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Editorial

Physio First is not "us and them", it is you and me.

With this edition, my six-year tenure as Editor of our team that is *In Touch* comes to an end. It has been a truly fulfilling role and when I say I have worked with the best you know who you are. We have covered a wide range of topics over the 24 editions, thanks to the generosity of the many great people who have given freely of their time and expertise in order that we Physio First members might benefit and become more informed practitioners.

Physio First has always been for its members, made up of its members and driven by volunteers who are its members. It was never "us and them", it has always been "you and I" who are Physio First.

I have been a volunteer post-holder for more than 18 years and a Physio First member for even longer. Physio First has always been there for me, as a support structure as I worked through my career in private practice and, in recent years, by anticipating the changing issues in our marketplace to help us be MORE in the healthcare business environment.

So, what of the future?

Physio First will grow from strength to strength through its dedicated members, and its standing in the business community. Our organisation's vision has always been that members compete on quality rather than on having the lowest price forced on us. Validated data collection will drive the quality agenda throughout our profession, and being able to demonstrate Quality Assured Practitioner (QAP) and Quality Assured Clinic (QAC) status puts us ahead of the competition as it becomes the norm as a requirement for purchasers of physiotherapy. The innovation of the Physio Co-op will enable those who participate to influence our marketplace in a way that allows private physiotherapists to lead it, rather than react to it.

The place of *In Touch* in our Physio First future is in continuing to support our members by adding to our knowledge base and improving our outcomes. Thank you to all those who have contributed to this, my final edition, for meeting that important remit; it means a lot that you give so freely of your time and energy in making our publication happen.

I would like to take the opportunity to thank Helena for being such a great support, and Tobias who has been my "wing-man" for the past six years. *In Touch* wouldn't happen without you, and I look forward to seeing Tobias taking the on the reins of Editor.

Finally, I'm sure you will have noted that this edition is delivered in sustainable packaging. This has been something we have been striving towards for a while, aware that we need to be part of the solution to our plastic-filled world, so thanks to our Physio First executive, and our design and production team at Pages Creative for working hard to make this happen.

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The role of the gut microbiome in musculoskeletal rehabilitation

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It is generally accepted that adequate nutrition may assist in musculoskeletal recovery although precise guidelines are not available. Recent discoveries on the importance of gut microbes on human health have highlighted how the interaction between the gut microbiome and a person's diet has important effects on bones and muscle. In this article, we review what is the gut microbiome, the evidence of its impact on musculoskeletal physiology and discuss its implications for physiotherapy and rehabilitation.

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1 Appreciate the role of gut microbes in musculoskeletal physiology and the implications for physiotherapy and rehabilitation.
2 Understand the pathways leading to musculoskeletal pathology that are influenced by the gut microbiome.
3 Recognise the value of targeting the gut microbiome through dietary interventions for improved musculoskeletal outcomes.

Introduction

It is generally accepted that nutrition can help to minimise the impact of musculoskeletal injuries and improve the rate and quality of recovery. Each type of injury to bone, tendons, ligaments, muscles, etc., requires specialised nutrients to expedite the recovery process. Nutrients help with the production of new tissues and in enhancing the body's natural healing responses. For example, vitamin supplementation may help improve some of the outcomes of recovery (Tack *et al* 2018).

A large body of evidence exists showing that the microbes in the human gut have a strong impact on how nutrients are processed and how this can affect the diverse health and disease issues that are directly relevant to musculoskeletal rehabilitation. In this article, we review first what is the gut microbiome, then how the gut microbes impact bone and muscle metabolism, and how this may translate into benefits for musculoskeletal rehabilitation.

What is the gut microbiome?

The human gut microbiome refers to the collective genomes of the micro-organisms within the human digestive tract. There are approximately 100 trillion bacteria within the human gastrointestinal (GI) tract, which is roughly equal to the number of human cells within the body (Bull & Plummer 2014; Rath & Dorrestein 2012). The gut microbiota are mainly composed of strict anaerobes (Harris *et al* 1976) with the average person harbouring roughly 1,000 microbial species in the GI tract, most of which colonise the colon (Bull & Plummer 2014). While the human genome consists of approximately 23,000 genes, the microbiome encodes over three million genes producing thousands of metabolites (Vyas & Ranganathan 2012).

The gut microbes can be considered organisms, living in symbiosis with humans, that have evolved to undertake many metabolic functions that the human host is unable to do (Bull & Plummer 2014), consequently influencing the host's fitness, phenotype, and health (Rath & Dorrestein 2012). There is, therefore, an interplay between the gut microbiome and the musculoskeletal system that has potential practical implications on musculoskeletal rehabilitation.

There is great emphasis on evidence-based practice and physiotherapists are continuously seeking out up-to-date research, not only to enhance their own knowledge, but also with the aim of assisting their patients to return more quickly to work or play post-injury, or to explore how to maximise the athletic performance. One question commonly asked in physiotherapy clinics is whether there are any dietary products which may be of help with rehabilitation and / or performance and, indeed, the guidance of a physiotherapist on beneficial gut microbes can help patients / athletes with their outcomes.

"PATIENTS OFTEN ASK IF THERE ARE ANY DIETARY PRODUCTS THAT WILL HELP WITH REHABILITATION"

The composition of gut microbiome

Characterising microbiome composition most commonly involves DNA based methods. The microbial genes present in faecal samples or in colon biopsies are categorised using next generation sequencing methods, and this allows the characterisation of bacterial communities present in the human gut. These tests currently exist for research purposes only, so an individual who wants information on their own gut microbiome composition must rely on crowdfunding initiatives such as the British Gut Project (**britishgut.org/**) or the American Gut Project (**humanfoodproject.com/americangut/**), or find a private company willing to do it, something that is currently not regulated by health authorities.

A decade ago, it was thought that discovering the genetic basis of complex diseases, such as osteoporosis and osteoarthritis, would revolutionise health and pharmacotherapies. These days, we regularly read items in the popular press about the role of the gut microbiome. The analysis of the gut microbiome has become possible because it is now feasible to sequence and classify the thousands of different bacteria in the gut by using next generation sequencing or even shotgun sequencing on DNA extracted from human or animal faecal samples. This has allowed the scientific community to analyse and compare the gut microbial composition and correlate it with various health traits.

Although some of the claims may appear slightly more difficult to digest (**https://www.scientificamerican.com/article/gut-second-brain/**), the fact remains that gut microbes regulate fatty acid metabolism (Matey-Hernandez *et al* 2018), innate immunity (Thaiss *et al* 2016b) and inflammation (Buford 2017), all of which will have an effect on injury healing or post-surgical recovery and thus be relevant to different aspects of musculoskeletal rehabilitation.

How can gut microbes affect health in general?

Much of our knowledge of the function of gut microbes derives from preclinical animal models. These studies have shown major differences in immune, metabolic and neurochemical behavioural profiles in animals (mostly mice) that are raised under germ free (GF) conditions.

The intestinal immune system has developed a tightly regulated control to optimise protection against pathogens, while at the same time avoiding potentially harmful immune responses toward antigens from food and the microbiota (Hakansson & Molin 2011). The immune mechanisms implicated in the interactions with microbes can either be direct or indirect via metabolites, e.g. short chain fatty acids, bile acid derivatives, or breakdown projects from food components. It involves both T and B cells as well as the stimulation of chronic Th1 and / or Th17 cell responses (Hakansson & Molin 2011; Levy *et al* 2017).The relationship is bi-directional and interconnected in the sense that the host's immune response also modifies microbiome (Zhang *et al* 2015), virome composition (Zhang & Luo 2015), and the gene expression of microbes (Obata *et al* 2015).

Gut microbial enzymes contribute to bile acid metabolism generating unconjugated and secondary bile acids that act as signalling molecules and metabolic regulators influencing various important pathways in the host (Long *et al* 2017). The gut microbiota provides essential capacities for the fermentation of non-digestible substrates like dietary fibres and endogenous intestinal mucus. Fermentation of these non-digestible substrates supports the growth of microbes that possess the pathways for fibre degradation and leads to the production of short chain fatty acids (SCFAs) and gases (Wong *et al* 2006). The major SCFAs produced are acetate, propionate and butyrate. Butyrate, arguably the most important SCFA for human health, forms the main energy source for human colonocytes, can induce apoptosis of colon cancer cells and can activate intestinal gluconeogenesis having beneficial effects on glucose and energy homeostasis (De Vadder *et al* 2014). Propionate is transferred to the liver where it regulates gluconeogenesis and satiety signalling via interaction with the gut (fatty acid) receptors (De Vadder *et al* 2014). Acetate is the most abundant SCFA and is an essential co-factor / metabolite for the growth of other bacteria, reaches the peripheral tissues and is used in cholesterol metabolism and lipogenesis, and could play a significant role in central appetite regulation (Frost *et al* 2014). Short chain fatty acids have been found to be generally protective of diet induced obesity and insulin resistance (Lin *et al* 2012), and butyrate and propionate, but not acetate, have been found to control gut hormones and reduce appetite and food intake in mice (Lin *et al* 2012), although the effects may be site specific and dose dependent.

The gut microbiome also appears to play a role in the development and progression of obesity. Most studies of humans show lower diversity and dysbiosis in overweight and obese subjects. When microbes in faecal matter are transplanted from obese humans into germ free mice, these mice show an increased weight gain compared to mice that receive microbes from normal weight humans (Goodrich *et al* 2014). Additionally, studies in mice have revealed that intestinal microbiome configurations associated with obesity persisted during dieting and promoted faster weight gain after being transplanted into germ free mice, indicating that the microbiome might

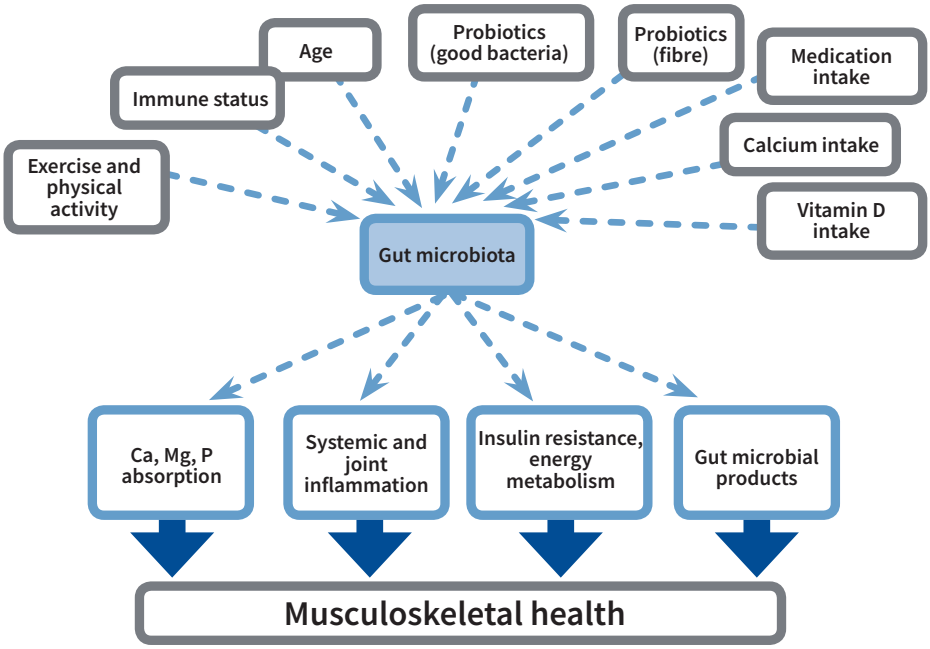

FIGURE 1: Diagram representing the various pathways via which the gut microbiota can influence musculoskeletal rehabilitation

contribute to weight regain, potentially explaining the so-called "yo-yo" effect (Thaiss *et al* 2016a). Much of the evidence comes from mouse models, but in addition long-term weight gain, i.e. over a period of 10 years, in humans correlates with low microbiome diversity (Menni *et al* 2017). This association was exacerbated in the presence of low dietary fibre intake (Menni *et al* 2017).

