

## Supplementary File 2.1 Over-arching principles to consider when treating PFP

FINDINGS	ILLUSTRATIVE QUOTES
Considering PFP as a multifactorial condition	
PFP as a multifactorial condition	<p data-bbox="694 438 2027 502">“The biggest thing with Patellofemoral pain is that it’s a multifactorial condition, so you’ve got a lot of different things that cause the problem and then also contribute to the maintenance of pain.” (1)</p> <p data-bbox="694 542 1680 574">“It’s not just one thing that causes it, it’s very much a multifactorial problem.” (10)</p> <p data-bbox="694 614 1993 678">“It’s probably the interaction of two or three (factors) which is the problem, as opposed to having one magic bullet.” (12)</p> <p data-bbox="694 718 2004 758">“Multimodal physiotherapy is the only way we can deal with overuse or repetitive movement disorders.” (14)</p> <p data-bbox="694 798 2027 901">“There’s never one mode that is the end-all, be-all, the only treatment for it. People are complex machines, we need complex methods of assessing them, and therefore there has to be a multimodal approach to treatment.” (15)</p> <p data-bbox="694 941 1332 973">“The holistic approach should be the treatment.” (17)</p>
On the importance of tailoring intervention programs	<p data-bbox="694 1045 2004 1109">“I don’t do a comprehensive multimodal physiotherapy approach for every patient, because not every patient needs it, it’s more targeting that intervention.” (1)</p> <p data-bbox="694 1149 2027 1252">“The gold standard evidence for patellofemoral pain is a multimodal physiotherapy approach, which includes strengthening, taping, biofeedback, hip muscle strengthening, includes patellar mobilisation, massage, taping..... but which actual components each individual needs vary (sic) quite a lot.” (4)</p> <p data-bbox="694 1292 1993 1356">“The multimodal approach can sometimes be quite inefficient in that some parts of the package aren’t really going to help the patient very much.” (8)</p>

“I don’t think there’s ever going to be one programme that’s going to catch everybody and help everyone that has Patellofemoral pain..... you can’t throw one rehab programme and expect everyone to feel better from that, or improve” (9)

“The sad thing is, some patients get all this, they get all four biomechanics, all five flexibility, all five muscle re-education, and that’s what we’re trying to stop.” (11)

“I don’t think there’s a straightforward single approach to everything.” (12)

“Using assessment components to identify a subgrouping layer.” (14)

“If you want to treat someone on a multimodal perspective, you need to determine first what modes should be included in that overall approach.” (15)

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#### Keys to success

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Addressing pain and at what treatment stage

“The most important aspect, probably reducing their pain, that’s obviously what they’ve come for.” (1)

“First of all, you need to reduce their pain..... I think if you can do that within one to two treatments, whether it be with some mobilisations or some tape, they’re going to be much more trustworthy of you and your knowledge about the condition.” (5)

“The key thing for me is the pain. Absolutely, you need to focus on the pain.” (8)

“If you don’t actually deal with the pain, then you can do whatever you like to the biomechanics, but the person won’t improve..... pain will mean that the way the muscles work will be poor... If you get rid of their pain, they think you’re absolutely a genius. Then you can work on the biomechanics.” (10)

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The importance of patient education

“Education, that’s probably the biggest priority of what you need to look at.” (1)

“Education is key.” (2)

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“Education is the key ingredient to any good therapy.” (6)

“Education and exercise are the most important things that we can do. Other things definitely do help, but I don’t think they’re as important.” (7)

“Lack of knowledge, patient-specific advice and education is absolutely critical.” (8)

“It’s always an important component, is to educate your patient.” (9)

“Lack of knowledge, and that’s where the biggest piece” (15)

“Patient-specific advice and education is critical.” (16)

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Empowering the patient through education

“Educating the patient to make sure they understand what’s causing their pain and how it’s developed and what they can do to try and fix it.” (1)

Educating a patient about how much of a role loading plays in their pain, how it relates to their aggravating activities, and educating them that they can actually change their pain, they can get to a point where they can manage it.” (5)

“The most important thing I was able to do was educate the patient on what was wrong with them and what they needed to do to help themselves to get better.” (7)

“Help them to understand what may be causing their pain..... it helps the patient have confidence in the treatment plan that you’re giving to them.” (9)

“If the person understands what’s going on, then it’s a really important step towards how they can improve it.” (10)

