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Choosing Wisely after a sport and exercise-related injury

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A B S T R A C T

Low-value care is receiving substantial attention in many fields of medicine but little-to-none in sports medicine. Common interventions for sport and exercise-related injuries include medical imaging, medication, surgery and rehabilitation, but there is emerging evidence of the inappropriate use of these interventions. This chapter aims to increase awareness of low-value care in sports medicine by answering four key clinical questions: Does my patient need imaging? When is it appropriate to prescribe opioids? Does my patient need surgery? Does it matter how rehabilitation is delivered? Increasing awareness of low-value care in sports medicine will ensure patients with sport or exercise-related injuries avoid care that provides little-to-no benefit or causes harm and receive care that is evidence based and truly necessary.
There are many situations when imaging, opioids, surgery and supervised rehabilitation are entirely appropriate. However, this

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chapter considers contexts where use of these interventions could be considered unnecessary and potentially harmful.

Background

Choosing Wisely is a global initiative that aims to reduce low-value care and ensure patients receive care that is based on the best available evidence. Low-value care provides little-to-no benefit, causes harm or provides a benefit that is too small when considered in relation to its cost. Low-value care is, therefore, a waste of health resources and would not be desired by an appropriately informed patient [1]. In an attempt to reduce low-value care, more than 220 professional societies worldwide have published Choosing Wisely lists outlining tests and treatments that are unnecessary or that clinicians and patients should question.

Awareness of Choosing Wisely is increasing, and there are now eight countries that have contributed to more than 1300 Choosing Wisely recommendations. The majority of recommendations come from medical (n = 646) and surgical societies (n = 243). However, there are only ten Choosing Wisely recommendations published by sports medicine societies. This suggests that the problem of low-value care in the management of sport and exercise-related injuries is not recognised by sports medicine societies as much as other disciplines.

Common interventions for people with sport and exercise-related injuries include medical imaging, medication, surgery and rehabilitation. Appropriate use of these interventions is important to maximise recovery rate, but there is emerging evidence that overuse of health services for sport and exercise-related injuries may be a problem. For example, the annual incidence of ACL reconstructions [2,3], hip arthroscopy [4–6] and rotator cuff repairs [7,8] has increased remarkably in recent years at a higher rate than could be expected by population growth. In addition, many of these surgical procedures provide similar outcomes as those of non-operative management and none have been evaluated against a placebo [9–13]. The challenge is, therefore, in considering whether low-value care is contributing to some of the growth seen with these interventions, and if so, what should be done about it.

Increasing awareness of low-value care in sports medicine is the first step towards ensuring shared decision making with patients with sport or exercise-related injuries and ensuring that they receive care that is evidence based and truly necessary. In this chapter, we aim to answer four key clinical questions regarding the management of sport or exercise-related injuries: Does my patient need diagnostic imaging? When is it appropriate to prescribe opioids? Does my patient need surgery? Does it matter how rehabilitation is delivered?

There are many situations where these four interventions are entirely appropriate, and these are well described and evidenced in the literature. However, this chapter takes a different approach and will consider contexts where use of these interventions is not justified and could be of low value. Our position is that encouraging high-value care and discouraging low-value care are equally important in advancing the science and practice of sports medicine.

Does my patient need imaging?

Encouraging the appropriate use of diagnostic imaging continues to be a hot topic in healthcare, with more than 500 Choosing Wisely recommendations targeting unnecessary imaging. In sports medicine, imaging the 'right' patient will ensure a timely diagnosis that guides management, while imaging the 'wrong' patient can be a waste of time and resources, and potentially harmful. The majority of clinicians would be aware of the risks of exposure to ionising radiation from plain radiographs, computed tomography (CT) and bone scans, which can be especially harmful in children and adolescents. However, unnecessary imaging can also lead to the identification of 'incidentalomas' (findings that were never going to cause harm) and the 'medicalisation' of normal findings (e.g. lumbar spine disc degeneration in older adults). Ultimately, this practice labels someone with a diagnosis that causes more harm than benefit (overdiagnosis).

Imaging for suspected fractures

The decision to request imaging for a patient with a suspected fracture – usually commencing with a plain radiograph – is complex. Missing a fracture can delay treatment and lead to the need for more complex treatment, which in some cases results in long-term disability. For example, missing a growth plate fracture in a child could have major long-term implications, including disturbances in growth and angulation of bones, while missing a scaphoid fracture could result in long-term limitations in wrist and hand function. However, imaging every patient to avoid missing an important diagnosis is a waste of health resources that may also cause harm in the form of unnecessary exposure to radiation.

How clinical decision rules can help

Judging the level of suspicion for a fracture is challenging, particularly for junior clinicians. Fortunately, there are validated clinical decision rules to help clinicians determine whether imaging for a suspected fracture is necessary. For example, the Ottawa Ankle Rules have a sensitivity of 99.4% (level 1 evidence from a systematic review of 66 studies of diagnostic accuracy, n = 22,273 participants) [14], which makes them useful for identifying patients who have a low probability of a foot/ankle fracture and do not require imaging. Successful implementation of the Ottawa Ankle Rules could reduce foot/ankle radiography by up to 40% in clinics seeing the general population [15,16] and up to 70% in clinics serving military or paediatric populations [17,18]. However, adoption of the Ottawa Ankle Rules appears to be limited. More than 90% of emergency department physicians report they are familiar with the Ottawa Ankle Rules [19,20], but only 42% use the rules to guide decision making [20], and less than one third are able to correctly list the components of the rules [20]. This might explain why foot/ankle radiographs are still ordered in 70–95% of cases of ankle injury despite only 20% presenting with a fracture [21].