All these aspects can influence an individual's health and, as such, may be relevant to take into consideration as part of a holistic rehabilitation programme. More importantly, however, there are direct links between the gut microbiome and muscle, bone and joint biology which could have a more direct impact on MSK rehabilitation (figure 1).

The gut microbiome and muscle physiology

Injuries to muscles are a common cause of absence from training and competition in athletes. The muscle acts on bone through the tendon and the fascia. The failure of one or more of these structures results in various degrees of loss of function of the muscle(s) involved. Therefore, avoiding these injuries proactively and, if they happen, effective treatment for the injury, reduces the number of absences from training / sports sessions. This effectiveness can be achieved by the rehabilitation process, including adequate rest and taking dietary supplements.

As previously mentioned, several studies have highlighted the key role of the microbiome in insulin resistance and inflammatory pathways. Considering the role of skeletal muscle in glucose metabolism, animal studies have investigated the relationship between gut microbiota and skeletal muscle metabolism. For example, skeletal muscle in mice that have bacteria in the gut have altered metabolic efficiency compared to the germ free mice that have no gut microbes (Backhed *et al* 2007). When gut microbes are transferred from obese pigs to germ free mice, the muscle fibre characteristics and the metabolic profile of the skeletal muscle of the obese pigs were replicated in the recipient mice (Yan *et al* 2016), highlighting the importance of the gut microbiome in skeletal muscle composition and metabolism. Some of the muscle fibre changes noted were similar to those seen in aging skeletal muscle, e.g. increased proportion of slower contracting fibres. This raises the possibility that faecal microbial transplantation could be used as a means to transmit muscle fibre characteristics between humans, perhaps even from young to old, as a means of improving skeletal muscle function by altering its structural composition (Yan *et al* 2016).

Gut microbiota modulation in animal models has produced preliminary supportive data for an effect on skeletal muscle. For example, it has been reported that muscle mass and function, measured by grip strength and swim time, is increased in healthy mice that have been supplemented with the bacterium L. plantarum (Chen *et al* 2016). Such studies suggest that targeting the gut microbiota may be used as a tool to modulate muscle mass. To date, two probiotic randomised controlled trials have shown improvements in athletic performance among elite athletes. A small, four-week trial of probiotic capsules in male runners reported increased run time to fatigue in the probiotic group (Shing *et al* 2014), while a trial of probiotic yoghurt in teenage female endurance swimmers reported improved aerobic performance (Salarkia *et al* 2013).

A later randomised controlled trial of 60 adults aged 65 years and older explored the effect of modulating the gut microbiota on muscle function and frailty. Participants received either a prebiotic (F-GOS), or a placebo over a period of 13 weeks, and both exhaustion and handgrip strength were shown to significantly improve in those receiving the prebiotic treatment (Buigues *et al* 2016).

> "THERE IS A POSSIBILITY THAT FAECAL MICROBIAL TRANSPLANTATION BETWEEN HUMANS COULD BE USED TO ALTER SKELETAL STRUCTURAL COMPOSITION"

"A GOOD GUT MICROBE PROFILE CAN IMPROVE THE PROFILE OF SKELETAL MUSCLES"

The strengthening of muscles is a key element in the rehabilitation of both the athlete and the frail patient. Given the strong correlation between muscle cross-sectional area and muscular strength (Maughan *et al* 1983; Schoenfeld 2010), increased muscle mass is a primary goal of athletes or patients involved in strength training or in rehabilitation for return to normal life. Genetic background, age, gender, and other factors have been shown to mediate the hypertrophic response to a training protocol, affecting both the rate and the total amount of gains in lean muscle mass (Kraemer *et al* 1999). A physiotherapist should also consider the importance of gut microbes and their role in the rehabilitation of the patient / athlete. A good gut microbe profile can be achieved by eating fibre rich diet, taking probiotic supplementation and / or avoiding medications that kill "good" gut microbes, all of which will ultimately improve the profile of skeletal muscles via aforementioned pathways.

The gut microbiome and bone metabolism

Bone metabolism is regulated by a bone turnover process that depends on the balance between osteoblasts and osteoclasts. The effects of the immune system as modulated by the gut microbiome on bone remodelling have been investigated in several recent studies. It has been reported that gut microbes microbiota exert anti-anabolic effects (suppressing osteoblastogenesis) and pro-catabolic effects (enhancing osteoclastogenesis) in mice (Novince *et al* 2017).

The influence of microbiota and probiotic treatment has been studied in hormone deficiency induced osteoporosis models. Hormone deficiency can be induced experimentally by surgical ovariectomy. Britton *et al* (2014) showed that using the probiotic treatment Lactobacillus reuteri significantly protected mice from bone loss after ovariectomy in association with reduced levels of a bone resorption marker and decreased osteoclastogenesis. Supplementation with the probiotic Lactobacillus reuteri suppressed ovariectomy induced pro-osteoclastogenic bone marrow lymphocytes and directly suppressed osteoclastogenesis in vitro (Britton *et al* 2014). Similarly, Ohlsson *et al* (2014) found that treating mice with either the single Lactobacillus strain, or a mixture of three probiotic strains, protected mice from the ovariectomy induced cortical bone loss and bone resorption. This protection was associated with altered inflammatory profiles (Ohlsson *et al* 2014).

In addition, it has been shown that gut microbiome composition influences the absorption of key vitamins and minerals such as calcium, magnesium and vitamin D (Whisner & Castillo 2018), all of which are crucial to bone metabolism and play a role in musculoskeletal rehabilitation (Tack *et al* 2018).

In a recent double-blind, placebo controlled study, women from the population who were 75 to 80 years old and had low bone mineral density (BMD) were randomised to receive orally the probiotic Lactobacillus reuteri or a placebo daily, which found that supplementation reduced loss of tibia total volumetric BMD compared to the placebo (Nilsson *et al* 2018), suggesting that the results in animals are directly relevant to humans and that bone remodelling can be influenced by probiotic supplementation.

Aging results in loss of muscle and progressive bone loss, leading to bone fragility and increased risk for osteoporosis and fractures (DiGirolamo *et al* 2013; Marques *et al* 2011). Age-related sarcopenia may coexist with osteoporosis, establishing a vicious cycle between dysfunctional muscle and bone. Exercises help to improve the bone density and muscle strength (Marques *et al* 2011; Daly *et al* 2008; Fehling *et al* 1995; Morel *et al* 2001; Menkes *et al* 1993; Maïmoun & Sultan 2011) and physiotherapists use evidence of the efficacy of exercise to promote healthy lifestyles. It is worth remembering that gut microbes have an important role in bone remodelling and, as previously mentioned, in reversing the sarcopaenia through endocrine pathways.

The gut microbiome, arthritis and the joints

Studies with intestinal microbiota have shown that inflammatory forms of arthritis, characterised by changes in gut microbiome composition, compared to controls. In fact, there is considerable evidence linking intestinal dysbiosis with the autoimmune mechanisms involved in the development of rheumatoid arthritis (Horta-Baas *et al* 2017), ankylosing spondylitis (Babaie *et al* 2018) and psoriatic arthritis (Chimenti *et al* 2018). Furthermore, the gut microbiome also influences cartilage metabolism; altered gut microbiome composition that make mice less prone to metabolic syndrome result in less cartilage damage in response to increase joint loading compared to obese and wild type mice (Guss *et al* 2019).

These studies suggest that targeting the gut microbiome can have a beneficial bone, muscle and joint metabolism. However, to date, most studies are derived from animals and there are no routine clinical tests to assess an individual's microbiome composition. On the other hand, the available clinical trials of dietary interventions using pre- or probiotics very promisingly suggest that targeting the gut microbiome can have substantial effects on musculoskeletal traits. It is therefore to be hoped that future clinical research will focus on the joint effects of traditional physiotherapy along with dietary supplementation to assess whether patients recovering from

surgery or injuries, or facing disabling conditions such as arthritis, can obtain greater improvement using a combined approach. This could be an interesting research project. Additionally, dietary supplementation will give patients a greater role and ownership in their rehabilitation process.

So, while this this article has tried, based on the evidence available to date, to answer the question: "Is there a diet which will help my condition?", there is a need of further well-designed studies which explore and concrete the evidence of the importance of gut microbes as a useful clinical tool for the physiotherapist to offer training athletes, and rehabilitating patients.

About the authors

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Red flags in the management of people with low back pain

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Red flags have become an essential and integral component of the clinical examination, but questions have been raised as to whether they are currently used in the most effective way to help in the clinical decision making regarding potential serious pathology in the spine. Have red flags moved away from their original purpose, which was to prompt further enquiry and / or examination, and developed into a screening tick list to reassure clinicians?

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1 Review the background evidence relating to red flags.
2 Explore the current role and purpose of red flags in a clinical setting.
3 Discuss the reasoned approach to how clinicians use red flags for their future decision making.

Introduction

Red flags have been used extensively in musculoskeletal physiotherapy, specifically in the management of low back pain (LBP), since 1994 to help clinicians identify and manage potential serious pathology. The Clinical Standards Advisory Group (CSAG 1994) highlighted and recommended the use of these red flag triggers in their report. This seminal piece of work brought together the evidence available at the time to develop three diagnostic categories for low back pain:
1. simple back ache (mechanical / non-specific back pain)
2. nerve root pain
3. red flags (potentially serious spinal pathology)
with two additional sub-categories added:
4. Cauda Equina Syndrome (CES)
5. inflammatory disorders.

These categories are still broadly used today, even if some of the terminology has been revised, and they provide a solid basis for the diagnostic triage of patients with low back pain. The CSAG group also acknowledged that back pain is a bio-psychosocial issue and should be treated in a much broader, holistic way, which was a big step forward at the time.

The work of CSAG was important in bringing together the evidence at the time and for advising clinicians on the development and management of care pathways for this patient group. Their work also coincided with the development and expansion of extended scope roles for physiotherapists working in this field, and provided a basis for a competency framework for the further expansion of these roles.

The CSAG group also outlined several key "red flags" for people with back pain. They suggested that the following factors should alert the clinician to potentially serious spinal pathology, and advised consideration of onward referral and further management if patients presented with any of the following:

- age of first onset of severe spinal pain <20 or >55 years of age
- violent trauma (RTA / fall from height)
- constant, progressive, non-mechanical pain
- night pain
- Thoracic pain
- past medical history of carcinoma
- systemic steroid use, drug abuse, HIV
- systemically unwell
- weight loss
- persisting severe restriction of lumbar flexion
- widespread neurology
- structural deformity.

These red flags were drawn from clinical consensus and best practice available at the time. Over the years, these were expanded to include additional subjective and physical examination red flags which were included in numerous clinical guidelines for the management of low back pain (Waddell *et al* 1996; Mercer *et al* 2006; Koes*et al* 2010; Delitto *et al* 2012; NICE 2016).

The inclusion of so many red flags in so many guidelines poses a problem for the treating clinician and for those

> "A PREVIOUS HISTORY OF CANCER WAS THE ONLY RED FLAG ASSOCIATED WITH INCREASED LIKELIHOOD OF METASTATIC SPINAL DISEASE"

commissioning services. The real issue for the clinician is "what should I do if I identify a patient with a red flag?"

The role of red flags today

Many current guidelines explicitly state that if a patient presents with one or more red flags, then they should be referred on urgently for a specialist opinion (Van Tulder *et al* 2006; Verhagen *et al* 2016). While at first glance this might seem straightforward and appealing, the reality is somewhat different. The clinical utility and value of red flags has been questioned by many over the years, and the move toward a more nuanced and clinically useful tool has gathered significant momentum. Moffett *et al* (2006) advised clinicians: "do not uncritically accept one red flag in isolation – the context is crucial". Similarly, Underwood (2009) said "the evidence underpinning red flags for malignancy is weak", and Underwood & Buchbinder (2013) stated that red flags were "a popular idea that didn't work and should be removed from guidelines". Henschke & Maher (2006) recognised that there were challenges in the use of red flags and suggested that they undertook further evaluation.