“Encouraging the patient to be a little bit more educated about what’s happening, to realise that the treatment is not necessarily going to make things better immediately.” (11)

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“It is important to educate the patient on the potential causes of their pain and why, because I think it helps them quite a bit, because a lot of times they don’t know and they’re frustrated by it.” (12)

“Teaching them how to symptom-manage and understand what to do when they have relapses and how to get going again.” (13)

“I spend a lot of time explaining to patients, so that they understand why they’ve got this pain.” (14)

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On the issue of patients actively engaging or being passive recipients of therapy

“Some people are looking for the passive laying on of hands, the cure, and all that kind of stuff, and for Patellofemoral pain, that just isn’t where it’s at.” (8)

“Explain to the patient that there’s a balance between intrinsic (active) and extrinsic (passive) therapy.” (1)

“Unless you establish a very good therapeutic alliance early on, you’re going to be doomed to failure..... You’ve really got to get the patient to do an awful lot of work independently of the therapist.” (4)

“I think a large component of it is what the patient is willing to do for themselves. Because a lot of the treatment is quite exercise-based, and involves a bit of a time commitment on their part.” (5)

“Educating them on the benefits, or lack of benefits, of ultrasound, interferential types of external modalities” (15)

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Managing expectations

“Educating (patients) that patellofemoral pain is often not something that you can cure or fix long-term, it’s something that people generally live with for the rest of their life, there’s sometimes cure to it.” (1)

“I don’t believe that anyone is cured.” (5)

“This condition is not cured, it is managed, and that’s completely different.” (10)

“I think therapists spend too much time thinking they can cure this, probably instead of actually trying to educate the patient on how to manage it.” (13)

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Activity modification

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Controlling the amount of loading activities

“Modifying either the rate that you’re running, the distance or the time that you’re running, or alternating walk-run periods so that you’re still running.” (5)

“I basically advice everyone to reduce their primary aggravating activities.” (7)

“the initial advice may be to reduce the activity that’s causing the pain. So, it might be climbing stairs, it could be squats, it could be running.” (9)

“I tell people to stop doing the activities that cause them pain until we can correct their movement patterns.” (9)

“There’s a certain amount of activity modification that needs to be done. And that might be a small amount or quite a big amount.” (11)

“Activity modification. Very important, initially, that’s very important.” (12)

“That’s incredibly significant, if we can offload the tissues (through activity modification), they don’t hurt.” (13)

“I think that’s really important” (activity modification) (14)

“Number one (is) reduction of primary aggravating factors. You’re going to see a reduction in pain and symptoms just from doing that alone.” (15)

“I think that you need to reduce the aggravating factors in the sports activities that are causing pain. I’m a big, big advocate of not things in pain, because I really believe that what you end up doing is you end up compensating your movement patterns for the pain, and that can get you into other trouble.” (16)

“Reduction of primary aggravating factors is very important, but it’s only a solution on a short-term.” (17)

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The importance of individualising

“You can’t ask someone to just stop their activity.” (9)

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activity modification

“I think it’s a very negative thing to say, ‘oh, you’ve got to stop doing all of those things.” (10)

“You can’t ask a runner to stop running, you can only ask them to be reasonable about the mileage that they incur on a weekly basis.” (15)

“Changing people’s activity patterns, just initially to reduce the abusive load is critical, looking at either the pattern or the total load, but then gradually re-establishing that.” (4)

“You need to return to activity steadily and allow the tissues to readapt to the load, which is probably just as important as how they are loaded.” (13)

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Addressing psychosocial factors

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Identifying psychosocial factors

“Psychological or psychosocial interventions that really, if you’re thinking about someone with chronic Patellofemoral pain, and particularly those young girls who have had it for so long and no matter what you try, it doesn’t work, I think introducing more kind of psychosocial, or a more psychosocial approach, is likely to be beneficial.” (5)

“(There is) a sort of psychological subgroup, that you can look at their biomechanics and their activity patterns until the cows come home, but until you sort out the psychological component of their problem, it isn’t going to make any difference

“There’s always, probably, some underlying psychological or some psycho-social issues.” (9)

“The one thing that is here that needs to be thought about is, which patients aren’t going to benefit from treatment..... there’s a psychological element, and there are certain patients who will not benefit from physiotherapy.” (11)

“Anyone with chronic pain of anything, there definitely becomes a psychological component to it. I definitely think that is a compounding factor.” (12)

“There’s a psychosocial component to every long-standing pain.” (13)