Validated decision rules can also help clinicians identify patients with a low probability of serious injury to the knee, cervical spine and head following trauma and guide the appropriate use of imaging. For example, the Ottawa Knee Rules have a sensitivity of 98.5% (systematic review of six studies, n = 4249) [22] and are useful for identifying patients with a low probability of a fracture to the knee that do not require imaging. The Canadian C-Spine Rules (sensitivity = 90–100%; systematic review of nine studies, n = 26,843) [23] and the National Emergency X-Radiography Utilization Study (NEXUS) criteria (sensitivity = 83–100%; systematic review of seven studies, n = 53,865) [23] are useful for identifying patients with a low probability of a clinically important cervical spine injury. The Canadian Computed Tomography Head Rules high-risk criteria have a sensitivity of 99–100% (systematic review of four studies, n = 14,023) and are useful for ruling out the need for a CT head scan [24].

Wise imaging where clinical decision rules do not exist

Widespread use of clinical decision rules could reduce low-value imaging for sport and exercise-related injuries, but there are many clinical presentations where the decision to request imaging cannot be guided by a validated decision rule (e.g. athletes with a suspected stress fracture).

Stress fractures occur when there is an imbalance between bone formation/re-modelling and bone reabsorption at a particular site [25]. This is largely due to increased cyclical loading that is of insufficient intensity to cause a fracture after a single exposure but, over time, leads to an accumulation of bone damage that exceeds the bone's ability to re-model [25]. Bone stress injuries occur on a pathology continuum from physiological remodelling to the accumulation of bone damage, which progresses to a stress reaction, stress fracture and, finally, a complete fracture [25].

Advances in technology have made magnetic resonance imaging (MRI) the preferred imaging approach for detecting many stress fractures (or early signs of bone stress) and have reduced the need for ionising radiation (CT or bone scans) [26]. Although there are no validated diagnostic criteria for identifying patients with a high probability of a stress fracture, understanding the timeframe and factors that increase the risk of developing a stress fracture could guide the appropriate use of imaging. Factors associated with an increased risk of developing a stress fracture include high-intensity loads

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introduced over short periods (e.g. tarsal stress fractures in sprinters) [27], low-intensity loads with a high number of repetitions (e.g. hip stress fractures in long-distance runners) [27], training modifications [28], poor nutrition [29] and menstrual cycle irregularities [30]. The predictive value of individual or multiple risk factors for identifying a stress fracture is unknown, and many studies on risk factors are small cross-sectional studies. Therefore, until clinical decision rules are validated for identifying athletes at high or low risk of a stress fracture, clinicians should use information gathered through a thorough history and examination to inform their decision to request imaging. Further, in the absence of research supporting the use of ongoing imaging for stress fractures, the decision to order repeat imaging should be based on whether the findings will directly inform future management.

Imaging athletes with non-specific low back pain

High-quality research is lacking

The overuse of imaging for low back pain has been identified as a global problem that not only wastes scarce healthcare resources but also causes substantial harms [31]. However, it is unclear whether the harms of imaging apply to athletes. The primary reason why imaging is harmful in the general population is that it leads to the identification of structural 'abnormalities' that are common in people without low back pain. For example, disc bulges are present in 50% of people aged 40 years old and disc degeneration in 52% of people aged 30 years old [32]. Further, abnormal imaging findings can lead to additional tests and treatments that likely explain why imaging results in greater disability, higher medical costs and an increased likelihood of receiving surgery [31].

There is evidence from small observational studies that imaging findings may not always be clinically meaningful for athletes with low back pain. For example, a cross-sectional case–control study of 24 elite male gymnasts and 16 age-matched non-athletes found that athletes were more likely to have disc degeneration (75% vs. 31%, $p < 0.05$) but not more likely to experience low back pain [33]. Similarly, a cross-sectional case–control study of 134 retired professional athletes and 28 age-matched non-athletes found that retired athletes were more likely to have spondylolysis, disc height loss, and other abnormal imaging findings but were not more likely to experience low back pain [34]. Nevertheless, in the absence of high-quality research in this area, particularly large longitudinal studies, the relevance of common lumbar imaging findings in athletes is unclear.

The challenge of deciding when imaging is appropriate

Although imaging is strongly discouraged for the general population with non-specific low back pain, there are cases where imaging is appropriate. Approximately 1% of low back pain cases in primary care present with a serious spinal pathology: examples include malignancy, fractures, inflammatory conditions or cauda equina syndrome [35]. The appropriate use of imaging in these cases can ensure patients receive a timely diagnosis and appropriate medical treatment to prevent serious complications including long-term disability or death. Unfortunately, discerning between cases of non-specific low back pain and low back pain caused by an underlying serious pathology is difficult, and clinicians often over-request imaging out of fear of missing an important diagnosis [36].

'Red flags' are findings on history and examination intended to alert clinicians to patients that might have a serious pathology, but many red flags endorsed in guidelines have unacceptably low diagnostic accuracy or are yet to have their diagnostic accuracy evaluated [37]. For example, the following red flags have low positive likelihood ratios (LR^+) for identifying malignancy (systematic review of eight studies, $n = 6622$): >50 years old (LR^+: 1.9–2.7 in primary care, four studies, $n = 4216$; LR^+: 1.7 in secondary care, one study, $n = 257$), insidious onset of symptoms (LR^+: 1.1 in primary care, one study, $n = 1975$) and failure to improve after one month (LR^+: 2.6–3.1 in primary care, two studies, $n = 2596$) [37].