Red flags are also very common in patients who have been shown to have no serious spinal pathology. Prekumar *et al* (2018) found that 96% of people with back pain had night pain but no serious pathology, and 80% of people with LBP and no serious pathology have been shown to have at least one red flag (Hartvigsen *et al* 2018). Equally challenging is that 64% of patients with serious pathology in the form of spinal malignancy had no red flags (Prekumar *et al* 2018).

Greenhalgh & Selfe (2009) acknowledged that there was an "almost overwhelming profusion of red flags", citing work by Roberts *et al* (2005) that had identified 119 items in the subjective history and 44 in the physical examination that had been identified as red flags in the literature. In a review of the various red flags mentioned in 16 current guidelines for the management of low back pain, Verhagen *et al* (2016) identified 46 separate red flags covering specific conditions: malignancy (14), fracture (11), infection (12) and CES (9). There were also 23 red flags that were not condition specific. They found a lack of consensus between guidelines and a lack of evidence for the accuracy of the red flags that were mentioned.

Cook *et al* (2017) summarised the evidence for red flag screening in a narrative review, concluding that there's "nothing to see here, move along". While this may appear dismissive of what has been a cornerstone of espoused best practice, the approach is supported by the evidence, where very few of the red flags have good evidence to support their use as prognostic tools. However, there are some red flags that have been shown to be helpful in predicting serious pathology.

Downie *et al* (2013) reviewed the evidence for the predictive value of red flag screening for patients with spinal malignancy and fracture. They concluded that of all the red flags for LBP, only a previous history of cancer indicated an increased likelihood of spinal metastatic disease. For spinal fractures, only age, a previous history of fracture and a history of cortico-steroid use were associated with an increased risk of fracture. These findings were further supported by the work of Henschke *et al* (2013) who found, similarly, that a previous history of cancer was the only red flag associated with an increased likelihood of metastatic spinal disease.

Spinal infection is similarly challenging to diagnose, particularly in the early stages, as many of the classic features are not present (Lener *et al* 2018). While pain is present in up to 90% of cases, this does not help to differentiate the cause (Nagashima & Tanida 2018). Only around 50% of patient with spinal infection will present with fever, and 30-70% will present with no sign of infection at all (Lener *et al* 2018; Nagashima & Tanida 2018). The low specificity of signs and symptoms is acknowledged, though guidelines still suggest that worsening pain associated with a fever, a fever and pain associated with a recent diagnosis of sepsis and increasing erythrocyte sedimentation rate (ESR) and c-reactive protein (CRP) associated with pain, should prompt the clinician to further investigation (Elie *et al* 2015).

For CES, the picture is equally as challenging. The correlation between clinical presentation of CES and a positive scan is between 14-48% (Fairbank 2014) and there is little evidence to support the use of any one of the CES signs and symptoms to predict diagnosis and outcome. Indeed, it has been suggested that guidelines relating to CES should be re-written to exclude many of the current CES red flags, which Todd (2017) call "white flags"; essentially symptoms that have very little hope of recovery, such as incontinence and urinary retention. Tests such as anal tone testing have been shown to poorly predict positive MRI scan findings (Domen *et al* 2009; Gooding *et al* 2013; Ahad *et al* 2015). The sensitivity and specificity of this and other tests was explored by Balasrubian *et al* (2010) and of all the tests, saddle sensation testing has the highest predictive value for a positive finding on MRI scan.

In a retrospective review of nearly 10,000 patients with predominantly LBP, Prekumar *et al* (2018) concluded that negative responses to red flag questions

should not reassure the clinician about the absence of serious pathology. Equally, they concluded that positive responses to red flag questions should not lead the clinician to conclude that the patient has serious pathology, i.e. infection, cancer, fracture and CES, though in certain conditions the likelihood may be increased.

The future of red flags in clinical decision making

So, where to go with this challenge? Clearly there is a move to try to improve the way we use red flags. The red flags themselves have been shown to have generally poor predictive value and the error perhaps has been in the interpretation of these items rather than the items themselves. Use of red flags as a starting point in the examination, as a prompt to the clinician to explore further and question the patient more closely, should be helpful. This approach is a much more qualitative one and has the potential to broaden the depth of questioning of each patient and guide their management. An approach centred around careful questioning and developed clinical reasoning may prove more beneficial than a reliance upon quantitative and experimental evidence, which has been shown to be lacking (Malterud 2001).

As a result of the change in perception of the role of red flags, and the recognition of the evidence that they have poor predictive value for serious pathology, a need was identified to develop a tool to support clinical decision making around red flags in the spine. An international research collaboration, led by the International Federation of Orthopaedic and Manipulative Physical Therapists (IFOMPT), has been established. The group consists of Sue Greenhalgh, Laura Finucane, James Selfe and myself from the UK, and James Benecuik from Canada, Aaron Downie from Australia, Bill Boissonault from the USA, and Annalies Pool and Arianne Verhagen from the Netherlands. This group is aiming to develop a clinical decision making tool to help clinicians reason their way through various potentially concerning spinal clinical presentations.

This project has been supported by grants from the CSP, the MACP and more recently the Physio First Private Practitioners Educational Fund (PPEF), and is due to conclude at the end of 2019. The generous £30,000 project grant from the PPEF Scheme A2 has enabled the team to employ a research assistant and provide dedicated time for team members to push this work forward. The project has several stages.

PHASE 1: SYSTEMATIC REVIEWS

Systematic reviews (SRs) have been used, or, where not available, have been undertaken to evaluate and summarise available evidence, to support clinicians in identifying red flags in patients who may have one or more of the four serious spinal pathologies: malignancy, fracture, infection and CES. The findings from the SRs will be used to frame the questions to be used in the second phase of the study.

PHASE 2: CONSENSUS / RATING PHASE

The purpose of this phase is to establish a consensus on which red flags are important in identifying each of the four serious pathologies. The Haute Autorité De Santé (HAS)method will be used to establish consensus between experts in the field through an iterative and feedback process. The HAS method helps to formalise the degree of agreement among experts by identifying and selecting, through iterative ratings with feedback, the points on which experts agree, disagree or are undecided. The guidelines are subsequently developed based on the agreement points. These experts are being identified from a worldwide group from multidisciplinary backgrounds, to include physiotherapists, osteopaths, chiropractors, spinal surgeons, oncology physicians, patient representatives, among others. The group will be asked to rate particular statements relating to each pathology, for example, “A past history of cancer is considered an important red flag in identifying malignancy”. Each statement will be rated between 1 and 9, 1 being totally inappropriate and 9 being totally appropriate. Statements will be considered appropriate when the median score is seven or above and all scores are five or above. This phase will consist of two rounds with analysis of the results between the rounds undertaken by the steering group. This part of the research is taking place from January 2019 and will inform the phases 3, 4 and 5.

> “IT HAS BEEN RECOGNISED THAT RED FLAGS HAVE POOR PREDICTIVE VALUE FOR SERIOUS PATHOLOGY”

PHASE 3: DRAFTING OF FRAMEWORK

Following the two rounds of the consensus process, draft recommendations for a framework will be developed by the steering group.

PHASE 4: INTERNATIONAL PEER REVIEW

The draft recommendations will be presented to an international peer review group for their opinion and input. This peer group will consist of up to 50 worldwide clinicians from a similar range of background to those in Phase 2 of the study.

PHASE 5: FRAMEWORK DEVELOPMENT

The final phase of the project will involve the steering group developing the clinical reasoning framework for clinicians, using the results from Phases 1 - 4. Once complete, this framework will be disseminated through publication and conference presentation, nationally and internationally, to reflect the international nature of the team involved and the input of the participant. The international IFOMPT network will also be used to disseminate the findings.

It is hoped that this piece of work will conclude with a pragmatic and useful tool that will support physiotherapists in their clinical decision making, by providing a clear reasoning pathway to help clarify the role of red flags in the management of these patients. Far from challenging and diminishing the role of red flags, it should offer additional support for their continued use as part of a thorough and reasoned examination. It is also anticipated that the framework will offer a safety net for patients where there are potential concerns and give clinicians the confidence to undertake watchful waiting where appropriate, rather than rush to unnecessary imaging or intervention.

About the authors

Chris is a past Chair of the MACP and has worked on numerous national guideline development committees relating to spinal pain. He is currently Chair of the Education Awards Panel and the CSP and a Trustee of the CSP Charitable Trust. He works closely with his co-authors.
Sue is a Clinical Fellow at Manchester Metropolitan University and is on the National Low Back Pain Steering Group. She has both led and been involved with a number of research studies and is currently leading a qualitative study into the experience of FCP.
Laura, a past Vice Chair of the MACP and the current Vice President of IFOMPT, is leading on the current project. She has worked with the authors in publishing and developing courses and research in the area of serious pathology.

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Other resources

British Orthopaedic Association (BOA) www.boa.ac.uk/pro-practice/

The evolving role of the musculoskeletal physiotherapist in the management and rehabilitation of patients living with cancer

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As cancer survival rates improve and patients live longer, there is much that physiotherapists can do to help them return to as full and healthy a life as possible; enabling them to build the confidence to return to work and to sport and other activities that enrich and add quality to their lives. This article explores how we can collectively contribute to improve our skills and access to resources to help meet the needs of those of our patients who are living with cancer.

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1 Consider the evolving role of the private practice physiotherapist in the management of patients living with cancer, often referred to as cancer survivors (CS), and how this could be developed and improved.
2 Help increase awareness of skills and confidence in the physiotherapy management of CS.
3 Highlight resources, courses, appropriate research articles, references and reading material readily available.
4 Consider how the clinical decision-making skills for ascertaining what range in the spectrum of "red flags" is safe and appropriate to treat.

Introduction

There are more than 2.5 million people living with cancer in the UK and this is predicted to rise to 4 million by the year 2030 (National Cancer Survivorship Initiative 2015; Lait 2018). Each year 300,000 people are diagnosed with cancer and around half of these are of working age (Chartered Society of Physiotherapy 2012, 2017). As the diagnosis and treatment interventions for cancer improve, the mortality rates decrease. Of the 58,000 women a year diagnosed with breast cancer, 85% are now surviving beyond five years (Kenyon *et al* 2018), with two out of three of these women now expected to live for 20 years or more beyond their cancer diagnosis (Bruce *et al* 2018). Many more people are now living with cancer and returning to work, sport and their other normal activities, and aiming to improve the quality of their lives, fitness and wellbeing. (Dorland *et al* 2016; Malone *et al* 2017).

The National Cancer Institute's definition of a cancer survivor is: "one who remains alive and continues to function during and after overcoming a serious hardship or life-threatening disease… and who is considered to be a survivor from the time of diagnosis until the end of life." (**https://www.cancer.gov/publications/dictionaries/cancer-terms/def/survivor**)

It defines cancer survivorship as focusing on "the health and life of a person with cancer post-treatment until the end of life. It covers the physical, psychosocial, and economic issues of cancer, beyond the diagnosis and treatment phases. Survivorship includes issues related to the ability to get healthcare and follow-up treatment, late effects of treatment, second cancers, and quality of life." (**https://www.cancer.gov/publications/dictionaries/cancer-terms/def/survivorship**)

Many CS patients endure complications that arise from post-cancer interventions such as surgery, chemotherapy, radiotherapy or targeted immunotherapy. These complications can be debilitating, distressing and can interfere with, and hinder, recovery. As a result, increasing numbers of patients are seeking help for these complications from healthcare professionals, including physiotherapists. Evidence reveals, however, that for many their needs are unmet. The National Cancer Survivorship Initiative (NCSI) and Macmillan Cancer Support are consequently advocating a shift in cultural awareness of this growing population, and for enhancing the provision of services that enable and support these patients in returning to work and improving wellbeing and outcomes. The NCSI outlines a framework for cancer survivorship in five steps:

1. providing information and support from the point of diagnosis
2. promoting recovery
3. sustaining recovery
4. managing the consequences of recovery
5. supporting patients with active and advanced disease.