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Addressing fear-avoidance behaviours

“Sometimes patients are very fearful of even moving and unless this is addressed they just decondition and that makes the problem worse.” (1)

“Particularly in the younger girls I see, they have this fear of movement, this fear of loading up their knee, and so they actually offload so much that they get weaker and therefore more pain.” (5)

“For patients that become phobic to certain activities or become a little bit anxious about doing certain activities, the advice is that, you know, those activities are probably very important to do and that they need to be done in particular ways, in which they’re not painful, and that certain treatments and certain exercises might well benefit them.” (6)

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## Supplementary File 2.2 Exercise Prescription Principles

FINDINGS	ILLUSTRATIVE QUOTES
Dose	
Dose considerations in relation to compliance and quality	<p data-bbox="698 427 1944 459">“The simpler you make it, the better it is, the more likelihood you have of someone being compliant.” (1)</p> <p data-bbox="698 491 2040 563">“Try to keep it around no more than three to four (exercises).... We don’t give them more than 20 minutes a day worth of work, and we find that’s the best approach.” (15)</p> <p data-bbox="698 603 2033 675">“Give the patient some very specific activities, and usually a relatively small number of activities, but the patient has to do them very, very well.” (8)</p> <p data-bbox="698 715 2033 786">“I kind of have a three exercise policy in that I don’t like giving people more than three exercises, because they never do them.” (5)</p> <p data-bbox="698 826 2040 898">“I give them no more than four exercises to do, that they can do any time, any place, anywhere..... you want it to become part of their daily routine” (10)</p>
Closed and open chain exercises	
The link between closed kinetic chain exercises and restoration of normal function	<p data-bbox="698 1010 2007 1042">“I focus a lot on closed chain exercises and exercises specifically that will incorporate the hip musculature” (9)</p> <p data-bbox="698 1074 1783 1106">“I always do closed kinetic chain, and mainly because I think it’s specificity of training.” (10)</p> <p data-bbox="698 1137 1962 1169">“Closed chain exercises are probably going to be more useful for re-engaging patterns of movements.” (2)</p>
The perceived value, or otherwise, of using open kinetic chain exercises	<p data-bbox="698 1281 1888 1313">“It doesn’t really matter what you do (open or closed chain), as long as it’s relatively pain-free.” (11)</p>

“Open kinetic chain or closed kinetic chain, I think both are going to be effective, depending on what your focus is. “ (15)

“Open and closed kinetic chain, I’ll take them together, I think both are very important in a combined use of both, not one of them but both, and we do have some evidence that seems or shows that it’s important.” (17)

“We’re usually looking to work closed chain but there are some benefits to open chain.” (4)

“I’m not a big fan of open kinetic chain..... I wouldn’t seriously bother with those, (they) don’t do anything remotely useful when it comes to the control mechanisms.” (8)

““Don’t do any straight leg raises, because they will make it worse..... anything where you are straightening your leg out with no weight on your foot, is no good..... all it does is irritate your fat pad.” (10)

Preferences for open or closed chain

“Open versus closed, my preference is closed kinetic chain, because it is more functional.” (5)

“I think it’s a must to include closed chain exercises. I don’t think it’s a must to include open, but I don’t think it’s detrimental to include open kinetic chain.” (9)

“If this person is significantly weak compared to the tasks they need to undertake, then open chain exercises are going to help to facilitate getting over that critical level of strength.” (12)

“I obviously use more closed chain, I think, definitely. But a lot of times I start off open chain, initially, especially if they’re really painful.” (12)

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Supervised or Unsupervised exercise

Importance of supervision

“I think supervised exercise, unless someone is very independent, very knowledgeable, supervised exercise

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initially is critical, so they get that feedback.” (4)

“(If) you’ve got direct supervision, not only their techniques and making sure that they’re getting the right activation of the right muscles, but also if there’s someone there telling them, ‘right, now, you do your exercises,’ obviously, you’re going to get a better effect.” (5)

“It’s very important to have good form when you’re doing any exercise.” (6)

“You spend a lot of time supervising the patient initially to get them to do the exercises properly. Once you’re confident that the patient’s doing the exercises properly, then the unsupervised exercise is massive.” (8)

“Very strong advocate of supervised exercise. I don’t like unsupervised, because a lot of the times patients end up doing it wrong.” (12)

#### Practicality of supervised exercise

“I would see my patients, at most, once a week, usually more like every two to four weeks, so that’s just not an option to supervise them.” (5)