Only a few red flags endorsed in guidelines are useful for identifying patients with a fracture or malignancy. Significant trauma and prolonged corticosteroid use have the highest positive likelihood ratios for identifying a spinal fracture (LR^+ range: 3.4–12.8 and 4.0–48.5, respectively), with different combinations of red flags providing even greater positive likelihood ratios (systematic review of 14 studies, $n = 14{,}088$) [37]. For malignancy, a past history of malignancy is the only red flag with acceptable diagnostic accuracy (LR^+: 0–14.7 in primary care, two studies, $n = 3101$; LR^+: 31.7 in accident and emergency, one study, n = 482) [38]. However, the value of a combination of red flags in predictive modelling is currently unknown [38]. Wise use of the correct alerting features can sensibly guide further diagnostic workup, but uncritical application of the wrong red flags will likely drive overuse.

Imaging for sport and exercise-related injuries and incidental findings

The harms of imaging sport and exercise-related injuries have not been established, but the high prevalence of incidental imaging findings in asymptomatic people should alert clinicians to the possibility that such findings are not necessarily contributing to a patient's symptoms. For example, rotator cuff abnormalities appear to be more common in asymptomatic (vs. Symptomatic) people from 20 to 29 (7% vs. 4%) and 30–39 years of age (21% vs. 14%) but not for those aged 40–49 (4% vs. 40%), 50–59 (10% vs. 61%) and 60 years or above (23% vs. 65%) (systematic review of 30 studies, n = 6112 shoulders) [39]. Superior glenoid labral tears were present in 72% of asymptomatic people aged between 45 and 60 years undergoing MRI (n = 53) [40], while the prevalence of any structural abnormality in asymptomatic people aged between 40 and 70 years undergoing shoulder ultrasound was 96% (n = 51) [41]. However, the low prevalence of full-thickness supraspinatus or infraspinatus tears (<10%) in the later study might highlight a finding that is more likely to be clinically important. For the cervical spine, disc bulges are present in up to 75% of asymptomatic people in their 20s, with the prevalence increasing with age (e.g. >90% of asymptomatic people in their 50s have a disc bulge) (cohort study, n = 1211) [42].

For the hip, cam morphologies are present in 37% of asymptomatic people (systematic review of 26 studies, n = 2114) [43] and between 12% and 68% of people with hip pain (systematic review of 30 studies, n = 10,949 hips) [44]. Although high-quality research is needed to confirm these findings – as most of the studies are at high risk of bias – it does raise concerns that routine imaging of athletes with hip pain could lead to overdiagnosis and overtreatment. For example, athletes with hip pain that receive imaging might be given a structural diagnosis to explain their symptoms, such as femoroacetabular impingement of the hip caused by cam morphology. As cam morphologies are linked to the development of radiographic osteoarthritis [45], arthroscopic hip surgery might be recommended under the assumption that 'fixing' these structural abnormalities will not only reduce an athlete's pain but also prevent future osteoarthritis. However, hip arthroscopy is effective at 'fixing' the structural cause of femoroacetabular impingement, and it does not prevent the development of osteoarthritis [46] and only provides a small benefit over education and physiotherapist-led exercise for reducing disability at 12 months (reduction of 6.8 points on a 0–100 scale, 95% CI: 1.7 to 12.0, randomised controlled trial, n = 348) [13]. A systematic review of 18 case series (level IV evidence) and 977 athletes also found that 87% of athletes return to some level of sports participation following hip arthroscopy for femoroacetabular impingement syndrome [47]. However, a recent observational study (n = 189, level III evidence) found that only 57% return to their pre-injury level of sports participation [48].

There is also low-quality evidence that following an ACL injury, radiographic changes do not correlate with symptoms. A longitudinal cohort studies of 154 male soccer players found that those who developed radiographic knee osteoarthritis following an ACL tear had similar symptoms and function compared to those who did not develop osteoarthritis [49]. Another longitudinal cohort study (n = 75 athletes) found similar findings; there was no correlation between radiographic patellofemoral joint osteoarthritis following an ACL tear and symptoms or function [50].

Imaging to predict future injury and guide return to sport decisions

There have been studies that have assessed whether imaging findings can predict future injury or guide return to sport decisions. However, further high-quality research is needed to support the use of imaging in this context. For example, abnormal MRI findings following a hamstring tear are not associated with an increased risk of future injury (e.g. hyperintensity, muscle involved, and injury grade and location; systematic review of 11 studies, n = 697 hamstring injuries) [51]. Only one study found that a certain type of intratendinous hamstring tear was associated with delayed return to sport (longitudinal cohort study, n = 65 hamstring injuries) [52]. However, another cohort study (n = 70 athletes) found considerable overlap in return to sport times between those with small and large intratendinous tears [53], which raises doubts about the clinical applicability of the findings from Pollock and colleagues [52].

There is low-quality evidence that physical examination findings are useful for predicting return to sport and could be considered an alternative to routine imaging for hamstring tears and high ankle sprains. However, more research is needed before firm conclusions are made. For example, a systematic review of 16 studies ($n = 1216$) found moderate-quality evidence that some clinical findings are useful for predicting return to sport time following a hamstring tear – such as magnitude of pain at the time of injury (three studies at high risk of bias, $n = 356$), patient-predicted return to sport time (one study at low risk of bias, $n = 74$) and clinician-predicted return to sport time (two studies at high risk of bias, $n = 141$) [54]. In addition, the proximal spread of tenderness following a high ankle sprain was correlated with return to sport time ($r = 0.68$, 95% CI: 0.34 to 0.86), while the extent of interosseous membrane injury on ultrasound was not ($r = 0.35$, 95% CI: −0.11 to 0.67) (prospective case series, $n = 20$) [55].