This framework highlights the role of the healthcare professional in enabling and supporting the cancer patient at all stages of their survivorship and,

"WE CAN DO A LOT TO SUPPORT THE CANCER PATIENT AT ALL STAGES OF THEIR SURVIVORSHIP"

while there is already much we as physiotherapists offer in this respect, there is also much we could do better to support and help these patients towards recovery, self-management and improving their quality of lives through all stages of their journey, from diagnosis to intervention and beyond.

Unfortunately, there is relatively little study on the effectiveness of physiotherapy in treating the complications of cancer intervention, although there is some research on the effectiveness and benefits of exercise for the range of cancer diagnoses, and at different stages of cancer treatments (Sheill *et al* 2018; Lowe *et al* 2016; Lin *et al* 2016; Pyszora *et al* 2017). For example, the UK PROSPER trial is a large randomised controlled trial (RCT) aimed at assessing the effectiveness of a physiotherapy led exercise programme to help prevent shoulder problems in women following breast cancer surgery (Bruce *et al* 2018). There are also some studies on the benefits of massage and advice to help minimise the effects of lymphoedema (Leclerc *et al* 2016; Richmond *et al* 2018). However, with regard to both the role of the physiotherapist, and the effectiveness of different treatment modalities used for the management of CS patients with musculoskeletal (MSK) complications, published research is minimal. As Fourie & Robb (2009) noted: "Axillary web syndrome (AWS), also described as cording, is recognised as one of the impairments following breast cancer surgery, yet there are no formal guidelines on which to base therapy interventions." Almost a decade later this still seems to be the case (Kenyon *et al* 2018).

A growing number of MSK physiotherapists, together with leading cancer specialists, have identified a need for supporting these patients and for the prioritisation of more research and healthcare provision. However, NHS resources are limited, overstretched and struggling to meet this growing demand for treating MSK problems arising from cancer care complications, and many patients are turning to non-cancer specialist settings, including private physiotherapist practices for help. As Lait (2018) recommends: "we need to look to the wider physiotherapy workforce to upskill people in cancer care."

The public health cost for addressing and treating the complications of cancer treatment is rising significantly. It has been estimated that the annual cost to the economy of lost working days with CS patients is £5.3 billion (NCSI 2015). Many health complications, whether they appear months or even years down the line, can be long lasting and so can be considered a chronic condition (Kenyon *et al* 2018; Malone *et al* 2017; Dorland *et al* 2016). Physiotherapy is, therefore, expected to become an increasingly important option in the rehabilitation of post-cancer patients as a way of enabling them to return to work and fitness levels, regain their independence and so improve their quality of life (Alappattu *et al* 2015). This, in turn, could make an increasingly valuable contribution to reducing public health costs.

The long-term management and rehabilitation of patients, post-cancer intervention, is an emerging and growing field for all multidisciplinary health professionals. However, many MSK physiotherapists are fearful and apprehensive of treating patients with a diagnosis of cancer (Lait 2018; Kenyon *et al* 2018). The reason for their lack of confidence is understandable. When I qualified as a physiotherapist in the early 1980s, MSK physiotherapists were constantly informed and reminded that we didn't treat patients with cancer symptoms because of the possibility of disturbing the underlying tumour or any undetected metastases. While Grieve (1984), an early pioneer of MSK manual therapy skills, advised that "previous malignancy in other than spinal tissues need not contraindicate mobilisation of spinal joint problems so long as the possibility of metastases can be reasonably excluded and treatment is prudent", Greenhalgh & Selfe reminded that a history of malignancy is one of the "red flags" or physical indicators of serious pathology (Greenhalgh & Selfe 2006, 2010), that needs to be taken into consideration as part of the clinical reasoning process when assessing patients and determining a course of physiotherapy intervention.

Kenyon *et al* (2018), citing Hunt, points out that "leading specialist cancer physiotherapists in England have identified a general lack of leadership and understanding of cancer rehabilitation among the NHS workforce. These findings of fear and vulnerability in practice indicate a need to ensure that assessment and treatment of cancer related impairments are included in undergraduate and continuing education programmes, research initiatives and professional discourse. This is particularly important to support physiotherapists treating people… in non-cancer settings, such as community rehabilitation, general MSK outpatients and women's health services!" (Kenyon *et al* 2018).

The CSP special interest group, the Association of Chartered Physiotherapists in Oncology and Palliative Care (ACPOPC), Macmillan Cancer Support and the NCSI, in line with a developing field of research in the overall management of cancer, are all driving to expand and improve this infrastructure and all have a range of information in downloadable pdf format, the titles of which are listed under the useful resources or references section at the end of this article.

There is, however, no "rough guide" from which to draw in-depth guidance

> "MANY PHYSIOTHERAPISTS ARE FEARFUL OF TREATING PATIENTS WITH A DIAGNOSIS OF CANCER"

so MSK physiotherapists already working in this field have had to use their clinical reasoning skills and experiences for assessing the risk: benefit ratio of treating a patient with what would normally be considered "red flag" presentations (Leerar *et al* 2007). This can be a daunting position to be placed in as a practitioner and MSK physiotherapists often feel isolated and unsupported.

In the qualitative study of British MSK physiotherapists' experiences of working with women who had had surgery for breast cancer, Kenyon *et al* (2018) found that these physiotherapists have developed their own evidence base drawn from their documented clinical findings, outcome measures and clinical reasoning skills. The observed positive responses in their patients has given them the confidence to continue and build up their expertise.

There is certainly a need for more physiotherapist and healthcare professionals to receive training in this area of patient care, but while there are a handful of international, ground-breaking educators, such as Willie Fourie, a physiotherapist from South Africa who, for two decades has offered excellent courses on the assessment and treatment of post-mastectomy soft tissue impairment, and Michelle Lyons who lectures extensively in the USA and the UK on the complications and management of post-treatment gynaecological and prostate cancers, there are few post-graduate courses in the UK and training for undergraduates is minimal.

Cancer survivors and physiotherapy

Three of my patients have, in order to illustrate the human face of this article, generously offered to give a brief narrative of their journey from diagnosis, treatment and through to the benefits of physiotherapy.

SALLY'S STORY:

"I have had ten years cancer free which makes me view life in a very positive way; even when it rains!"

Sally's diagnosis of cancer of the throat and tongue was followed, in some cases months after initial treatment, by a range of complications.

In March 2008, I was diagnosed with squamous cell cancer at the back of the left side of the tongue and throat. The hospital team were excellent. I had surgery which removed 80 per cent of the tumour, followed by seven weeks of weekly chemotherapy and 28 days of radiotherapy. I was also unable to eat so had a tube inserted directly into my stomach which necessitated eight hours in a sedentary position each day to enable the liquid food to run through the tube. This tube feeding continued for nine months until my weight was stable. I also had the teeth on the left side of my mouth extracted to enable better access to the tumour.

It took over a year to recover but there are a number of complications which I am left with, for some of which I had targeted physiotherapy, initially from the NHS physio which was for a limited time. They felt that they had completed physiotherapy treatment, having improved my mouth and jaw area. There are as I am sure you are aware not enough NHS physiotherapists and no funding to pay for more. I was given mouth and tongue exercises to continue on my own once the sessions were completed. My left side has some permanent nerve damage due to the surgery, which affected my posture, arm and shoulder movement. My local GP treated me with acupuncture for some of the complications which developed a number of months after the treatment was completed in 2011/12 which occurred in my back, neck and shoulder. However, there was no long-term improvement. In 2014, physiotherapy was recommended to me by a friend who had lymphoedema. I had treatment for my left neck and shoulder surgery and the physio gave me exercises for my posture, arm and shoulder area which gave me less pain, less tightness and more movement. My left shoulder area was still very tight and needed several sessions of treatment. I now have full movement in my shoulder and can carry items, my neck is much more flexible and my posture is better.

I developed osteoarthritis in my right knee, which I was told may have increased in severity more quickly as a result of radiation. I was asked by the NHS to self-refer for treatment when I saw a specialist in 2015. I was given a series of exercises without a final appointment to note any changes. However, since then I have had treatment from the physiotherapist privately and I have become more mobile as a result of my treatment. I am now able to attend Pilates classes and after nine years have returned to singing in a community choir.

I feel that I was very lucky and had the best treatment possible at the time. I think my mouth area and swallowing were of primary concern to the NHS physiotherapists and treated accordingly. Many of the complications arose much later so this was difficult to follow up by the initial physiotherapists. I have recently discovered that the alveoli in my left lung are compromised as a result of the radiotherapy. These things are to be expected and I am still here which is amazing. I have been so lucky with my treatment. Whatever happens I have had ten years cancer free which makes me view life in a very positive way; even when it rains!

MAX'S STORY:

"The hardest step is the first step"

Max underwent a prostatectomy in June 2018. Quoting an old Taoist saying: "the hardest step is the first step", the hardest step for him was having the courage to accept his wife's suggestion to have physiotherapy and to talk about his issues of incontinence. He had been on the waiting list for NHS physio and weeks later was making little progress with his incontinence and so was becoming very withdrawn and avoiding going out walking, socialising and doing all the other things he enjoyed doing.

I had radical robotic prostate surgery early June 2018. I had a catheter fitted for two weeks following the operation. After removal I was informed that I would need to wear pads to help me deal with incontinence. Prior to surgery I had been doing pelvic floor exercises for well over six months, about 10 a day. I had read the literature given prior to surgery which indicated that incontinence would be a possible side effect but that recovery varied; some men recovered within weeks, others in a few months, but for some men it was much longer and could require further medical treatment.

By October my incontinence had not improved and I resigned myself to living with the problem as best I could. I became socially withdrawn and spent most of my time in and around the house. My wife suggested I should seek help from an independent physiotherapist (I was on the waiting list for NHS physio, but no appointments were available) as well as seeing a local Pilates teacher whom she had used in the past.

It's quite a big issue to discuss one's incontinence with an unknown person, albeit a professional physiotherapist. I wasn't sure what to expect. After I'd explained my relevant medical history, I was immediately reassured that there was something she could do to help me. The relief I felt at that moment was immense. I felt that I would be able to move forward.

She examined my posture and my abdomen along with my neck and shoulders, after which she told me that she felt my body was kind of locked up and probably reacting to the trauma of the operation and subsequent incontinence. She asked me about the pelvic floor exercises I was doing and asked me to demonstrate them. She told me that they were not really helping because I was using the wrong muscles. She instructed me to using a lower group of pelvic muscles in a much gentler way. She based this knowledge on a book by Prof. Craig Allingham "Prostate Recovery MAP Man's Action Plan". At the end of the session she lent three books concerning men's incontinence and prostate cancer recovery.

Craig Allingham's (2017) book has been a turning point in my recovery. I initially saw my physio for three sessions a week during which she helped me to recognise the different range of pelvic muscle groups around the penis and anus, and we discuss other aspects of my life, and how to improve my overall strength and mobility. I now see her once a month. She has liaised with my Pilates teacher which has also helped in strengthening my inner core and my flexibility.

Seeing my physio has had a profoundly positive effect on my situation. Within a week of my first consultation I felt more in control of my situation and a gradual but small improvement in my incontinence. She has helped me set goals to aim for which I've tried to reach. I now lead a much fuller social life. I've rejoined two activities that I had withdrawn from and I'm generally much more socially active again. Through her guidance and physiotherapy sessions I feel more confident about my future and more in control of many more aspects of my health and body.

I feel that the NHS and Prostate Cancer website information on pelvic floor exercises is a little bit lacking and may be misleading. Men who are about to undergo prostate cancer treatment should be given much clearer and more honest information about incontinence and how to improve one's chances of dealing with and improving the situation. I think Craig Allingham's work should be recommended; it is possible to view his video sessions via YouTube.