“We need to supervise it to some degree, because we need to make sure that they’re doing it correct. And then I think you need to make sure that they can do it on (their) own ..... our job is to get them independent.” (16)

“I definitely think that unsupervised, or doing exercises on their own can be done and people can feel better.” (9)

“I expect them to do a home programme, so that if I’m going to change the behaviour pattern of the muscle, they need to practise, and practise is very important.” (10)

“I’m a big fan of unsupervised exercise. These people can’t come in every day, or even two or three times a week, they have to be educated to the level where they can do unsupervised exercise and do it properly.” (15)

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## Other Principles

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On balancing muscle strength and movement control

“I have a gut feeling that a good strengthening programme is as good as most motor control programmes, providing that there is good posture and form during exercise and that pain are not exacerbated untoward.” (6)

“Power is nothing without control. And, to me, that’s pretty much it. What we’re doing, as physiotherapists, is very much about trying to improve control at some level with the patients, and if you can improve that control, that will have an impact on their pain.” (8)

“I would be favouring isometric to slow contractions of reasonably high load that are pain-free and done in good form, would be the exercise programmes I would be keen on doing, as opposed to low-load slow contractions that try to balance of VM and VL.” (6)

“Moving to power exercise, high-velocity, power exercises, are important if someone wants to go back to sports that acquire that kind of functionality.” (6)

Exercise principles to optimise outcomes

“They do need to maintain some programme to prevent a recurrence. And it may only be once a week, or incorporating a couple of really simple VMO or gluteal type exercise into their usual exercise programme.” (4)

“Exercise needs to be done regularly, there’s not much point in doing exercise once every now and again when you go and see the physio. Exercise, for the most, needs to be repeated for it to be of any benefit.” (6)

“(Exercises should) facilitate them getting back into functional activity. So, if their problem was going up and downstairs, exercises that help them to achieve that, or if they want to get back to running, exercises that help them to achieve their goals.” (7)

“Let’s say someone does an exercise, an activity, and it gives them a two out of ten pain, which then resolves within minutes of finishing the activity, that’s going to be perfectly acceptable, as opposed to somebody who

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gets a two out of ten pain which then persists for a number of hours afterwards.” (12)

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## Supplementary File 2.3 Exercise Specifics

FINDINGS	ILLUSTRATIVE QUOTES
Foot and ankle	
Exercises to control foot pronation	<p data-bbox="696 427 1984 496">“Those people (with excessive foot pronation) could benefit from being given foot muscle exercises to allow them to elevate their midfoot.” (9)</p> <p data-bbox="696 536 1581 564">“I do foot exercises, ... train the tibial posterior and peroneus longus.” (10)</p> <p data-bbox="696 604 2024 715">“I would much rather teach that foot to be stronger – and we don’t have a lot of evidence for that yet, but ... by strengthening the foot so it does it on its own and doesn’t need a brace to hold it up, I think would be a much better way to approach a musculoskeletal injury like that. ” (16)</p> <p data-bbox="696 754 2040 783">“We promote barefoot running, minimal footwear running, strengthening the feet as opposed to orthotics.” (16)</p>
Quadriceps	
The importance of quadriceps strengthening	<p data-bbox="696 898 2029 962">“If they’re just kind of generally weak and a bit low tone, then even some really basic quad strengthening, like a one-leg rise, or a two-leg rise.” (5)</p> <p data-bbox="696 1002 1554 1031">“Quadriceps strengthening is a component that should be included.” (9)</p> <p data-bbox="696 1070 2040 1181">““Someone with chronic Patellofemoral pain that has an atrophied quad and – critical muscle, we’ve got to build that up. However, I do see a lot of patients with Patellofemoral pain that have no quad weakness. If anything, they have hypertrophied quads. And I would not be strengthening them.” (12)</p> <p data-bbox="696 1220 1984 1292">““If you strengthen the quadriceps, you relieve Patellofemoral pain..... (That) changes the loading within the joint, and so improves the local situation.” (13)</p>

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“Quadriceps strength, I don’t really focus on too much, I think it’s probably more associated with the condition and it’s due to disuse rather than the fact that they’re actually – the weakness is what’s caused the problem.” (1)

“Rarely, if ever, do we prescribe quadriceps strengthening ..... quadriceps (strength) is not the root cause of the injury, it’s the resultant of the injury and the pain” (15)