A systematic review provided evidence that asymptomatic people with Achilles or patella tendon abnormalities identified on ultrasound – such as hypoechogenicity, thickness and increased vascularity – are at increased risk of developing symptomatic Achilles [5 studies, $n = 274$ tendons; Relative Risk (RR) = 7.33, 95% CI 2.95 to 18.24] or patella (9 studies, $n = 590$ tendons; RR = 4.35, 95% CI 2.62 to 7.23) tendons [56]. These findings could have important implications for targeting injury prevention programmes towards those at risk of developing a symptomatic tendinopathy. However, some have challenged the usefulness of predictors of injury that have not had their test properties validated in relevant populations, and where an injury prevention program is yet to be proven to be more effective among those with the predictor of injury than those without [57].

When is it appropriate to prescribe opioids?

The use of opioid analgesics for the management of musculoskeletal pain has been the subject of considerable discussion and debate in recent years. The harms associated with long-term opioid use are well established, and there is emerging evidence that even short-term use (<1 week) is associated with serious risks, including dependence [58]. Conversely, opioids only provide a small analgesic effect for chronic musculoskeletal pain [59], while evidence supporting the effectiveness of opioids for acute musculoskeletal pain – including sport and exercise-related injuries – is limited.

Harms of opioids

Opioid use is associated with serious risks including dependency, addiction, tolerance, overdose and death [60,61]. Nearly 16 million people worldwide (1 per 400 people) – or approximately half of the 33 million people who use an opioid – suffer from opioid dependence [62]. Disability due to opioid dependence has increased by 70% since 1990 [62], and nearly 70,000 people die each year from an opioid overdose [63]. Many people misuse (between 21% and 29%) or become addicted to opioids (between 8% and 12%) [64] and continue to use opioids for a long term [65].

Opioid use among athletes

Data on the efficacy of opioids for the management of sport and exercise-related injuries are limited, but their use appears to be widespread. For example, a survey of 644 retired National Football League (NFL) players found that 52% used opioids during their career, with 71% of these players reporting misuse [66]. Opioid use among retired NFL players was three times higher than that in the general population, with 26% of those who used opioids during their career reporting the use of a prescription opioid in the last 30 days [67] and 15% of those who misused opioids during their career reporting misuse at the time of the survey [66].

Concerns over the use and potential misuse of opioids among athletes in the National Rugby League in Australia have prompted governing bodies to consider testing for the use of prescription drugs [68]. Further, opioids have been prohibited in competition for athletes involved in sports subscribing to

World Anti-Doping Code. This includes most competitions at national level or above, and all professional sports.

Opioid use and misuse are not only an issue for adult athletes. Compared to adolescent males not playing sport, those playing sport are almost twice as likely to be prescribed an opioid (observational study, n = 1540 and 4,187, respectively) [69,70] and over 10 times more likely to misuse an opioid [70]. Further, opioid misuse in adolescents appears to be influenced by which sport they play (observational study, n = 13,636) [71], which could reflect differences in injury prevalence or culture across sports, such as acceptance of opioids, and opioid seeking and prescribing behaviours.

Evidence for opioids

Most of the trials of opioids enrol patients with chronic pain and measure short-term effects. Hence, their efficacy and safety in acute pain (e.g. low back pain or sport and exercise-related injuries) and for long-term use in chronic non-cancer pain are largely unknown. Despite being classed as a strong analgesic, their effects on pain are similar to simple analgesics such as nonsteroidal anti-inflammatory drugs (NSAIDs). For example, the short-term analgesic effect of opioids for chronic low back pain (reduction of 10.1 points on a 0–100 pain scale, 95% CI: −13 to −7; moderate-quality evidence from 13 studies, n = 3419 participants) [59] is comparable to NSAIDs (reduction of 11.1 on a 0–100 pain scale, 95% CI: −13.8 to −8.4; moderate-quality evidence from 9 studies, n = 2537 participants) [72]. The recent SPACE trial (n = 238) demonstrated that opioids are not superior to non-opioid analgesics for improving pain intensity or pain-related function in people with moderate to severe chronic low back pain, hip osteoarthritis or knee osteoarthritis [73]. This context supports the current advice to avoid opioid use, if possible, and, if not, to use the lowest dose for the shortest duration possible.

Prescribing opioids when alternatives are ineffective

Today, clinicians face the challenge of adequately treating sport and exercise-related injuries amidst the harms of opioids and uncertainty around the effectiveness of simple analgesic alternatives in this context. It is, therefore, important for the clinicians to understand the benefits and harms of pharmacological alternatives, understand how to safely prescribe an opioid when alternatives are ineffective and practise shared decision-making.

Evidence and usage of simple analgesics

There is high-quality evidence that paracetamol is not superior to placebo for managing spinal pain (short-term reduction of 0.5 on a 0–100 pain scale, 95% CI: −2.9 to 1.9; one randomised controlled trial, n = 1526 participants) but is associated with abnormal results on liver function tests [74]. While NSAIDs are more effective than placebo for acute low back pain, the effect is modest (reduction of 6.4 points on a 0–100 pain scale, 95% CI: −10.3 to −2.5; moderate-quality evidence from five studies, n = 814 participants), and there is an increased risk of gastrointestinal adverse events (RR = 2.5, 95% CI: 1.2 to 5.2; high-quality evidence from three studies, n = 1167 participants) [72].