Making a difference to CS patients

We are taught that a patient with a history of cancer is considered a "red flag" for treatment, but how red is this red flag? What clinical reasoning questions are required to make an informed and robust clinical decision? And what is the most effective help a physiotherapist can offer them at this stage to help improve their quality of life?

There are a number of variables in the reasons for a CS patient seeking help from a private physiotherapist for a MSK problem. It could be that:

- their condition is directly related to the cancer diagnosis
- it is a consequence of the interventions they have received for their cancer (Malone *et al* 2017; Kenyon *et al* 2018; Leclerc *et al* 2016)
- it may be something entirely unrelated to the cancer, i.e. osteoarthritis, or a sporting, RTA or work-related injury.

A detailed assessment to gain clarification of the cause of their symptoms, as well as an holistic and supportive approach, is essential. Here are some key points to consider when dealing with this patient population.

HISTORY AND ASSESSMENT

Having a better understanding of a patient's journey from diagnosis to treatment and beyond, including their fears and concerns, is essential. Anxieties can persist even when the patient has been given the all clear. The fear of cancer may never really leave them. Complications from cancer treatment can arise immediately or may occur months, or even years, later and can be long lasting (Malone *et al* 2017; Kenyon

PENNY'S STORY:

"I was so lucky to have a little knowledge of the importance of mobility and healing effects for all the structures with massage..."

Penny is a physiotherapist colleague who underwent surgery for breast cancer in April 2018.

I was lucky enough to have an easily treated lump, found by myself in March 2018, and diagnosed as cancer on 16 April 2018 after tests. Following surgery on 18 May 2018, I had a few complications, namely:

- *supposed allergic skin reaction, relieved by anti-histamines*
- *seroma under axilla wound about five days post-op which was aspirated and fortunately did not reoccur to any extent*
- *cords, or axillary web syndrome with pain, stiffness radiating down my right arm almost to wrist.*

After radiotherapy, there was further scarring around the breast wound with pain and stiffness locally and again spreading to upper quadrant of my chest and to my elbow developed.

I was very fortunate to have physiotherapy friends I could call upon to give me massage for the initial lymphatic cords and UQ pain, and I obtained advice from the internet, as well as from a massage specialist I knew from the USA. I had been given a home plan of exercises from the breast care nurse, but this was very limited and the way in which the situation worsened after radiotherapy was not well explained. I believe physiotherapy contact from the outset would have helped explain post op complications and if necessary one or two visits if and when required.

I was so lucky to have a little knowledge of the importance of mobility and healing effects for all the structures with massage.

The physio based at the Macmillan centre was not able to help, but he suggested that a lymphoedema physio specialist may know what to do about the lymphatic cords. However, I was told they could not do so as they were too overworked. The literature recommended a physiotherapist breaking (or releasing) the cords, but I couldn't find anyone who could do that. I was fortunate in that I am a Pilates instructor and the lymphatic cords released while I was doing the Mermaid exercise. My arm and chest were very much more comfortable after that.

Definitely knowing appropriate exercises to do and getting help when needed made my rehab / journey through this much easier.

In my professional work I have been able to help a woman who has had a total mastectomy and I have seen how devastating that surgery has been especially without support to assist in wound care, and rehabilitation. The first massage I gave her really changed her outlook on life. I am sure we all have friends or acquaintances who have not been as fortunate as I have been. It is certainly good to have a work-life to look forward to.

et al 2018). For many, just having the option of talking to a practitioner in an open, honest and sensitive way about their problems can be very helpful and reassuring (Lait 2018; Kenyon *et al* 2018; Malone *et al* 2017).

During the history and assessment process you should consider:

- Documenting a detailed account of not only the medical history and post diagnosis interventions, but also clarifying the type of cancer, it's grade / aggressiveness, likely response to treatment and possible sites for metastatic spread. This will be decisive for the choice of physiotherapy intervention. The CSP (2014) guide "So Your Patient has Cancer?" provides a table of the likely areas for metastatic spread of different primary tumours.
- Developing a greater awareness of "red flags", combined with a physical examination and palpation of the affected areas to facilitate critical thinking for decision making.

MANUAL THERAPY

Surgery and radiotherapy can induce connective tissue dysfunctions and restrictions. This, in turn, can contribute to impairment of joint mobility, and postural and muscle imbalances. Myofascial / fascial mobilising techniques can significantly improve pain and restore mobility and normal function, especially post breast cancer surgery (Fourie & Robb 2009; Kenyon *et al* 2018). It should be noted, however, that some patients can be very self-conscious of the affected or operated areas and may have perceptions of mutilation, e.g. following a mastectomy, prostatectomy, and surgery for head and neck cancers. Palpating this area can be reassuring for some patients as it enables them to come to some acceptance of the disfigured part of their body and to become less fearful of it (Pidlyskyj *et al* 2014; Kenyon *et al* 2018).

EXERCISE AND ADVICE

Postural advice and muscle imbalance retraining helps improve postural awareness and postural dysfunctions.

Supervised exercise programmes aimed at strengthening weak muscles and helping to regain stamina, endurance and cardiovascular fitness are shown to be of benefit (CSP 2012), not only following interventions, such as breast cancer treatment (Bruce *et al* 2018), but also in cases of pelvic floor dysfunctions following gynaecological, prostate, bladder and bowel cancer interventions. There is a high (80%) incidence of incontinence following surgery for endometrial cancer and around a 60% incidence following both bowel cancer (Malone *et al* 2017) and prostate cancer surgery (Wolin *et al* 2010).

Devising a recovery and rehabilitation programme that enables patients to transition back into work, daily activities, sport and other interests should not only acknowledge any issues and risks, it should also take into account the

concerns the patient may have with regard to their return to work or lack of confidence. This awareness helps to develop achievable goals for the patient (Dorland *et al* 2016; Malone *et al* 2017).

All exercise forms, e.g. Pilates, tai chi, yoga etc. can be considered. As Michelle Lyons advocates: "Yoga has enormous potential as a therapeutic tool for… cancer survivors and as exercise prescription experts, we can add yoga as a multi-purpose tool to our skill-set."

Developing the skills for treating CS patients

One of the main objectives in the NCSI's Vision document (2015) is to support providers and others to implement the necessary measures for improving cancer survivorship outcomes. They highlight "the need to promote a cultural shift in professionals towards shared decision making and supporting patient self-management." To this end they advocate using patient reported outcome measures (PROMs) "to collect patient symptoms, concerns and quality of life routinely from diagnosis onwards, will help focus on what really matters to patients".

The CSP outlines four stages of cancer rehabilitation for which these PROMs can be utilised:
1. Preventative – aiming to reduce the impact of expected disabilities as a result of cancer and helping people learn to cope with them.
2. Restorative – aiming to return the patient to pre-illness level of function without disability.
3. Supportive – aiming to limit functional loss and provide support in the presence of persistent disease and the continual need for treatment.
4. Palliative – aiming to put in place measures to eliminate or reduce complications and provide support, such as symptom management. Exploring options for improving audit provision towards a broader understanding, accurately predict outcomes for cancer patients following interventions at these different stages, and thus to advise them appropriately.

Physiotherapists can use these PROMs to build a database of evidence which could be a springboard for further research. Evidence-based practice has for years been used as a benchmark for best practice. However, there are variables in physiotherapy practice that are not always easy to quantify or evaluate accurately, which means that outcome measures can have their limitations. For instance, the therapeutic relationship that takes place between the patient and clinician may be the most important factor that enables an unconfident and fearful patient to gain trust, motivation and compliance with a physiotherapist. How can this be measured?

The concept of evidence informed practice (EIP) has evolved recently to address these limitations and to recognise the contribution of the practitioner's clinical experiences and judgements combined with the patient's views and experiences, triangulated with evidence drawn from research studies. As Holmes (2016) states on the Research in Practice for Adults (RiPfA) website: "This approach is also about supporting practitioners and commissioners to become more confident in using and generating new evidence. We need to develop a sector in which practitioners across disciplines are active agents in evidence; research literate, critically curious, hungry for knowledge and supported to generate new evidence to fill gaps and improve the quality of evidence available overall." Nevo & Nevo (2011) reinforce this approach by adding that EIP should also allow "…ample room for clinical experience as well as the constructive and imaginative judgements of practitioners and clients who are in constant interaction and dialogue with one another".

With their emphasis on critical thinking, reflective practices and manual therapy skills, private physiotherapists in particular are in a prime position to gather the evidence that will inform future practice and contribute to expanding understanding in line with NCSI and government recommendations, and for devising more specific guidelines.

Physio First's own Data for Impact (DfI) study, with its accompanying Quality Assured Practitioner (QAP) scheme, is an audit tool that not only enables us to assess our own effectiveness, but also allows us to prove the effectiveness of physiotherapy to the general public and measure the patient's experience of our interventions. This can also create a foundation for building a framework of evidence that can form the building blocks for further research, trials and training courses to enable physiotherapists and other healthcare professionals to further develop their skills to better support these groups of patients. However, currently, the DfI is limited in its scope and so unable to capture fully the multi-layered approach that would suit the CS patient group more comprehensively.

The World Health Organisation's (WHO) International Classification of Functioning, Disability and Health (ICF) framework (Glaesell *et al* 2011), has developed Core sets of ICF categories that are specific to a condition and have, to date, been developed for both breast cancer and head and neck cancer. Although these Core sets, which can be downloaded from **www.icf-core-sets.org** cover most of the relevant categories, they do not cover all, but they are continuously updated and refined, and can be a useful auditing outcome tool (Cooney *et al* 2013).

What next for CS patients

From discussions I have had with colleagues, it appears there are a number of physiotherapists throughout the UK who are treating CS patients. They are often working in isolation, with little research or guidelines to support them and, as any patient with a history of cancer is considered a "red flag" (Leerar *et al* 2007), any physiotherapist treating this population is working in a red flag zone.

While the Association of Chartered Physiotherapists in Oncology and

Palliative Care is well established and an excellent resource, its focus tends to be more towards palliative care. For those physiotherapists interested in offering MSK treatment for patients living with cancer, it would be valuable to be able to access more specific guidance, support and advice.

Patients with a history of cancer are increasingly living for many years after diagnosis, so we may need not only to develop more detailed guidelines and navigational pathways to generate confidence and motivation for treatment, we should also, as a profession, be considering and exploring the possibility of "red flag" physiotherapy, and the clinical decision making skills for ascertaining what range in the spectrum of redness is it safe and appropriate to treat, and expanding our range of skills to manage difficult conversations with a patient, such as any suspicion of the possible recurrence or metastases associated with their presenting symptoms, and then supporting them through such issues.

From our Physio First point of view, it would be good to have a "physiotherapy for CS MSK patients" category on our Find a Physio facility to help signpost users to accessing an appropriate specialist therapist, and the availability of specialist courses that help with clinical reasoning and decision-making skills for treating "red flagged" patients, teach manual therapy for fascial and connective tissue, and scar and soft tissue release techniques would be helpful; and a conference that focused on the role of the MSK physiotherapist in cancer survivorship would be the icing on the cake!

Acknowledgments

I would like to thank the following:
Karen Kenyon and Clare Lait, physiotherapists specialising in MSK physiotherapy in oncology, for their support and advice.
Michelle Earle, a fellow Macmillan physiotherapist who has given me advice and support over the last 20 years.
Nina Kika, Mel and Zelah for proofreading.
Above all, to Max, Sally, Penny, and all my patients living with cancer who have given me the inspiration, courage, confidence and determination to keep on going and to further my understanding and improve my practice.