“It’s where we go from there which is probably just as critical.” (13)

“The root cause of the injury lies elsewhere in terms of improper hip and/or foot mechanics, lack of strength, flexibility, other places.” (15)

The combination of VMO exercise with quadriceps exercises

“Most people would get some sort of VMO timing retraining, so, trying to get their VMO to switch on before VL as opposed to more the strength based stuff.” (5)

“Quadriceps strengthening, I do very specific strengthening..... I do it with biofeedback, so people get information about how their quads are working. I will mostly do it in weight-bearing, I will do little tiny small squats, (and) in conjunction with getting the gluteal working.” (10)

“VMO might be in an atrophied state. So, if that’s the case, then we’ll prescribe some quadriceps strengthening.” (15)

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Gluteal exercises

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Importance of gluteal/hip strengthening

“I might look at doing strengthening exercises at the hip in order to try and facilitate hip and pelvic control, preventing hip adduction, pelvic drop.” (1)

“I will do a lot more hip-down work.” (4)

“There’s not a lot of evidence for hip strengthening, but I use hip strengthening routinely.” (7)

“There’s quite a body of evidence now to suggest that patients with Patellofemoral pain have weak hips, and

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therefore, then, that should be part of the treatment.” (11)

“Most patients benefit well from hip strengthening and hip control..... if they’re weak at the hip, then poor hip mechanics, definitely got to get the hip strengthening.” (12)

Using functional exercise to facilitate gluteal strengthening

“Hip-strengthening, again, I try and incorporate that in a more functional sense, so more the single leg squat type exercises. If someone’s really struggling, though, a simple clam or a hip abduction inside lying is generally what I would use, or some theraband.” (5)

“I’m going to start back sort of with simple close chain activities, maybe like a wall squat or some hip hikes or something, just to get them using their hip musculature.” (9)

“I do gluteal strengthening..... I don’t do clams, I don’t do any of the non-weight-bearing stuff.” (10)

Balancing strength and control at the hip

“For many patients, regaining control of hip function as opposed to strength is very important.” (1)

“It’s more about correcting their movement patterns and then strengthening their hip musculature.” (9)

“(If) you’ve got good muscle control, you’ve got the problem sorted.” (8)

“I believe that gluteal control is very important, and we’re not just talking about gluteus medius but also gluteus maximus, particularly in people that are running.” (10)

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Core

Incorporating core strengthening

“There’s no evidence for trunk strengthening and I would use trunk strengthening quite frequently.” (7)

“Trunk strengthening, I think it’s important for postural control and dynamic control of movement.” (14)

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“We do a lot of core stability.” (16)

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Biofeedback

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Using electromyographic biofeedback, or not, to retrain VMO

“I don’t really do anything to do with their vastii timing or biofeedback... (1)

“Biofeedback-wise, I actually don’t use it in a clinic because I think it takes too long.” (5)

“I’m not a big fan of using biofeedback EMG. And I would be putting a lot of emphasis on strengthening and the proximal end rather than on VM-VL rebalancing..... It’s very hard for patients to pick up on and I only go there if, you know, there’s very little else I can do with them.” (6)

“I haven’t used that (VMO biofeedback) as a key component of any of my rehab that I’ve ever done.” (9)

“The trouble is with the biofeedback tool’s actually quite naff, and so they may not be giving you an awful lot of feedback themselves..... whether or not you think that’s accurate enough to show those differences. Because these differences are in milliseconds.” (11)

“I don’t believe there’s a way you can train VMO in isolation. I don’t think there’s the evidence base to do it.” (13)

“Biofeedback (to retrain VMO), I don’t use it much in patients anymore.” (17)

Incorporating other forms of biofeedback to improve hip and knee control

“I use a lot of biofeedback in my practice, especially related to the hip.” (12)

“The single leg squat is probably the one that I would use most often, clinically, and getting them to squat with a much better alignment, so keeping a horizontal pelvis but also the knee of their squatting leg, directed forward and not collapsing medially.” (5)

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“Video feedback is going to give you an ability for the patient to understand better what they’re doing wrong.” (13)

“I love biofeedback, I think it can come in many forms, so the retraining, we’ve moved biofeedback using biomechanical data, like forces, or tibial shock or angles. But I think that you could use EMG, you can use a mirror I think biofeedback, we don’t really capitalise on it as much as we should.” (16)

“Exercises in front of mirrors, is about trying to give the patient the feedback about their control mechanisms, which is about improving the pattern of activity.” (8)