At this stage, there is more evidence on the harms of simple analgesics for sport and exercise-related injuries compared to benefits. For example, a review of medication usage at professional football (soccer) tournaments from 2002 to 2014 found that players taking NSAIDs were five times more likely to experience gastrointestinal cramps and bleeds, haematuria and cardiovascular events (e.g. arrhythmia and palpitation) than those not taking NSAIDs [75]. Despite this, more than half of male football players used NSAIDs during professional tournaments, up to one third used NSAIDs before every match and 10% inappropriately used more than one NSAID at a time [75]. Clinicians should, therefore, closely monitor an athlete for any adverse events and avoid prolonging treatment when there is little-to-no benefit.

How to safely prescribe an opioid

There will be cases where non-opioid treatments have been prescribed appropriately and are not improving a patient's symptoms, but before prescribing opioids, there are a number of steps a clinician should take.

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Risk mitigation strategies must be implemented to reduce the risk of serious adverse events. This includes an opioid risk assessment (including questions about a history of past or current substance abuse, the presence of a psychiatric disorder and a family history of substance abuse) and a patient–therapist agreement to have one prescriber, no early repeats, no loss replacements and a tapering plan [76]. Clinicians must also consider potential interactions between opioids and other drugs or diseases, include an upper dosing threshold, trial immediate release oral opioids first, regularly assess the patient's pain and activity and monitor for any adverse events or aberrant behaviours [76].

A time-limited course of low-dose opioid analgesia is also recommended, and clinicians should advise their patients to use the opioid medicine sparingly. Repeat prescriptions for opioids should be avoided, and use for more than 3 days is not encouraged in light of recent evidence to suggest the risk of long-term opioid use begins to increase after the third day of use and increases rapidly thereafter [58].

Tapering of the opioid should be considered for patients who are not improving (particularly if the patient is taking a morphine equivalent dose of ≥50 mg/day), at risk of overdose (morphine equivalent dose of >100 mg/day), demonstrating signs of misuse or overdose (e.g. confusion and slurred speech) or experiencing serious adverse events [76]. There is no gold standard tapering protocol, although a 10% decrease in dosage per week (or per month for patients who have been using opioids for a long term) is recommended [76].

Does my patient need surgery?

Deciding whether surgery is the best option for an athlete with a sport or exercise-related injury is complex because there are very few placebo-controlled trials and only a small number of comparative effectiveness trials comparing surgery to non-surgical alternatives. In addition, surgery is expensive, comes with risks and typically limits a patient from performing their usual activities for weeks, if not months.

Surgery for 'wear and tear'

The high prevalence of abnormal imaging findings in people without symptoms raises questions about the rationale for surgery that aims to 'fix' structural abnormalities. This is particularly relevant for sport and exercise-related injuries that do not have a traumatic mechanism (commonly referred to as 'wear and tear'), as the correlation between abnormal imaging findings and symptoms is poor.

Surgery evaluated in placebo-controlled trials

All of the placebo-controlled trials of orthopaedic surgery have been conducted in populations with 'wear and tear' and found that surgery is not superior to placebo. These trials investigated the efficacy of arthroscopy for degenerative meniscal lesions (n = 146) [77], arthroscopy for knee osteoarthritis (n = 180) [78], arthroscopic subacromial decompression (two studies; n = 313 and 210, respectively) [79,80], surgical excision of a degenerated portion of the extensor tendons for chronic tennis elbow (n = 26) [81] and others including percutaneous vertebroplasty, intradiscal electrothermal therapy for low back pain and tidal irrigation for knee osteoarthritis [82]. These trials provide high-quality evidence that the above surgical procedures are ineffective. In addition, as both arms in all of the above trials improved, the effectiveness of these surgeries is largely due to placebo (e.g. patient expectation), non-specific effects (e.g. fluctuation in symptoms and regression to the mean) or elements common to both arms (e.g. post-surgical advice and rehabilitation).

Surgery yet to evaluated

Many other surgical procedures for 'wear and tear' are yet to be investigated in placebo-controlled trials but are growing in popularity. For example, hip arthroscopy for femoroacetabular impingement has not been evaluated against a placebo and only provides a small benefit over non-operative management [13]. Nevertheless, the annual incidence of hip arthroscopy increased over 3-fold between 2004 and 2009 in the United States [4], over 7-fold between 2002 and 2013 in England [5] and more than doubled between 2007 and 2010 in Korea [6].

In light of the costs, risks and emerging evidence against surgery for 'wear and tear', clinicians must think critically about surgery that is it yet to be tested in a placebo-controlled trial. Further, with ongoing implementation of placebo-controlled trials of surgery, it is possible that surgeons will be unable to provide interventions that have not be proven safe and efficacious in randomised controlled trials, applying a similar standard of proof as required for drugs [82].

Surgery following musculoskeletal trauma

The assumption that most complete ligament, muscle or tendon injuries require surgery remains widespread. However, no surgery for these conditions has been evaluated against a placebo, and there is increasing evidence to support non-operative management for traumatic sport or exercise-related injuries, such as ACL tears and Achilles' tendon ruptures.

Anterior cruciate ligament reconstruction and unrealistic expectations

For many decades, ACL reconstruction was considered the only treatment that provided acceptable outcomes following an ACL injury and could return athletes to sport [9]. This likely explains why many athletes and teams have unrealistic expectations about surgery. For example, a prospective case-series of 181 athletes found that over 90% of athletes expect to return to their previous level of sports participation following an ACL injury [83]. However, only 65% of athletes return to their previous level of sports participation (systematic review of 69 studies, $n = 7556$) [84] and 23% experience a second ACL injury at some point (systematic review of 19 studies, $n = 72{,}054$) [85].

