 47	Some epidemiological evidence, and laboratory testing.
Appropriate equipment	Many types of injuries are apparently caused by old, unsuitable, inappropriate equipment.	Falls, dragging following falls, burns or blisters to the hands, all other mechanisms.	Use of appropriate equipment which is in good condition has in other sports reduced injuries. The dragging of a rider along the ground after a fall from a horse could reasonably be overcome by stirrups which released the foot automatically.	20, 37,40	Some epidemiological evidence.

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APPENDIX 2: DETAILS OF THE STUDIES EXAMINING KNOWLEDGE OF HORSE BEHAVIOUR

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
No horse is a safe horse. Prevention of accidents and injuries is dependent upon using knowledge previously obtained from studying horse activities.		A review of the literature relating to the hospitalised, disabling and fatal injuries sustained by horseback riders. A profile of injured riders was presented. The most common injuries are to the upper extremity, then lower extremity. The most common type of injury is soft tissue, followed by fracture and concussion. Riders less the 21 years have most injuries, more women than men. Suggestions are made for further investigation, and for prevention.			Bixby-Hammett D, Brooks WH. 1990.
Dealing with horses can be unpredictable as illustrated by the dramatic and unexpected manner in which injuries can occur.		Retrospective descriptive study of the 38 horse-related fatalities between 1975-1990 in Alberta, Canada. Each case was reviewed by type of injury, age, gender, month of incident, supervision at the time of injury, helmet usage, and the performance of an autopsy. 22 died of head injuries. Only one victim wore a helmet. 47.4% (of 38) were 20 years or less.			Aronson and Tough, 1993.
Conclusions and Recommendations: Some of the deaths may have been prevented, or injuries might have been minimised by riders' wearing approved riding helmets, having better knowledge of horse behaviour, or having received instruction from qualified teachers.					

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
The effectiveness of safety education which includes education about horse behaviour of youth and young adults may be evident in the USPC data, which show a decrease in the percentage of horseback riding accidents in that age group.		Injuries to persons under 25 years resulting from horse-related activities were obtained from state medical examiners, from NEISS, from US Pony Clubs, National Park Service. There were 64 fatalities, mostly due to head injuries, the most frequent non-fatal injuries were contusion/abrasion, fracture, strain/sprain to the upper extremity, lower extremity, and face/head			Bixby-Hammett, 1992
Conclusions and Recommendations: Greater knowledge (of injuries related to horseriding) may reduce the severity of injuries, riding instructors should be certified, pediatricians should be involved with advising parents and be involved in boards of horseriding groups.					
Author gives detailed instructions on how to warm-up a horse before taking part in events. By doing so the relationship between the horse and rider is strengthened (and presumably may lead to fewer injuries).					Pawley Z. 1995
Conclusions and Recommendations: A warm-up routine needs to become almost ritual, because it forms a relationship between the rider and the horse.					

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
		In a 5-year study (1982-86) of injuries to USPC members aged 6-21 years, there were 130 accidents resulting in 212 injuries. The activity most commonly associated with injuries was cross-country (29.2%), the most frequent injury type was bruise/abrasion (29.3%), then closed fracture (21.7%). Body part injured not reported. Over one-third of the accidents in the USPC study occurred during lessons. In previous studies of horse-related accidents the highest injury rate was associated the with lessons			Bixby-Hammett DM, 1987.
Conclusions and Recommendations: There is a definite need for an accepted standard by which instructors are certified for teaching.					
		A retrospective study of 20 patients admitted to a spinal unit as a result of a horse-related injury was conducted. Patients were interviewed concerning details of the horse, the rider, and the circumstances and outcome of the injury. It was found that 70% of the accidents were attributable to the behaviour of the horse. Rider error was a significant contribution. In seven cases the rider was considered to have insufficient experience			Silver JR, Lloyd Parry JM. 1991.