“Video people on their own phones doing their exercises when we teach them..... people actually come back doing the right things, it’s amazing.” (4)

“Get them to do it in front of mirrors, so that they can actually get the visual feedback, so that they can see whether they’ve got the control or they haven’t got the control.” (8)

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## Stretching and addressing flexibility

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### On the importance of stretching

“Flexibility, range of motion, often look at that, maybe not as immediate priority but certainly longer-term, that can certainly help in terms of stretching.” (1)

“Flexibility is often compromised, particularly ITB but also hamstrings, calf, and often the quads, often positive trigger points in quads, TFL, ITB.” (4)

“Stretching, I use if people appear to have tightnesses in their muscles and they appear to be related to their pain.” (7)

“I think flexibility/range of motion is an adjunct.” (9)

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“Flexibility, range of motion. Stretching. I don’t use it that much. Only if it’s really tight.” (17)

The importance of ITB stretching

“I don’t think you can stretch your ITB, and that’s where the foam roller is much more effective in terms of releasing tension in ITB.” (5)

“I’m not a great fan of the Iliotibial band stretching ..... the Iliotibial band probably is a non-modifiable factor.” (8)

“Iliotibial band stretching, I tend to do more specifically, so that it stretches the distal component.” (10)

“Sometimes, in my clinical practice, if it’s (ITB) shortened we do it. I don’t believe that much in it.” (17)

Addressing hamstring flexibility

“Hamstrings, I think people need 80 degrees of hamstring range for normal everyday function.” (4)

“Stretching, I think, is definitely important, particularly calf-hamstring.” (5)

“I think the evidence base for flexibility, particularly around the hamstrings.” (8)

“I will do a hamstring stretch if the hamstrings are tight. You have to be a little bit careful with that, because hamstring stretching can often cause the patella to push down into the fat pad and cause an increase in symptoms.” (10)

“There’s a high degree of association between short hamstrings and Patellofemoral pain.” (13)

Addressing calf flexibility

“Calf, I think you need 15 degrees of dorsi-flexion minimum or else you’ll get compensation at the knee and/or the foot.” (4)

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“Stretching, I think, is definitely important, particularly calf-hamstring.” (5)

“If gastroc and the hamstring are really tight, then you’re going to be walking around on the flexed knee the whole time, which is then going to increase the overload on the Patellofemoral joint..... increase the flexibility, and you’re going to decrease the load on the Patellofemoral joint, and, again, you’re going to reduce the pain.” (8)

“Calf stretching, if it’s appropriate ..... sometimes just stretching the calf is sufficient to minimise the excessive pronations through the midfoot.” (10)

“Certainly dorsiflexion, range of movement, without collapsing into a sort of pronated position which drags the knee inwards, which is likely to be significant.” (13)

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## Supplementary File 2.4 Movement Pattern and Gait Retraining

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### Movement Pattern and Gait retraining

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#### Potential effects of movement and pattern gait retraining

“I do gait retraining ... rather than focusing on exercises, focusing on the actual movement pattern and teaching them how to move properly ... it makes logical sense, and it works, certainly clinically.” (1)

“certainly those things that tend to reduce load through the lower limb, like getting a little bit more mid-foot to fore-foot stroke, rather than heel strike, shorter stride lengths, staying more upright in terms of your trunk and then trying to land a little bit more softly, tends to reduce that impact that you get up through your lower limb, and I think that has an effect on people’s pain, or certainly runners with pain.” (5)

“I try and do movement pattern retraining, with most patients.” (7)

“We really need to think about ways of changing the way someone sits, stands, goes up and down stairs, walks, and really make a very small subtle change, so they’re not staying in their end of range. And, if we do that, the patient will stay symptom-free.” (10)

“We do gait retraining with the majority of the patients that we see. Just strengthening alone is not going to change mechanics.” (16)

“Trying to retrain a normal movement is very important for the patient.” (17)

#### The challenges of implementing gait retraining

“Clinically, I don’t have the time necessarily to spend with someone, implementing the types of programmes that they use in the studies, particularly the real time feedback.” (5)

“Gait re-training is very difficult, and I would only do it on somebody who was really, really struggling to get back to reduce their pain, and I’d done everything else and they weren’t getting any better.” (7)

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“It takes a good amount of work to really be able to change somebody’s movement patterns.” (9)