The same case-series also demonstrated that 98% of athletes expect little-to-no increase in their risk of developing knee osteoarthritis 10 years post-operatively [83]. However, approximately 40% of athletes will develop radiographic knee osteoarthritis 14–15 years following an ACL injury, with no difference between those who received surgery or non-operative management (longitudinal studies, $n = 154$ and 94, respectively) [49,50]. One study even found that 80% of athletes who received surgery ($n = 20/25$) and 68% who received non-operative management ($n = 17/25$) developed knee osteoarthritis 20 years after their ACL injury (between-group difference $p = 0.508$) [86].

Unrealistic expectations among athletes could lead to the belief that surgery will 'fix' their knee in both short and long terms. This belief becomes particularly problematic when an athlete experiences multiple injuries yet still pursues surgery to return to sport. Clinicians must, therefore, develop realistic expectations, share them with patients and explain that neither surgery nor non-operative management guarantees great outcomes.

Conservative management for anterior cruciate ligament tears

There is evidence supporting non-operative or delayed surgical management for ACL injuries (hereafter referred to as 'conservative management'). This should prompt the sports medicine community to question the reliance on early surgery as first-line treatment and encourage conservative management, as in some Scandinavian countries. The first randomised controlled trial to compare early ACL reconstruction ($n = 62$) to conservative management ($n = 59$) found no between-group difference across all outcomes and time points (up to 5 years), including pain, symptoms, activities of daily living, quality of life, sports participation and radiographic knee osteoarthritis [9,10]. However, given the size of the trial, there is a risk that important between-group differences were missed. This highlights the need for replication of these findings in large randomised controlled trials.

Over 50% of athletes initially treated non-operatively in the above trial opted for delayed surgery. This was largely due to episodes of instability and a lack of confidence in an ACL-deficient knee [9,10], suggesting that some athletes did not cope with non-operative management. There was no difference in sports participation between athletes who received surgery (early or delayed) and non-operative management [9,10]. However, the large number of athletes who opted for delayed surgery makes it difficult to determine whether all athletes can return to high-level sport following non-operative management alone. Further research is needed to answer this question, although ethical issues associated with withholding surgery will make it challenging.

Achilles tendon ruptures

Surgery is also not superior to non-operative management for Achilles tendon ruptures. A systematic review of seven randomised controlled trials comparing surgery to non-operative management found no between-group difference in Achilles tendon re-rupture rates or in the incidence of other complications such as nerve injuries and deep venous thrombosis [87]. The review also highlighted that outcomes following surgery and non-operative management are largely similar, but the lack of meta-analysis and size of the included trials raises concerns about the precision of these findings.

A randomised controlled trial comparing surgery (n = 49) to non-operative management (n = 48) found no between-group differences in hop and counter movement jump performance and plantar flexion power at 12 months. However, limb symmetry index (LSI) scores (ratio of performance between injured and uninjured leg) for a heel-rise endurance test were 10% high in surgical group at 12 months ($p = 0.012$) [88]. Another randomised controlled trial compared surgery plus accelerated rehabilitation (n = 49) to non-operative treatment including standard rehabilitation (n = 51). This trial found no between-group differences in symptoms, physical activity levels, self-reported performance of squatting, running and jumping, quality of life, plantar flexion power and heel-rise endurance at 12 months. However, LSI scores were higher in the surgical group at 12 months (13% higher for a hop test, $p = 0.040$; 9% higher during a counter movement jump, $p = 0.003$) [89]. There were two randomised controlled trials that assessed return to sport following an Achilles tendon rupture, but the results were conflicting. One trial (n = 111) reported that 57% of athletes treated operatively and only 29% treated non-operatively returned to their previous level of sports participation ($p < 0.005$) [90]. The other trial (n = 112) found that 54% of athletes in both groups were able to return to their previous level of sports participation [91]. More research is needed to determine whether there is a difference in return to sport outcomes between athletes receiving operative and non-operative management.

It is important that athletes are aware of the evidence for all available treatment options following an Achilles rupture and also that their expectations are aligned with the evidence. This will ensure patients are not swayed towards surgery in the hope of a ‘quick fix’. Just over half of athletes involved in sports that require repetitive jumping and sprinting return to their previous levels of sports participation following an Achilles tendon rupture [90,91]. For example, an observational study of professional basketball players (n = 18) found that only eight players returned to professional basketball for more than two seasons, while seven never returned [92]. Many patients also report symptoms, reduced quality of life and decreased physical activity levels and present with deficits in physical performance on their injured side 12 months after their injury (e.g. heel-rise endurance, hop and counter movement jump performance and plantar flexion power) [87,88], regardless if they receive surgery or non-operative management. Deficits can even be found in some outcomes six years after an Achilles tendon rupture (eccentric ankle power LSI scores: 81%–95%; concentric ankle power LSI scores: 82–85%), regardless of the initial management approach (observational study, n = 34) [93].

Does it matter how rehabilitation is delivered?

Few trials have compared rehabilitation to placebo or no treatment for sport or exercise-related injuries. Nevertheless, rehabilitation provides similar benefits to surgery for many sport injuries and could be a high-value alternative to surgery, which carries potential health risks. In this section, we highlight that the content of rehabilitation is of vital importance (provided there is adherence), while the mode of delivery of rehabilitation is negotiable. Awareness of the important aspects of rehabilitation could help athletes better manage their injuries and avoid overtreatment.