APPENDIX 3: DETAILS OF THE STUDIES EXAMINING RIDER EXPERIENCE

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
		Fatalities related to horses were examined for the period 1969-1982 in Sweden. Of the 57 deaths, 28 were a result of fall from horse-back, 9 from kick, 2 from trampling, horse rolling over 5, and 9 miscellaneous. 38/53 (72%) were head injuries. The age group most likely to produce victims was the 11-15 year olds (n=16); most horses in the age range 6-7 years.			Ingemarson H, Grevsten S, Thorén L. 1989
Conclusions and Recommendations: Riders with less experience should train in an indoor school under the surveillance of a teacher (without landscape obstacles). After 3 years experience, outdoor riding under supervision should be allowed. Riding outdoors and outside a paddock is recommended only for very experienced riders. Helmets are also recommended.					
		A retrospective study of 20 patients admitted to a spinal unit as a result of a horse-related injury was conducted. Patients were interviewed concerning details of the horse, the rider, and the circumstances it was found that 70% of the accidents were attributable to the behaviour of the horse. Rider error was a significant contribution. In seven cases the rider was considered to have insufficient experience			Silver JR, Lloyd Parry JM. 1991.
Conclusions and Recommendations: Concentration only on the value of preventative headwear will not eliminate serious spinal injuries.					

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
		An analysis was carried out of a 2-year period (1982-3) of horse activities of 18,408 US Pony Club members. Results were obtained for the most often injured body area, most common type of injury, most "dangerous" equestrian event (highest % of injuries), mechanism of injury, experience of rider. With relation to rider experience, most accidents occurred to riders with five or more years of experience and the least to riders with less than one year of experience.			Bixby-Hammett DM, 1985
Based on available evidence the American Academy of Pediatrics have made recommendations relating to horse selection and parent supervision which they believe may reduce horseriding injuries.					American Academy of Pediatrics 1992
Conclusions and Recommendations: The American Academy of Pediatrics recommends four steps for preventing and or lessening the severity of horseback riding-related injuries. Steps 1, 2 and 3 are: *Parents should be urged to verify that the horses their children ride are matched with their riding capabilities*. *Riding activities should be supervised commensurate with the skill level of the rider*					

Anecdotal evidence (Informed opinion)	Biomechanical testing	Epidemiological studies	Controlled trials	Consumer surveys (attitudes/acceptance)	Article reference
		In a 10-year prospective study by the US Pony Clubs where all accidents where injury occurred and an insurance claim was made, the most frequently injured areas were the head (14.4%), ankle/foot/toe (9%), spine (8.2%), face (7.8%) and wrist/ hand/fingers (7.8%). Of the 470 injuries the injury types were bruise/abrasion (35.1%), fractures (23.0%), sprain/strain (12.8%), concussion (9.4%). When comparing the number of members in a specific rating level (of knowledge and skill), lower rated riders had more accidents that other levels. Members with higher levels had no more accidents than their percentage of the membership would predict, although they spends many more hours with the horse than other rating levels.			Bixby-Hammett DM, 1992
Conclusions and Recommendations:. These results indicate that knowledge and skill reduce the risk of accidents in equestrian activities. Experience does not equate with skill and knowledge in accident prevention. The Pony Clubber who has five years experience with horses without having achieved an upper level rating for skill is at the greatest risk for accidents.					