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Useful resources

Books

Conquering incontinence: a new physical approach to freer lifestyle. Author: P Dornan. Allen and Unwin, Australia

Iyengar yoga cancer. Author: L Steinberg. Parvati Productions

The woman's yoga book: Asana and Pranayama for all phases of the menstrual cycle. Author: B Clennell. Rodmell Press

Websites

ICF documentation tool https://www.icf-core-sets.org/

ICF Core sets for patients with breast cancer https://www.icf-research-branch.org/icf-core-sets-projects2/cancer/icf-core-set-for-breast-cancer

ICF Core sets for patients with head and neck cancer 2017 https://www.icf-research-branch.org/icf-core-sets-projects2/cancer/development-of-icf-core-sets-for-patients-with-head-and-neck-cancer

Macmillan Cancer Support Cancer Statistics fact sheet pdf. https://www.macmillan.org.uk/_images/cancer-statistics-factsheet_tcm9-260514.pdf

Macmillan Cancer Support Allied Health Professions Competence Framework , for those working with people affected by cancer 2017, July https://www.macmillan.org.uk/_images/allied-health-professions-framework_tcm9-314735.pdf

NCI https://www.cancer.gov/publications/dictionaries/cancer-terms/def/survivor

NCI https://www.cancer.gov/publications/dictionaries/cancer-terms/def/survivorship

Physiopeadia The Flag System https://www.physio-pedia.com/The_Flag_System

Physio First. Data for Impact top tips: Making the most of your data

https://www.physiofirst.org.uk/asset/49768B13%2D5FC7%2D4823%2D974235B0D406CC28.42DBA303%2D4E66%2D4367%2DA97080999E029EA5/

Physio First Quality in private musculoskeletal care: Resource pack

https://www.physiofirst.org.uk/asset/FA0B600F-2923-4887-A47912A1B77C4544.87B4E9AC-9409-484C-93853FFFCB31AE90/

Further education

Michelle Lyons: https://celebratemuliebrity.com/upcoming-events/

Willem Fourie http://www.wayforward.co.za/courses.htm

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Theory-based behaviour change and communication skills for physiotherapists to support client self-management

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Physiotherapists can play a positive role in supporting their clients to engage in evidence-based health behaviour change and self-management of many chronic diseases. Internationally, many health systems and universities are now prioritising healthcare provider training in behaviour change skills. This article provides an update on research investigating the use of behaviour change techniques by physiotherapists in the promotion of physical activity and rehabilitation exercise adherence for musculoskeletal pain, and my own research into the use and development of self-determination theory in communication skills to support behaviour change in people with low back pain and osteoarthritis.

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1 Update knowledge on international developments in the education of healthcare practitioners in behaviour change skills.
2 Apply knowledge and current research of behaviour change techniques to the physiotherapy management of people with musculoskeletal pain.
3 Understand self-determination theory and its application to the development of physiotherapist communication skills training programmes to promote client autonomous motivation to engage in self-management behaviours.
4 Develop knowledge and skills in the design and evaluation of a range of physiotherapy training approaches and through validated outcome measures.

Introduction

The role of the physiotherapist is continuously expanding beyond the traditional realm of providing a range of "hands on" treatments. We are now one of the key players in the healthcare team supporting clients to engage in behaviour change, and the management of chronic conditions across the lifespan through the "hands off" support we provide (D-Arcy *et al* 2016). There is an increasing emphasis in clinical guidelines and health promotion campaigns on individual self-management and lifestyle behaviour changes related to increasing physical activity and healthy eating, smoking cessation and reducing drug and alcohol abuse. Many health systems and higher education institutions are now beginning to prioritise the training of healthcare providers and future graduates with the skills necessary to support client behaviour change (Fortune *et al* 2018; Freene *et al* 2017; Health Service Executive 2017; Sandborgh *et al* 2018). Options include face-to-face and online training in motivational interviewing and brief interventions using the 5As; ask, advise, assess, assist and arrange (Health Service Executive 2016).

Clinical guidelines for low back pain and osteoarthritis recommend healthcare programmes should include education and support for participant uptake of self-management behaviours, including specific exercise, physical activity, pain management using pharmacological and non-pharmacological approaches and coping skills (NICE 2014a, 2016). Client adherence to these types of programmes is frequently poor and, for a practitioner, often difficult to assess due to the limitations of client recall when using self-report measures (Hall *et al* 2015). The evidence for the effectiveness of self-management programmes is also weak and low quality (Toomey *et al* 2015). Despite recommendations from the Medical Research Council that interventions targeting client behaviour should be grounded in relevant behaviour change theory (Craig *et al* 2008), there is limited evidence of the effect of theory-based interventions for clients with chronic musculoskeletal pain (Keogh *et al* 2015). There is also minimal evidence of the effectiveness of theory-based training programmes for healthcare providers, including physiotherapists, to support such behaviour change.

Our research at University College Dublin, in collaboration with physiotherapy, health psychology and health science, is developing and evaluating theory-based physiotherapist training programmes to support behaviour change in clients with low back pain and osteoarthritis and is

> "IT IS OFTEN DIFFICULT FOR THE CLINICIAN TO ASSESS CLIENT ADHERENCE TO SELF-MANAGEMENT BEHAVIOURS"

a testament to the importance of interdisciplinary collaboration in the field of behaviour change research and clinical practice.

Behaviour change techniques

The National Institute for Health and Care Excellence (NICE) guidelines recommend healthcare providers use behaviour change techniques (BCT) to support individuals to change common lifestyle behaviours as appropriate (NICE 2014b). These are the smallest components of an intervention designed to change behaviour, i.e. its "active" ingredient, that can be observed, delivered and replicated by a practitioner (Michie *et al* 2013).
Research in this field has grown exponentially since the development, in 2013, of the Behaviour Change Techniques Taxonomy v1 (BCTTV1); a structured list of 93 BCTs categorised under 16 hierarchies, such as goals and planning, feedback and monitoring, and social support, which allows all disciplines working in the behaviour change field to speak a common language (Michie *et al* 2013).

There has recently also been an increase in studies reporting the use of BCTs by physiotherapists working in private practice and outpatient clinics, particularly in the promotion of physical activity and adherence to rehabilitation exercise programmes for musculoskeletal conditions (Keogh *et al* 2018a; Kunstler *et al* 2019a, 2019b; Marley *et al* 2017; Nicolson *et al* 2018).

It is beyond the scope of this paper to review this literature in detail, but key findings from these studies are that the BCTs of "goal setting behaviour", "instruction on how to perform the behaviour" and "graded tasks" are some examples of how they are frequently included in intervention protocols and reportedly being used by physiotherapists in surveys, while "self-monitoring of behaviour" is being used less frequently.

Behaviour change techniques associated with **"goal setting"** and **"self-monitoring"** of behaviour have been shown to be effective in general, overweight, obese and younger populations, but their effectiveness in older adults and those with chronic musculoskeletal pain is less clear (Keogh *et al* 2018a).

While the delivery of goal setting behaviour, defined in BCTTV1 as "set or agree a goal in terms of the behaviour to be achieved" (Michie *et al* 2014), is perhaps considered straightforward by many physiotherapists, it has been found to be difficult to deliver well, particularly in collaboration with a client and in a group setting (Keogh *et al* 2018a), and highlights the importance of effective training of practitioners in the delivery of BCTs.

Physiotherapists could also consider including self-monitoring of behaviour, i.e. "establish a method for the person to monitor and record their behaviour as part of a behaviour change strategy" (Michie *et al* 2014), within their toolbox by, for example, advising clients to use a physical activity app on their smartphone or investing in a wearable fitness tracker, e.g. Fitbit.

NICE guidelines have also recommended that healthcare providers **communicate effectively when supporting clients to change their behaviour** (NICE 2014b). It is also being increasingly recognised in the literature that the communication style of practitioners in their delivery of specific BCTs is an important area for future research (Hardcastle 2015).

Key communication skills for practitioners include reflective listening, showing empathy, developing rapport and relationships with service users and developing a person's motivation to change by encouraging and enabling them to manage their own behaviour (NICE 2014b).

Our research is in the development of these important communication skills to enable physiotherapists to promote client behaviour change through the application of behaviour change and self-determination theory.

Self-determination theory

Self-determination theory (SDT) is a metatheory which aims to provide a broad framework within which human motivation, personality and behaviour can be studied (Ryan & Deci 2000). According to SDT, people have three basic psychological needs:

- **competence**, i.e. the need to feel effective and capable
- **autonomy**, i.e. the need to feel free to engage in an activity and to have choice, and
- **relatedness**, i.e. the need to feel connected to and cared for by others.

There is now an increasing range of resources available for intervention developers, researchers and practitioners, including online training in the BCTTv1 (**www.bct-taxonomy.com/**) and a database of published intervention papers and reviews in which BCTs have been coded using BCTTv1 (**www.bct-taxonomy.com/interventions**)

These resources provide practitioners with free access to a large body of knowledge on which BCTs have been included in interventions and how they should be described and delivered in practice.

Social contexts that satisfy these, for example a physiotherapist using a needs-supportive communication style during client interactions, promote autonomous motivation to engage in health behaviour change. Strategies include collaborative goal setting, the provision of positive and information rich feedback, and acknowledging the client's feelings and perspectives (Keogh *et al* 2018b).

In contrast, a controlling healthcare climate that involves disregarding the clients' views, pressurising clients, and making decisions on their behalf without consultation leads to more controlled motivation and a lower likelihood of adherence to behaviour change (Lonsdale *et al* 2012).

The quality of motivation a client possesses is more important than the amount; and the more autonomous a person's motivation is, the more likely they are to initiate and maintain the behaviour.

Prior to our research, SDT had been successfully applied in general populations to support physical activity, weight loss, smoking cessation, diabetes self-management and medication adherence (Lonsdale *et al* 2012), but an SDT-based intervention had not been previously tested in a physiotherapy setting for any population.

Communication skills training programmes

Our research in this field has included the development and evaluation of SDT-based physiotherapist training programmes for individual and group interventions using a variety of training methods, including small group teaching, individualised coaching, and e-learning.

FACE-TO-FACE TRAINING

The Communication Style and Exercise Compliance in Physiotherapy (CONNECT) SDT-based communication skills training intervention and its evaluation have been reported in detail (Lonsdale *et al* 2012, 2017; Murray *et al* 2015, 2018). It involved physiotherapists attending two four-hour training workshops and individualised coaching from Dr Chris Lonsdale, an expert in SDT, involving 18 communication strategies linked to the three SDT domains of competence, autonomy and relatedness, for delivery during individualised physiotherapy treatment.

A strategy linked to competence is **"employing SMART goal setting"**, i.e. agree on goals that are specific, measurable, achievable, recorded and time-based, by using language such as: "Earlier you mentioned that you are finding it hard walking for long periods. For this week we could set a target of 15 minutes walking a day, how many days do you think you could achieve that target in the next week?"
A communication strategy related to autonomy is **"gauging patient readiness to accept advice"**, i.e. ask the patient if they are ready to consider advice regarding activities outside the clinic by using language such as: "There are a number of things you can do that will help… would you like to hear a few suggestions?"

The effectiveness of the CONNECT training programme on physiotherapists' needs-supportive behaviour during clinical practice was demonstrated in a randomised controlled trial (Murray *et al* 2015). Compared with control physiotherapists (n=12), independent blinded ratings of audio recordings of client-physiotherapist interactions during the first treatment session demonstrated that CONNECT physiotherapists (n=12) were significantly more needs-supportive (Cohen's d = 2.27; P<.01). One of our key findings was the need to tailor future training programmes to the individual communication skills of physiotherapists to optimise the effectiveness of training.

A subsequent multicentre cluster randomised controlled trial of individual physiotherapy treatment set in Ireland's public health service (Lonsdale *et al* 2017) found significantly higher ratings of adherence to physiotherapists' home-based recommendations in people with chronic low back pain treated by CONNECT physiotherapists (n=131), compared to the control group (n=124; d=.28, P=.01). Participants also demonstrated a moderate increase in perceived competence and a decrease in amotivation levels. However, there were no differences between groups in physical activity, disability, pain or quality of life.