Rehabilitation following an ACL reconstruction provides a great example of how the content of rehabilitation is more important than how it is delivered. The primary goal of rehabilitation is to restore pre-injury knee function and address modifiable factors that increase the risk of re-injury, such as inadequate quadriceps strength, hop performance and agility (longitudinal study, n = 158) [94]. In doing so, the hope is that the risk of future knee osteoarthritis will reduce. Rehabilitation must, therefore, provide sufficient stimulus to drive strength and functional performance adaptations, while avoiding acute spikes in training volume or intensity that could increase the risk of injury [95]. It is also recommended that athletes wait at least 9 months before returning to sport as the risk of re-injury halves for every month return to sport is delayed up until 9 months post-surgery (longitudinal study, n = 106) [96] and time is strongly associated with meeting strength and performance milestones that reduce the risk of re-injury [94,96].

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Recommendations for post-operative rehabilitation of ACL injuries put a strong emphasis on the content, providing guidance about exercise selection and timeframes for progression [97]. In contrast, much less emphasis is placed on how post-operative rehabilitation is delivered [97]. This is because based on current research, home-based exercise appears to be just as effective as physiotherapist-delivered exercise following an ACL reconstruction [98–100]. For example, a randomised controlled trial of 40 athletes post-ACL reconstruction found that 20 sessions of physiotherapist-delivered exercise over 9 months (involving targeted calf and hamstring exercises, neuromuscular training, aerobic exercise and a graded return to sport) was not superior to an identical home-based program for improving function, hop test performance, strength, and sports participation [e.g. mean (range) Tegner Activity Scale at 12 months: intervention 6 [3–8] vs. control 5 [3–10], $p > 0.05$] [98]. Similarly, a randomised controlled trial of 145 athletes following ACL reconstruction found that 14 physiotherapy sessions involving a similar exercise program (SD: 4) was not superior to three sessions (SD: 1) (both complemented by home-exercise) for improving quality of life, range of motion, laxity and quadriceps or hamstring strength, even up to 4 years of follow-up (e.g. between-group difference in flexion range of motion at 2–4 years: MD = 0.7, 95% CI: −1.1 to 2.5, $p = 0.43$, $n = 66$) [99,100].

The addition of education addressing psychological readiness, kinesiophobia and adherence to rehabilitation, as well as different rehabilitation protocols could improve the value of physiotherapy in this population. However, trials confirming the value of different approaches to rehabilitation are needed before clear recommendations on the level of supervised physiotherapy for different populations (e.g. young vs older athletes and elite vs amateur), if any, are required in addition to home exercise. Furthermore, improved reporting of post-operative exercise protocols will not only assist clinicians to deliver evidence-based rehabilitation but also assist researchers identify limitations in existing exercise protocols and investigate more optimal approaches.

There are many other examples in the rehabilitation literature where simple interventions are just as effective as more intensive and potentially more costly interventions. The evidence supporting less intensive rehabilitation following hip and knee arthroplasty, lumbar surgery, arthroscopic rotator cuff repair and post-immobilisation of a fracture is outlined in Table 1. Clinicians must outline the evidence supporting different types of rehabilitation to their athletes and be comfortable providing simple interventions in cases where ‘more’ is not always ‘better’. This will help athletes decide on the most appropriate approach to rehabilitation based on their preferences and circumstances, such as socio-economic status and access to a rehabilitation provider.

Summary

Low-value care in sports medicine is receiving little attention in comparison to other fields of medicine, and more high-quality evidence is needed to guide the appropriate use of imaging, opioids, surgery and rehabilitation for sport and exercise-related injuries. This is important to enable well-informed clinicians to share evidence-based recommendations with patients and thus facilitate shared decision making within clinical sports medicine.

Imaging should be guided by clinical decision tools, the identification of valuable red flags, and if necessary, clinical judgement based on the findings from a thorough patient history and examination.

There is no evidence to support opioid use for sport- and exercise-related injuries but strong evidence demonstrating their harms. Clinicians should exhaust all non-opioid and non-pharmacological treatment options before considering a prescription for an opioid.

Surgery for sport and exercise-related injuries is rarely superior to placebo or conservative management. Hence, taking a less biased and ultimately more evidence-based approach is important for surgery that is yet to be evaluated against a placebo, particularly where conservative management is a viable first-line alternative.

Clinicians should recognise that the content of rehabilitation is far more important than how rehabilitation is delivered. Provided all essential components of rehabilitation are adhered to, intensive supervised rehabilitation is rarely superior to less complex interventions.

There will always be professional athletes willing to experiment with expensive and non-evidence-based interventions, and this will continue to drive low-value care in sports medicine. However,

Table 1
Evidence from systematic reviews and trials evaluating less intensive rehabilitation interventions.