APPENDIX 4: DETAILS OF THE STUDIES EXAMINING THE EFFECTIVENESS OF PROTECTIVE HEADGEAR

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
Authors suggest that approved protective headwear had been properly worn, the results on injury events might have been very different.		Retrospective descriptive study of the 38 horse-related fatalities between 1975-1990 in Alberta, Canada. Each case was reviewed by type of injury, age, gender, month of incident, supervision at the time of injury, helmet usage, and the performance of an autopsy. 22 died of head injuries. Only one victim wore a helmet. 47.4% (of 38) were 20 years or less.			Aronson and Tough, 1993
Conclusions and Recommendations: Some of the deaths may have been prevented, or injuries might have been minimised by riders' wearing approved riding helmets, having good knowledge of horse behaviour, or having received qualified instruction. Public education encouraging the proper use of protective headwear is necessary if there is to be a reduction in the severity of these injuries.					
Authors suggest properly secured head gear should provide some protection but that the literature lacks definite proof that helmets are effective. They suggest the problem is due to poor helmet design and improper use during riding.		Medical records at Virginia Medical Center of 136 patients 19 years or less admitted to hospital for equestrian-related injuries between 1973 - 1987 were examined. 55% had head and facial trauma, 42% fractures other than head. 75% of patients were thrown or fell from horse, 15% kicked, 10% horse fell or stepped on them.			Barone GW, Rodgers BM. 1989
Conclusions and Recommendations: The most common injury was head and facial trauma, with fractured extremities being the second largest group. From this review it appears that if effective safety gear, which is readily available, is utilised, many of these severe injuries could be prevented.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
Authors acknowledge that, from the medical evidence, headwear has become a requirement, but question the standard, location and form of protection of current headwear.		A review of the literature relating to the hospitalised, disabling and fatal injuries sustained by horseback riders. A profile of injured riders was presented. The most common injuries were to the upper extremity, then lower extremity. The most common type of injury was soft tissue, followed by fracture and concussion. Riders less the 21 years had most injuries, more women than men. Suggestions for further investigation, and some suggestions for prevention.			Bixby-Hammett DM, Brooks WH. 1990
Conclusions and Recommendations: Further investigation is needed on previous horse-related injury, epilepsy, drowning, gender, deaths, and the protective effects of lessons, experience vs knowledge, safety helmets, stirrups, and body protectors. Knowledge of horse activity is needed. They concluded that the foremost requirement for riders is that certified protective headgwear secured by a chin strop or harness be worn by all riders at all times when mounted.					
The authors opinion is that wearing protective headwear decreases the frequency and severity of accidents in all sports		Injuries to persons under 25 years resulting from horse-related activities were obtained from state medical examiners, from NEISS, from US Pony Clubs, National Park Service. There were 64 fatalities, mostly due to head injuries, the most frequent non-fatal injuries were contusion/abrasion, fracture, strain/sprain to the upper extremity, lower extremity, and face/head.			Bixby-Hammett 1992
Conclusions and Recommendations: Greater knowledge (of injuries related to horseriding) may reduce the severity of injuries, riding instructors should be certified, pediatricians should be involved with advising parents and be involved in boards of horseriding groups.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
The author states helmets should be fitted properly, with the chin strap comfortable and used. A brimless helmet is better.		Since the US Pony Club required juniors to wear USPC-approved helmets at AHSA shows, there have been no skull fractures among riders.			Bliss 1988
Conclusions and Recommendations: Discussion of many means of preventing injury, concentrating on the development of a "tuck and roll" fall technique. Also briefly discusses helmets, and protective vests.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
				A survey of 837 horse riders on attitudes to helmet wearing showed that only 20% wore helmets every time they rode, and 40% never wore an equestrian helmet. The dominant reason for not wearing, was unsuitable design. In six focus group interviews, most felt the helmets to be uncomfortable, hot, heavy, and to look silly. 56% felt safer wearing a helmet. The report describes a program to increase wearing rates. The program achieved a purchase response of 15-92% depending on the club.	Condie C, Rivara FP, Bergman AB, 1993.
Conclusions and Recommendations: The study indicated that riders are well-informed about the need for helmets and the main reason for non-use is inadequate helmet design. The strategies in the program included working with manufacturers to develop a low-cost, versatile helmet, efficiently distributing educational literature (62% of injuries occur around the home or farm where enforcement is impractical).					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		A retrospective analysis of emergency department presentations from 1986 to 1990 (five years) of horse-related injuries (142 cases) found that 63% were injured when they fell from the horse, the others while the horse was being handled. Two patients were bitten.			Hobbs, Yealy, Rivas. 1994
Conclusions and Recommendations: Equestrian activities are associated with a risk of serious injury to both riders and handlers of horses. Education of both the public and primary care physicians should focus on injury prevention. This should include the use of proper head protection.					
Conclusion based on opinion from severity and frequency of cases.		A retrospective survey of 59 head injuries arising from horse-related activities (out of 7172 head and spinal injuries admitted to a specialist head injury unit) found that horse-riding presented a significant risk of head injury to riders.			McGhee et al, 1987
Conclusions and Recommendations: The result suggest that the wearing of amateur riding headwear does not adequately protect the rider from scalp and skull injury, particularly in the occipital region. It is therefore suggested that the design of, and legislation with regard to, protective headwear for horseriding should be improved and enforced.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
	Cases of head injuries were selected (not stated how) to illustrate particular impact sites and types of surface struck. Impact tests which simulated the accidents were performed on the accident helmets in the laboratory to assess the energy absorption potential of some helmets for lateral impacts. In the tests, the aluminium headform and the steel striker of the British Standard test correspond to the helmet hitting a hard road surface.				Mills NJ, Whitlock MD. 1989.