“I don’t think it’s a viable option at this point in time ... “the naked eye cannot discern what is atypical. Even a 2-D system cannot really determine what is atypical. So, in order to determine what are the atypical movement patterns, you need a 3-D system.” (15)

“it’s very easy to see. We’ve videotaped them, it doesn’t take a lot of high-tech equipment.” (16)

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## Supplementary File 2.5 Taping, bracing and orthoses

FINDINGS	ILLUSTRATIVE QUOTES
Patellar taping and bracing	
Taping use and effects	<p data-bbox="698 427 1391 456">“In terms of pain, I think taping is often very effective.” (1)</p> <p data-bbox="698 499 1989 563">“I would tape most people. Really, the only time I wouldn’t is if they don’t want to be or if they’re allergic to tape. “ (5)</p> <p data-bbox="698 606 1126 635">“And I tape if people have pain.” (7)</p> <p data-bbox="698 678 1968 742">“You’ve got to tape them. Tape is the best thing to relieve pain..... You’ve got to tape all the time, until the pain’s decreased. ” (10)</p> <p data-bbox="698 785 1644 813">“It will decrease pain, quite dramatically, and almost unbelievably quickly.” (11)</p> <p data-bbox="698 857 1361 885">“(Taping is) useful in the short term for pain relief.” (12)</p> <p data-bbox="698 928 1503 957">“Taping of the Patellofemoral joint, not a big fan of that myself.” (6)</p> <p data-bbox="698 1000 2020 1099">“it’s a band-aid, basically, I think it helps alleviate pain, there’s good evidence to support that, but it’s not fixing the cause of the pain. So, you use it as an adjunct or an aid to get you to do something else, I think, is the very beneficial thing.” (12)</p> <p data-bbox="698 1142 2020 1209">“I don’t use it ..... I think if you can compress the patella, I think you can actually probably reduce pain, because what you’re doing is you’re reducing the contact stress.” (16)</p>
Bracing use and effects	<p data-bbox="698 1289 1738 1318">“I don’t think they work particularly well and I would tend to use tape over a brace.” (5)</p> <p data-bbox="698 1361 2020 1390">“If I were going to use bracing, it would be more for symptomatic purposes, to allow me to do something else.”</p>

(12)

“Bracing, I would only use for someone who couldn’t tape because their skin wouldn’t allow it, or just if they needed to use something for a longer period of time, or they didn’t want to tape.” (7)

““Bracing is not specific enough. I think you’d need to get it so you individualise it to each patient, the amount of tension and where you put it, particularly if you’re in a load of pain.” (10)

“The clinical reasoning for bracing is that you’re supposed to be able to control the patella – which is a load of rubbish.” (11)

“I don’t use it (bracing) that much, only if I think, in an active way, the patient will not get better. So, it’s an aid for getting better, if nothing works.’ (17)

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#### Foot orthoses

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When foot orthoses prescription is considered

“I use on a lot of people..... In some cases, just having something in their shoe, even if it’s just an off-the-shelf or prefab device, with minimal adjustment, I think that helps with their general alignment and their activation of their VMO and their glutei.” (5)

“Not every single person that comes in would require some sort of orthotic treatment.” (9)

“Foot orthoses alone are never the solution, and it has to be combined with some type of flexibility, muscle re-education, etcetera.” (15)

“Foot orthoses are much too much prescribed. So, I don’t believe that much in them.” (17)

“Use foot orthoses for reduction of pain..... But, like with most other conditions, you don’t always look at them as a long-term fix, it’s more just to take them out of pain.” (1)

“It’s not something I would do, at this point in my career, because I think that, long-term, you can do more damage than good. (In) the short-term, they can be helpful.” (16)

“People that are more mobile are more pronated in the foot, probably more likely to respond to a foot orthoses.” (5)

“People that have midfoot collapse, so that they have poor control through their subtalar joint, may benefit from an orthotic.” (9)

Prescription specifics for foot orthoses

“Because I am thinking temporary in most cases, I will usually opt for prefab. They are also cheaper and can be dispensed faster.” (1)

“Foot orthoses, I use, usually prefabbed.” (7)

“Foot orthoses, I do use, I use them, and I mostly use prefabricated. “ (10)

“Stick an orthotic under their foot, or you actively hold their foot and get them to squat again. And, if all of a sudden, their whole biomechanics is much better with that single squat and they say, ‘oh, my pain’s much better,’ then that immediately indicates, ‘okay, we need to focus on the foot.’” (1)