We concluded that the CONNECT intervention could be integrated with other behaviour change techniques such as self-monitoring, social support, and evidence-based interventions such as walking, to optimise behaviour change.

CONTINUING EDUCATION AND INDIVIDUALISED COACHING

As a follow-up study, we developed and pilot-tested the feasibility of implementing CONNECT in routine primary care physiotherapy settings, using a range of evidence-based strategies (Matthews *et al* 2015). These included:

- a continuing education meeting with a primary care physiotherapy team that introduced the SDT communication strategies, and a group discussion on how they could be used in practice
- two individualised coaching sessions by psychologist, Dr James Matthews, with individual physiotherapists to support their use of the SDT strategies in practice; including audio-recording treatment sessions with low back pain clients for assessment and feedback, self-monitoring and reflection on the audio recording, and goal setting and action planning after each coaching session.

We found this approach to communication skills training was feasible and acceptable to physiotherapists, but very time consuming, potentially costly and they did not receive enough support from colleagues during this process. This led us subsequently to develop

an e-learning training programme, discussed later.

SMALL GROUP TRAINING

We have recently developed the theory-driven, group-based self-management in people with osteoarthritis and low back pain through activity and skills (SOLAS) complex intervention, which has been reported in detail (Hurley *et al* 2016a, 2016b). The SOLAS intervention is a six-week, once-weekly 90-minute class, involving 45 minutes education and small group discussion around specific topics related to self-management, i.e. physical activity, specific exercise, pacing, pain coping strategies, healthy eating for lifestyle and weight management, pain management including medication and relaxation techniques. This is followed by 45 minutes group exercise with physiotherapist guidance on exercise selection. The SOLAS intervention is underpinned by self-determination theory and a range of evidence-based BCTs.

A comprehensive two-day training programme of the SOLAS intervention content, support materials, and nine SDT-based communication strategies was developed and delivered by myself and psychologist Dr James Matthews to small groups, i.e. five to seven physiotherapists (table 1).

Medical Research Council guidelines recommend that complex behaviour change programmes, such as SOLAS, educate their intervention deliverers to ensure implementation with high fidelity, and then evaluate their training (Craig *et al* 2008). The Kirkpatrick model was used to evaluate the SOLAS physiotherapist training programme (Kirkpatrick 2006) and involved the use of validated questionnaires and the double blinded rating of audio recordings of therapists delivering all six SOLAS classes within the feasibility trial (Keogh *et al* 2018b).

Our results showed that physiotherapists (n=13) were satisfied with face-to-face training [Reaction], their confidence in the SDT-based communication strategies and knowledge of some intervention content components significantly increased [Learning], and they delivered SOLAS in a needs supportive manner with high fidelity to intervention content [Behaviour] (Toomey *et al* 2017). The need for further refinements to the training programme to support the delivery of collaborative goal setting, action planning and problem solving was highlighted and taken forward into the e-learning training programme.

The subsequent SOLAS cluster randomised controlled feasibility trial, set in primary care clinics in the Dublin area (SOLAS n=7 clinics, n=59 participants; usual physiotherapy n=7 clinics, n=61 participants) found small improvements in perceived competence and motivation for both physical activity and self-management that favoured SOLAS, but these changes alone were not sufficient to promote long-term improvements in participant behaviour change (Hurley *et al* 2018). The feasibility trial identified the need for minor changes to the intervention content, BCTs and physiotherapist training programme to optimise its design, uptake and delivery for evaluation in a definitive trial (Hurley *et al* 2017).

STRATEGY	METHOD	EXAMPLES
Highlight the difference between controlling and information rich feedback	Through group discussion, exercise, video examples and small group activities	**Controlling feedback:** "You're doing very well, it's important to make sure you don't fall back next week" and "If you can maintain this I'm sure you will feel better"
		Information rich feedback: "Well done on your effort today. It was great to see you try a second set of those exercises for the first time today as you only managed one set last week"
Creating interpersonal involvement	Using active listening	Stay silent, listen and look, open body language, paraphrasing and empathising

TABLE 1: Examples of the SDT-based strategies included in training (Hurley & Matthews 2016)

E-LEARNING TRAINING

In response to potential upscaling to a definitive national trial of the SOLAS intervention, and the barriers to physiotherapists across Ireland attending face-to-face training, we developed an asynchronous, interactive, web-based e-learning training programme (E-SOLAS), the evaluation of which has been recently published (Hurley *et al* 2019). Adapted from the face-to-face training, E-SOLAS is hosted on Curatr, an online social learning platform that creates a collaborative learning environment and uses gamification principles.

Thirteen physiotherapists from primary care areas across Ireland completed E-SOLAS training over a four-week period and seven progressed to deliver the SOLAS intervention in primary care.

Our results showed physiotherapists were very satisfied with E-SOLAS training, that their learning and behaviour outcomes were comparable with face-to-face training, and the SDT strategies related to goal setting, action planning and problem solving were delivered to a higher level of competence than the face-to-face training.

Overall, physiotherapists found E-SOLAS an acceptable, appropriate, feasible and sustainable method of training. Most physiotherapists reported completing e-learning outside work hours, with the most commonly cited positive features being the range of brief video clips and the focus on communication skills and client motivation.

We have subsequently piloted this e-learning training with undergraduate physiotherapy and human nutrition and dietetics students and have received very positive feedback on its potential for integration into future healthcare provider education programmes, alongside some face-to-face training to provide peer social support and highlight key aspects of learning.

Summary

Physiotherapists play an important role in promoting clients' autonomous motivation to engage in self-management and physical activity behaviour change. Physiotherapists should ensure their toolbox includes current knowledge of the effectiveness of behaviour change techniques and skills in their effective delivery using evidence-based communication strategies. Self-determination theory-based communication skills training is an acceptable, evidence-based and effective form of training for physiotherapists involved in behaviour change. Readers involved in the development and delivery of other physiotherapy skills-based training programmes should find the comprehensive evidence-based approach to the evaluation of training described in this article useful and informative.

About the author

Dr Deirdre Hurley is a Chartered Physiotherapist, academic and researcher. She worked in public and private physiotherapy settings in Ireland, UK, Canada and Australia before moving into musculoskeletal physiotherapy research. Her current research focuses on the design, delivery and evaluation of self-management and physical activity behaviour change interventions for people with chronic low back pain and osteoarthritis.

Deirdre is also leading an international, interdisciplinary research group investigating e-learning as a tool to support the education of healthcare practitioners in behaviour change skills. She has obtained significant grant funding, published widely, disseminated her research extensively and received several international presentation awards.

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Perturbation-based balance training in falls prevention and sports injury rehabilitation

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This article critiques the role of perturbation-based balance training (PBBT) in the rehabilitation of balance in the elderly and sporting populations. It provides an overview of a novel way of delivering instrumented PBBT using the BalanceTutor™, and reports on a pilot study using this technology.

LEARNING OUTCOMES
TO SUPPORT PHYSIO FIRST QAP

1 Understand the role of postural control, stability, balance and perturbation in a patient's rehabilitation journey.
2 Recognise the role of perturbation-based balance therapy in different patient groups and its physiological effects.
3 Understand how technology can be used to safely and effectively give perturbation-based balance therapy in a clinical setting.
4 Recognise that clinical evidence directs us to modify and progress perturbation-based balance therapy to meet specific patient needs throughout their rehabilitation journey.

Introduction

Postural control is the foundation of our ability to move independently and safely in any chosen environment (Shapiro & Melzer 2010). There is an unexpected commonality to the rehabilitation of elderly fallers and injured athletes in that both these clinical populations need to be able to make the appropriate postural adaptations in response to unexpected perturbations. Postural perturbation is defined as a "sudden change in conditions that displaces the body posture away from equilibrium". Mechanical perturbation displaces the position of the body segments, which can in turn lead to displacement of the total-body centre of mass (COM), or disequilibrium (Horak *et al* 1997). In the elderly, the most common sources of mechanical perturbations are trips or slips, often resulting in falls. In the sporting population, additional sources include impact with other participants in the form of accidental collision or intended contact, e.g. a tackle in rugby.

Traditional strength, balance and aerobic exercise have been shown to give some reduction in falls risk in the elderly, but not necessarily a reduction in falls incidence (Gerards *et al* 2017).

The flaw in many balance rehabilitation programmes is that they ignore a basic principle of physical training: the concept of specificity. They focus on voluntary controlled exercises and do not include those that improve compensatory postural responses to unexpected perturbation (Shapiro & Melzer 2010; Gerards *et al* 2017). Perturbation-based balance training (PBBT) is an alternative approach. It incorporates exposure to repeated postural perturbations to evoke rapid balance reactions, enabling the individual to improve control with practice (Mansfield *et al* 2010).

Falls and the elderly

It is reported that up to one in three over-65s suffers a fall each year, costing the NHS an estimated £4.6 million a day. Falls occur most often in walking and transferring while standing (Kurz *et al* 2016; Robinovitch *et al* 2013; Shapiro & Melzer 2010; Mertz *et al* 2010). This is not surprising, if we consider that not only do the biomechanics of these actions rely on a purposeful displacement of centre of gravity outside the limits of balance and a subsequent step correction, but also that the base of support is reduced to the sole of one foot during this process.

Frail and older people are more likely to fall, as are those with neurological conditions such as stroke, Parkinson's and multiple sclerosis. Mansfield *et al* (2015) remind us that falls in these population groups often have a negative impact on confidence. When the fear of falling again leads to a further reduction in activity levels, it becomes as limiting as any residual physical deficit arising from the fall and is likely to cause further deconditioning of muscles, bones and

"FALLS IN THE ELDERLY OCCUR MOST OFTEN IN WALKING AND TRANSFERRING WHILE STANDING"

balance systems, which can increase the risk of falling again, and of harm from falling (Honaker & Kretschmer 2014).

Ligamentous injuries in sport

The knee and the ankle are reported as the most commonly injured joints during athletic participation. The two main issues in determining the success of sports injury rehabilitation are the percentage of those returning to their pre-injury level of participation and the percentage of those experiencing a recurrence of the original injury (Gutierrez *et al* 2009; Kemler *et al* 2016).

Gutierrez *et al* (2009) suggest that 85% of ankle injuries are lateral ankle sprains (LAS), which makes the lateral ligament complex the most often injured structure in sports and recreation. Kemler *et al* (2016) found that 18% of patients with an acute lateral ankle sprain suffered a reoccurrence within 12 months.

Ardern *et al* (2011) conducted a comprehensive meta-analysis on return to sport following anterior cruciate ligament (ACL) reconstruction. They reported that 82% of patients were able to resume sporting activity. However, only 63% returned to their pre-injury level of participation and only 44% returned to competitive sports.

Manual PBBT

Arresting a fall following a trip or slip requires rapid recognition of balance loss, followed by rapid and controlled activation of appropriate synergistic muscle groups to adjust base of support to regain stability. Perturbation-based balance training focuses on optimising the somatosensory response to balance loss, rather than modulation of the vestibular and visual stimuli per se. It aims to promote corrective stepping and trunk counter rotations, and upper limb saving reactions such as hand grasping for support where available. In manual PBBT, therapists employ a variety of physical techniques, and exercises are often performed on unstable surfaces such as foam pads and rocker or wobble boards (figure 1).

Gerards *et al* (2017) highlighted that unexpected, multidirection and variable perturbations are needed to produce most advantageous recovery and improvement. The proximity of the therapist to the patient may mean the patient gets significant visual and tactile cues that a perturbation is about to occur leading to a preparation of stability rather than a reaction to instability. It is also argued that these perturbations are expected, so do not accurately mimic the ground up and dynamic nature of trips and slips experienced while walking, and so will not stimulate and develop the required postural responses (Kurz *et al* 2016; Shapiro & Melzer 2010).