Conclusions and Recommendations: The authors point out that the BS test tests the *helmet*, not the effect on the head. The results showed that the foam materials used have insufficient energy absorption and/or insufficient thickness to prevent head injury. The authors quote that 25% of riding accidents occur on public roads. Bicycle and motorcycle helmets provide better protection that horse-riding helmets. The design of helmets could be improved for some types of potential head injuries, but not all.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
				Patterns of helmet use and attitudes toward helmets among horseback riders was determined from a cross-sectional mail survey of horseback riders (1991). Of 900 English-style riders, 517 wore helmets on their last ride compared with only 81 of 684 Western-style riders. Among 546 riders who did not own helmets, their most commonly cited reasons included believing that and , uncomfortable.	Nelson DE, Rivara FP, Condie C. 1994.
Conclusions and Recommendations: Increasing helmet use will require major educational efforts with horseback riders and design changes by manufacturers.					
Helmet use is unlikely to explain the entire difference between groups. Helmets are unlikely to protect internal organs, so it is possible that some other factor associated with helmet use, perhaps caution, also contributed to the better outcome for this group.		Data on children less than 15 years (n=32) presenting to one ED with horse-related injuries, over a 2-year period were analysed. Of 30 children who fell or were thrown from a horse, 20 were helmeted. Helmetless riders had more severe injuries on all measures, but the frequency of injury was about the same. Nine patients, all helmeted, were without significant injury.			Bond GR, Christoph RA, Rodgers BM. 1995.
Conclusions and Recommendations: Helmet use is associated with decreased frequency and severity of CNS injury.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
	This paper gives the result of impact and compression tests on materials used in horse riding helmets according to various methods of testing from Standards, as well as the results of simulating falls onto different surfaces. it was that existing riding helmets will not protect the side (or back or front) of the head from a vertical fall of 8 feet onto a tarmac road. On the other hand they would be adequate for a similar fall on a field or path.				Hunt H, Mills NJ. 1989.
Conclusions and Recommendations: Considering the risks in riding there is no logical reason why the impact protection level is high at some sites, lower at others, and not tested at others. The impact response of the helmet for side or frontal impact depends on the foam yield stress and thickness and the helmet curvature. Many helmet designs are inadequate.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		The author presents epidemiological data from Oklahoma on traumatic brain injuries (TBI) in horse riding during 1992. Of the 3106 hospitalised or fatal TBIs, 109 were sports-related, 38 were horseback riders who were thrown or fell from the horse. There no fatalities among the horse riders. None of the injured were wearing a helmet while riding.			Lantis S, 1995
Conclusions and Recommendations: The use of riding helmets can decrease the incidence of traumatic brain injuries. The author states that since helmets were required by the US Pony Club, they have contributed to a 20% decrease in injuries in the past ten years at junior competitions and jumping events. The American Academy of Pediatrics recommends (a) safety education programs for riders, parents and instructors; (b) matching the rider's skill to the horse's level of training; (c) approved helmets for young riders.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		A retrospective review of 155 patients incurring 156 horseback-riding accidents (160 hospital admissions) over a 6-year period (1983-1986) to neurosurgical hospitals in southern Alberta (Canada) was carried out. Only two patients were wearing protective headgear and received relatively minor injuries 81% of accidents occurred during recreational activity, 10.3% during work, 7% rodeo. *Only two patients had protective headwear*. 81.4% had falls (includes thrown from horse), 12 receiving further injury after the fall -kicked, crushed, dragged. Basic injury patters were head, spinal and peripheral nerve. Eleven patients died..			Hamilton MG, Tranmer BI (1993)
Conclusions and Recommendations: This injury profile underscores the importance of encouraging and, if necessary, enforcing the use of standardised protective headwear in association with adequate introduction to and training in the sport of horseriding.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		In this retrospective review of patients admitted to an accident and emergency department following a head injury in Nottingham. there were 17 horse riders. All riders were wearing protective headwear. Two riders (where the helmet was dislodged during the fall) were kicked. A postal questionnaire was used as a follow-up on helmet use.			Muwanga LC, Dove AF, 1985
Conclusions and Recommendations: There was no correlation between helmet wearing and skull fracture. However one helmet was not strapped on, six were dislodged by the fall. All riders must be made aware of the risk of head injury, that their helmet will offer no protection if it is not adequately fastened, and with the present design may still not protect even when fastened.					
The American Academy of Pediatrics recommends four steps for preventing and or lessening the severity of horseback riding-related injuries.					American Academy of Pediatrics 1992
Conclusions and Recommendations: Step no. 4 is: *Young riders, when mounted, should wear helmets that meet 1988 ASTM (American Society for Testing and Materials) standards and are certified by the SEI (Safety Equipment Institute). The helmets should be secured by appropriate chin straps. All organisations and activities (riding schools, horse shows, rodeos, etc) that promote or sanction horseback riding events should require entrants to use SEI-certified helmets*.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		A retrospective study of 103 injured horse riders comprised 32 professional jockeys, the remainder were amateur riders who had been transported by ambulance to an emergency department in Berkshire. The majority of injuries to the amateurs were to the head and face, while the jockeys mostly had upper limb injuries. Of 42 amateurs questioned later, 31 did not have the helmet's safety strap attached.			Whitlock MR et al 1987
Conclusions and Recommendations: The different patterns of injuries in professional and amateur riders would suggest that many injuries could be prevented by better protective clothing, especially headwear. It is also might suggest that falling on grass (jockeys) might be less hazardous than the conditions encountered by amateurs.					
USPC members are mandated to wear a hard hat at all times when mounted. In 1990 the standard of hat used changed from that used in the previous 8 years. From 1990, head injuries decreased by 26%, face injuries by 62%, clavicle by 57%. Other indicators decreased also, although neck injuries remained the same.		In a 10-year prospective study by the US Pony Clubs where all accidents where injury occurred and an insurance claim was made, the most frequently injured areas were the head (14.4%), ankle/foot/toe (9%), spine (8.2%), face (7.8%) and wrist/ hand/fingers (7.8%). Of the 470 injuries the injury types were bruise/abrasion (35.1%), fractures (23.0%), sprain/strain (12.8%), concussion (9.4%).			Bixby-Hammett DM 1992