Joint replacement surgery	**Knee arthroplasty** • Systematic review (five randomised controlled trials, n = 524) [101] o One-on-one outpatient rehabilitation is not superior to home-exercise for improving pain or function. • Randomised controlled trial (n = 249) [102] o One-on-one physiotherapy was not superior to group exercise or home exercise for improving range of motion, endurance (6MWT) and timed stair ascent and descent • Randomised controlled trial (n = 165) [103] o Intensive inpatient rehabilitation for 10 days followed by an 8-week home exercise program was not superior to home exercise alone for improving endurance (6MWT), pain and function (Knee Score) and quality of life **Hip arthroplasty** • Systematic review (five randomised controlled trials, n = 234) [104] o Physiotherapist-led outpatient rehabilitation is not superior to home exercise for improving gait speed (two trials), function, strength and power (one trial) and quality of life (one trial) following hip arthroplasty • Recent randomised controlled trial (n = 98) [105] o Physiotherapist-led outpatient rehabilitation was not superior to home exercise for improving WOMAC index scores, quality of life or strength (assessed by a Timed Up and Go test) • Cohort study (n = 51 following hip or knee arthroplasty) o Physiotherapist-led home exercise was not superior to a group exercise class for improving function, quality of life, strength, range of motion and endurance [106].
Lumbar disc surgery	• Cochrane review of randomised controlled trials (low- to very low-quality evidence) [107] o Structured exercise is superior to no treatment for improving pain (SMD = −0.90, 95% CI: −1.55 to 0.42; five studies, n = 272] and post-treatment functional status (SMD = −0.67, 95% CI: −1.22 to −0.12; four studies, n = 252) o There was no between-group difference in long-term functional status (SMD = −0.22, 95% CI: −0.49 to 0.04; three studies, n = 226) o Supervised exercise is not superior to home exercise for improving pain (SMD = −0.76, 95% CI: −2.04 to 0.53) and short-term functional status (SMD = −0.36, 95% CI: −0.88 to 0.15) (five studies, n = 229) • Recent randomised controlled trial (n = 169) [108] o Early rehabilitation was not superior to no referral to rehabilitation for improving pain, disability, perceived improvement and physical and mental health o Early rehabilitation resulted in higher medical costs and was not cost-effective than no referral to rehabilitation
Post-immobilisation of a fracture	**Ankle fractures** • Cochrane review [109] (four randomised controlled trials that investigated different exercise interventions, n = 366 − no meta-analysis) o No study provided evidence that structured exercise (with or without manual therapy and stretching) was superior to usual care for improving activity limitation, patient satisfaction, pain during functional tasks or range of motion **Distal radius fractures** • Systematic review (22 randomised or quasi-randomised controlled trials, n = 1299) [110] o Unable to conclude whether structured exercise is more effective than home exercise (three trials of 167 participants), or advice or no intervention (one trial, n = 56) for improving range of motion, grip strength and upper limb activity (PRWE) • Randomised controlled trial (n = 81) [111] o Accelerated rehabilitation was superior to non-accelerated rehabilitation for improving DASH scores at all time-points up to 12 weeks (reduction of 3 points at 12 weeks, 95% CI: 0.1 to 6.7) o There was no between-group difference in DASH scores at 6 months (MD = 2, 95% CI: −1.1 to 5.1) o Grip strength was the only objective measure that was significantly high in the accelerated rehabilitation group at 6 months (MD = 12 lbs, 95% CI: −21.0 to −1.9)
Arthroscopic rotator cuff repair	• Randomised controlled trial (n = 64) [112] o Passive stretching plus manual therapy twice per day (with no range of motion limits) immediately post-surgery was not superior to passive range of motion restricted to 90° flexion for improving range of motion

	o There was no between-group difference in the number of rotator cuff re-tears • Randomised controlled trial (n = 117) [113] o Supervised passive range of motion immediately post-surgery was not superior to delaying range of motion exercises for 4–5 weeks for improving range of motion or function (Constant score, Simple Shoulder Test score and American Shoulder and Elbow Surgeons score)
Rotator cuff tendinopathy	• Randomised controlled trial (n = 86) [114] o Usual physiotherapy was not superior to a self-management program involving a single exercise – where participants were offered follow-up sessions to support self-management and exercise progression – for improving pain and disability (Shoulder Pain and Disability Index), function (PSFS) and quality of life (Short Form-36)

N: number of participants; 6MWT: 6-min walk test; WOMAC: Western Ontario and McMaster Universities Osteoarthritis; SMD: standardised mean difference; MD: mean difference; PRWE: Patient-Rated Wrist Evaluation; DASH: Disabilities of the Arm, Shoulder and Hand; PSFS: Patient-Specific Functional Scale.

adopting an evidence-based approach to the management of sport and exercise-related injuries will ensure the science and practice of sports medicine continue to advance.

Practice points

- Imaging should be guided by clinical decision tools, the identification of validated red flags and findings from a thorough patient history and examination.
- The harms of opioid use far outweigh their benefits; hence, clinicians must exhaust all non-opioid treatment options before prescribing an opioid.
- Surgery should only be considered if conservative management is not a viable first-line treatment option, although clinicians should be cautious about surgery that is yet to be evaluated against a placebo.
- The content of rehabilitation is more important than how it is delivered, and at this stage, there is no evidence to support the use of intensive supervised rehabilitation over simple self-management approaches.

Research agenda

- High-quality research is needed to establish the importance of common lumbar imaging findings in athletes and whether there are any harms associated with routine imaging of sport and exercise-related injuries.
- Investigating the efficacy and safety of opioids in acute pain and for long-term use in chronic non-cancer pain is a research priority.
- Placebo-controlled trials of surgery for sport and exercise related injuries (e.g. ACL reconstruction) may help clinicians understand which surgical procedures are necessary and which are not.
- Large randomised controlled trials are needed to confirm existing evidence that surgery is not superior to non-operative management for ACL injuries, particularly for sports participation and risk of future knee osteoarthritis.
- Randomised controlled trials are needed to establish whether rehabilitation involving progressive strengthening and education addressing psychological readiness, kinesiophobia and adherence could improve the value of physiotherapy for athletes following an ACL reconstruction.

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Conflicts of interest

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