It is not possible to measure accurately the magnitude of the applied force in conventional PBBT and this can impact negatively on treatment progression, both in terms of safety and efficacy. Additionally, the risk of harm to both the therapist and the patient should not be dismissed. A pinched finger under a balance board, an awkward fall from a wobble cushion or a patient loss of balance being stopped by a therapist are not trivial events.

Despite these shortcomings, Mansfield *et al* (2015) found that individuals with neurological conditions who completed PBBT were less likely to report a fall, and reported fewer falls than those in the control groups. They concluded that PBBT appears to reduce fall risk among older adults and individuals with Parkinson's.

FIGURE 1: Delivering conventional non-instrumental PBBT in the clinical setting

"FALL RISK IN OLDER ADULTS AND INDIVIDUALS WITH PARKINSON'S IS REDUCED BY PBBT"

Taylor (2011) investigated the effects of PBBT on the lower limb in individuals undergoing ankle and knee rehabilitation, highlighting the role the somatosensory system has over the visual and vestibular systems in adapting to repeated and progressively stronger perturbations. As a result of this stimulation, the mechanoreceptors responding at lower loads and anticipatory responses are enhanced with stronger and more refined muscle fibre recruitment. The more attuned a reaction to a perturbation is, the quicker an individual can return to sport or daily function. Perturbation training also leads to positive adaptations in both muscles and non-elastic joint structures such as remodelling scar tissue.

Studies have also reported the success of PBBT in the rehabilitation of ACL ruptures, in "copers" those who compensate well and "non-copers" who adopt a "joint stiffening strategy". Chmielewski *et al* (2005) explored the dynamic knee stabilisation strategies of people who successfully compensate for the absence of an ACL following injury, while Hartigan *et al* (2009) investigated the role of PBBT vs strength training (STR) prior to ACL reconstruction. Results showed that those in the perturbation (PERT) group had more symmetrical quadriceps strength and no differences in knee excursions between their limbs at six months after ACL reconstruction, whereas those in the STR group had less strength symmetry and continued to have smaller knee excursions during the mid-stance phase of gait. Improved mid-stance excursion in the perturbation group therefore indicates that neuromuscular training rehabilitation programmes can improve movement patterns in the involved limb after ACL reconstruction in non-copers.

Technology developments in PBBT

Technology in the research environment has been developed to deliver instrumented PBBT; moving platforms, split treadmills, and walkways with sprung loaded trip plates and hidden slide plates. Many of these overcome the non-instrumented deficiencies and can deliver unexpected perturbations. The BalanceTutor™ (BT) device, originally devised by researchers at Tel Aviv University, is a bi-directional treadmill, mounted within a motion platform with an overhead "safety" harness (figures 2a and 2b).

The treadmill actuators can accelerate, decelerate and change the direction of the belt. The motion platform can translate the whole treadmill to the left or right at a preselected speed. This combination enables the therapist to safely deliver calibrated perturbations in the coronal or sagittal planes to simulate unexpected trips, slips and lateral perturbations akin to "barges". The speed of the treadmill can be varied incrementally between 0 and 7 kilometres per hour, enabling the perturbations to be applied in a variety of static postures, e.g. standing, step-standing, lunging, or in walking or running. The BT is equipped with centre of pressure and centre of mass sensors which enable perturbations to be delivered at selected phases of the gait cycle.

The essential safety feature of the BT is the body harness and suspension gantry. The harness does not impede movement, but if the user moves outside the limit of their stability control, the harness arrests their potential fall and provides an extra base of support to enable the patient to regain their balance. The treadmill can be stopped instantly by the therapist either before or after a terminal balance event.

The BT can be used for assessment of stability and to deliver PBBT for rehabilitation or "pre-habilitation" of numerous neurological, orthopaedic, elderly care or sports therapy related conditions.

Using a menu system, the therapists can design treatment programmes that can deliver perturbations either at set or random intervals. For anxious users, the countdown to the delivery of a perturbation can be displayed on a PC screen in front them. The centre of mass and pressure sensors facilitate the delivery of perturbations precisely at mid-stance irrespective of gait speed.

FIGURE 2a: The design concept for the Balance Tutor™

FIGURE 2b: The Balance Tutor™ applied in a clinic setting

> "PERTURBATIONS DELIVERED ARE LOW ENOUGH TO BE TOLERATED AND SAFE, BUT CHALLENGING ENOUGH FOR AN EFFECT TO BE SEEN"

Perturbations can be used to modify specific elements of gait that are known to be contributing to stability issues, for example facilitating weight transfer or lengthening steps. They can also be used to challenge specific elements of gait, for example by increasing movement through the ankle joint recovering from injury, or by using a perturbation to dynamically stretch a stiffer joint. Specific gait abnormalities can also be addressed.

In terms of PBBT protocols, Gerards *et al* (2017) suggest providing perturbations that are low enough to be tolerated and safe but challenging enough for an effect to be seen. Age appears not to impede stability re-education and there is substantial evidence that older people have the capacity to improve their balance strategies through PBBT (Pai & Bhatt 2007; Kurz *et al* 2016; Gerards *et al* 2017; Chien 2018). Evidence also exists for the importance of dual tasking to improve safety in walking (Löfgren *et al* 2019; De Freitas *et al* 2018) and using more complex activities such as backwards walking (Wang *et al* 2019). These protocols are easily accommodated using the BT.

The BT can also provide cardiovascular conditioning and general strengthening, accommodating the government guidelines of 120 minutes a week of cardiovascular exercise, balance exercises and strength training for older people (Foster & Armstrong 2018).

Papadimitriou & Perry (2017) suggest that the concept of "use it or lose it" applies to the retention of improvements in balance skills and this is magnified by senescence. Rossi *et al* (2014) propose that performing regular balance exercises and receiving booster sessions of PBBT is the optimal way for individuals to maintain gains. The availability of the BT in a clinical environment makes effective PBBT accessible for patients seeking "booster sessions" and continues to boost their confidence with regards to coping with unexpected perturbations.

The pilot study

Our own pilot study explored the potential of the BT to improve balance across a diverse range of conditions. We recruited subjects through social media and from existing active caseloads. Individuals who self-reported poor balance, or one or more of reduced leg strength, reduced confidence in walking, or a history of recent falls, were offered a trial of PBBT using BT. Conditions included acquired brain injury, stroke, polytrauma, knee replacement, Parkinson's, and back injury. Patients received 10 sessions of 30 minutes on the BT over either five or 10 weeks. Qualitative and quantitative measures included time taken to complete five sit-to-stands (STS), maximum comfortable walk speed, short physical performance battery (SPPB), four metres walk test and Mini-BES test which is a collection of measures for balance, strength, multitasking and walking speed measured out of 28, where 28 is best.

Many patients had already had conventional balance rehabilitation prior to this trial, which makes the improvements shown in figure 3 all the more encouraging. During this trial, no other exercises were added. At the conclusion of the trial, subjects were offered further appointments to learn maintenance exercises and falls prevention strategies. All 10 subjects showed some gains in strength, walking speed and balance, all of which are vital to reduce the risk of harmful falls.

Our qualitative measures were also formed from the participants verbally reporting:

- feeling safe, but challenged to improve
- often being pleasantly surprised at what they could achieve and how much they could challenge themselves
- that they could save themselves when they expected to fall
- surprise at being able to stand on the London underground
- the confidence to walk around their own home and outdoors
- being less reliant on walking aids
- lower heart rate and less breathlessness in fast walking and the ability to tolerate longer sessions of continuous walking
- gaining confidence to try running on a treadmill or outdoors
- that, following knee replacement

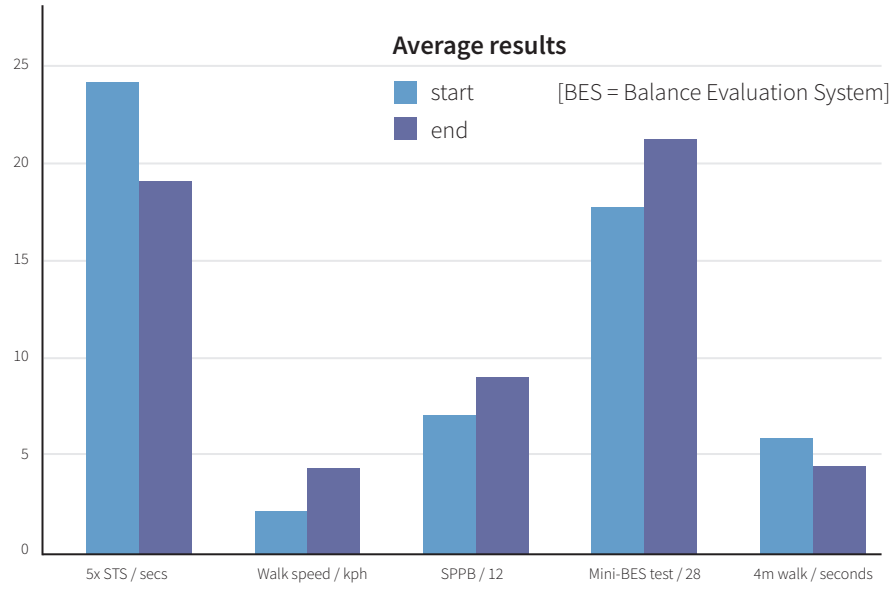

FIGURE 3: Graph indicating the average improvements in balance variables following rehabilitation with the Balance Tutor™

surgery, they no longer walked with a limp
- enjoying the new challenge and the ability to safely progress rehabilitation
- better balance and the ability to self-save when balance was disrupted
- more confidence when walking on uneven surfaces
- improved fitness and the confidence to keep exercising
- progress in recovering after plateauing with standard rehabilitation
- comments from family members, colleagues and carers that they were walking better
- improved walking speeds and confidence to the point that friends could no longer keep up with them.

It is also important to consider that people who feel more confident are more active. Falls rate should really be considered in the context of falls per hours of activity and, while this is difficult to measure accurately, it has been shown that people with low activity levels are more likely to have falls per 100 hours of activity. People with lower walking speed, low activity levels and muscle weakness are at more risk of falling (Klenk *et al* 2015).

Conclusion

A number of studies have demonstrated that PBBT can improve balance strategies, increase strength, and reduce incidence and impact of falls in the elderly and those with neurological conditions whose balance is impaired. With regard to sports injury rehabilitation, studies have indicated that PBBT may reduce the need for surgery and facilitate the return to participation. Individuals are more likely to return to fuller function following lower limb orthopaedic surgery if they engage in PBBT.

Technology now enables the delivery on instrumented PBBT and delivers unexpected perturbations which are more ecologically valid in the rehabilitation of fallers and sports injuries. In this regard, using the BT to deliver PBBT has been found to offer task-specific training that is safe and well tolerated.

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While the BT provides data regarding the velocity and direction of the delivered perturbation, this data has not yet been validated against any accepted static or dynamic balance test. The Star Excursion Balance Test (SEBT) is widely accepted and used in clinical and research settings. It has been shown to be a reliable measure and has validity as a dynamic test to predict risk of lower extremity injury, to identify balance deficits and inform response to training programmes in both healthy participants and participants with lower extremity injuries. Ethics approval is currently being sought for a study to validate the measures from the BT against the SEBT in a population of collegiate and county netball players. Further studies will evaluate the clinical effectiveness of therapy interventions using the BT in chronic ankle instability.

Additional funding is being sought for a feasibility trial to ascertain whether a falls management programme incorporating BT could reduce the cost of falls to the NHS. It is hoped that this will put the technology within the reach of the average clinic and enable wider adoption of its use throughout the UK.

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PhysioFunction will be holding a series of talks in Northampton in May 2019 on balance that will include a demonstration of the Balance Tutor

For more information and to register your interest in attending the event, please contact **marketing@physiofunction.co.uk**

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COPY DATE FOR *IN TOUCH* 167
SUMMER EDITION 2019 – 25 APRIL 2019

Published by Physio First.
Physio First, Minerva House, Tithe Barn Way, Swan Valley, Northampton NN4 9BA.
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