Conclusions and Recommendations: It is implied, but not explicitly stated, that the use of safety hats was responsible for the decrease. Compliance with helmet-wearing is stated to be excellent.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		In a self-report written questionnaire, of injuries sustained during their careers by 706 actively-competing professional jockeys, >1700 injury were reports, 64% of reports were fractures. The number of concussion's was high (8%) of report.			Press JM et al 1995
Conclusions and Recommendations: Although the industry has made some progress in improving safety by such interventions as helmet modifications, such a high number of concussion's suggests a possible role for more protective headwear for jockeys.					
		Over a 2-year period (1982-84) all horse-related injuries presenting to an Emergency department of an English hospital serving a rural population were analysed from clinical records and a postal survey. Of the 237 cases 22% required admission to hospital, 50% of these admissions were for head injuries.			Lloyd RG 1987
Conclusions and Recommendations: In comparison with other sporting injuries and absolutely horse-related injuries while not considerable in number are more likely to be in severe Head injuries constitute the major group of the more serous injuries. Head protection can be improved by using chin straps and using BS4472 (1969) helmets.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		In a 5-year study (1982-86) of injuries to USPC members aged 6-21 years, there were 130 accidents resulting in 212 injuries. The activity most commonly associated with injuries was cross-country racing or riding events (29.2%), the most frequent injury type was bruise/abrasion (29.3%), then closed fracture (21.7%). The body part injured not reported.			Bixby-Hammett DM, 1987.
Conclusions and Recommendations: Relative to other studies of horse riding activities, USPC members had a very low frequency of injury. The author attributes this, in part, to the requirement of USPC clubs that members wear approved protective headwear at all times.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		Six fatal and five non-fatal horse-riding related injury cases requiring neurosurgical treatment, collected between 1980-83 from hospitals in Oxford, are described in detail. Six riders died following falls; three (unhelmeted) were involved in hacking. Of the riders wearing headwear one was an experienced jockey wearing a helmet that provided insufficient protection, another a professional rider wearing a top hat, and the third was wearing an old helmet which provided inadequate protection. Of the 5 non-fatal cases, four were wearing good helmets which remained on after the fall.			Ilgren EB et al 1984.
Conclusions and Recommendations: The study clearly indicates the seriousness of head injuries suffered during horse-riding and suggests that the use properly constructed helmets may prevent serious brain injury.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
				Based on "the compelling evidence of helmet effectiveness", the European Consumer Safety Association (ECOSA) decided its main target will be to have achieve a high level of helmet wearing by the year 2010 in all EC and EFTA member states. Helmets for equestrian sports are not specifically mentioned, although "high risk" sports are.	Anon, 1993
Conclusions and Recommendations: Before helmet wearing is made mandatory, reasonable acceptance should be achieved among the prime target groups. Wherever helmet wearing has gained some reasonable level of acceptance and wearing levels to about 30% the introduction of compulsory wearing should be seriously considered.					
		The epidemiology of fatal and hospitalisation injuries due to falls from horses in New Zealand is described. There were 54 fatal falls for the period 1977 to 1986, and 773 admissions during 1987. Head injury accounted for 22.2% of the deaths in males and 38.9% in females. For the hospital admissions, 36% were head injuries and 51% of these were concussion's.			Buckley et al 1993
Conclusions and Recommendations: The magnitude and severity of the problem indicates that there is a need for helmet use and safe-riding practices.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
Although no studies have demonstrated the effectiveness of helmets for the horseriding population, hard-shell helmets greatly reduce the risk of head injury to bicyclists and motorcyclists and are likely to be effective for equestrians because of the similar mechanism of falling.		A literature review of fatal and non-fatal equestrian injuries was conducted. More females than males were injured, falls from were the most common cause. Fractures were common, head injuries responsible for 72-78% of deaths and hospitalisations (55-100%). However, it was found that the overall injury rate is low compared to.			Nelson DE, Bixby-Hammett, 1992
Conclusions and Recommendations: Pediatricians should know the medical contraindications for participation in equestrian sports. They should encourage all riders to obtain horse safety training and use protective headwear.					
		In a review of the literature, the author concluded that 90% of injuries occur in those riders <21 years of age, ~70% occur to amateur rides during unsupervised recreational riding, ~75% of injuries are due to a fall form a horse, while 15% are due to a kick. The most common injury is to the upper extremity, but the most common injury necessitating hospitalisation, causing death or disability, is to the head.			Masters RG. 1991
Conclusions and Recommendations: In this potentially hazardous sport, preventative measures, including the habitual use of an approved helmet, should be emphasised. Only 1-2% of those riders with neurologic injury wear adequate headwear: the majority wear either no helmet, an inadequate hat, or a helmet that is not secured to the head.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
Based on the available evidence Austroads have proposed changes in the Australian Road Rules including “people in charge of animals”.					(Aust Roads, 1995
Conclusions and Recommendations: The proposed Australian Road Rules includes a section relating to "people in charge of animals" (Part 18, Division 2, Rules 18.11 to 18.16). Rule 18.12 (1) states, *If you are riding a horse, you must wear a securely fitted protective helmet that has been approved by the Authority*. The justification for proposed change in Australian Road Rules is given as:*It is proposed that anyone riding a horse on a road, footpath or nature strip must wear a helmet. There is evidence that head injuries are an important cause of serious injuries when riders fall from horses, and that wearing a helmet decreases the severity of the injury in a fall. [The risk of head injury falling from a horse is higher than the risk involved falling from a bicycle, and compulsory helmet wearing for bicycle riders has resulted in significant reductions in injuries. A similar or greater effect will be obtained by requiring horse riders to wear helmets.]* About 75% of recreational riders throughout Australia now wear helmets, though there is not a present a legal requirement to do so. * The justification varies from state to state.					

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
		The authors examined all types of injuries reported to the American Horse Shows Association and US Pony Clubs. Time period not stated. Bruised and "shook-up" categories accounted for 45.5% of injuries in the AHSA figures, fractures 15.5%. In the USPC figures 24% were bruised and "shook-up" with 32 % fractures. The action of the horse was responsible for over 80% of the accidents in both. The accident rate was very low, 0.38 per 1000 entries in the shows. 30% of all injuries and 43% of injuries to younger riders are head and/or face injuries			Berhang & Winslett 1983
Conclusions and Recommendations:, Mandatory protective headwear regulations be considered, especially for youths.					
		A retrospective study of 20 patients admitted to a spinal unit as a result of a horse-related injury was conducted. Patients were interviewed concerning details of the horse, the rider, and the circumstances and outcome of the injury. It was found that 70% of the accidents were attributable to the behaviour of the horse. Rider error was a significant contribution. In seven cases the rider was considered to have insufficient experience			Silver JR, Lloyd Parry JM. 1991.

Anecdotal/Informed opinion	Biomechanical testing	Epidemiological evidence	Controlled trials	Consumer surveys (attitudes /acceptance)	Article reference
Conclusions and Recommendations: Concentrating only on the value of preventative heawgear will not eliminate serious spinal injuries.					