“Adjusting their foot, even manually, or with tape or with an orthotic and getting them to repeat an activity.” (2)

“If they’re struggling with their exercise intervention and they respond well to either a foot orthoses put under their foot or taping put under their foot, and a reassessment of a clinical activity, so, a squat or a step down.” (7)

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## Supplementary File 2.6 Adjunctive interventions

FINDINGS	ILLUSTRATIVE QUOTES
PFJ mobilisation	
The use, or otherwise, of PFJ mobilisation	<p data-bbox="698 427 1435 459">“Joint mobilisation, I would, probably use in most people.” (5)</p> <p data-bbox="698 497 1906 561">“If people had pain, I would do mobilisation and massage for the patella and around the patella, even though there’s no evidence for that.’ (7)</p> <p data-bbox="698 606 1951 705">“Mobilisation gets you the lot, because it’s very effective at giving short-term relief..... But, without other approaches on top of it, changing behavior, changing the way the patient moves, is likely to not be successful in the medium and long term.” (13)</p> <p data-bbox="698 750 1435 782">“It doesn’t often have a restriction I can find to mobilise.” (14)</p> <p data-bbox="698 826 1599 858">“I think it’s an adjunct, but I don’t think there’s a lot of good evidence.” (16)</p> <p data-bbox="698 896 1599 928">“I never do it, because I think the mobility is always good or too good.” (17)</p> <p data-bbox="698 967 1951 1066">“It’ (PFJ mobilisation) s non-functional, it’s non-weight-bearing, the patient doesn’t have any control over it. So, it’s a very passive kind of intervention, in a condition that I feel very fervently that the patient has to have their own level of control over managing their condition.” (8)</p>
Indications for PFJ mobilisation	<p data-bbox="698 1152 1939 1216">“Where people who have got restricted Patellofemoral joint, we’re looking to mobilise those tissues and really maybe spend quite a lot of time doing so.” (4)</p> <p data-bbox="698 1254 1957 1318">“If someone’s really restricted in their medial Patellofemoral joint glide, they’ll tend to recover really well, through a combination of that with ITB release, with VL release.” (5)</p> <p data-bbox="698 1362 1935 1394">“Joint mobilisation, I certainly will stretch the tight lateral structures with a lateral glide or a tilt..... (but)</p>

hypermobile patellas, I don't mobilise those." (10)

'If it's (the joint) hypermobile, the last thing you want to do is start mobilising the joint even more. If it's hypomobile, then you might have some rationale for trying to stretch the soft tissues." (11)

"Joint mobilisation, the only indication here is if you have a patella that is restricted..... If anything, there are more chronic Patellofemoral people, with more hypermobile patella and therefore joint mobilisation would not be indicated." (12)

"If you have someone who has a very mobile patella, and that would be someone who has a subluxing patella, then those people wouldn't require mobilization." (9)

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#### Foot and ankle mobilisation

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Addressing foot and ankle mobility limitations

"If motion is limited in the sagittal plane, this should be addressed through soft tissue or mobilisation. Otherwise more pronation is likely and this will cause medial collapse at the knee." (1)

"I will mobilise the subtalar joint, to improve calcaneal inversion, to improve shock absorption." (10)

"I sometimes mobilise the great toe, the first metatarsal phalangeal joint..... it can be quite stiff, and so that'll affect push-off, and then you'll internally rotate." (10)

"Just because somebody pronates, doesn't necessarily mean they need an orthotic. You have to look at why they're pronating, and address that as well, whether it's a motion restriction or weakness or whatever else." (12)

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#### Acupuncture or Dry Needling

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Using or not using acupuncture/dry needling use

"I would still do a bit of dry needling." (7)

"I do send people for acupuncture, I don't do it myself..... I would send someone who has recalcitrant Patellofemoral problems. So, if I feel that acupuncture will help, even though there's not a lot of evidence." (10)

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“I use acupuncture.” (11)

“It’s not something that I’d rush off to do.” (6)

“I think acupuncture in general doesn’t work, so, I don’t believe in it.” (17)

“I think acupuncture is quite useful in the patients that have got the more ischaemic end of the problem.” (8)

Using acupuncture/dry needling, or not

“If they’ve got a tight ITB complex or tight quadriceps in general, then acupuncture can help quite a bit with that.” (1)

“Good for trigger points, too, so trigger point acupuncture as well as TCN-type acupuncture.” (4)

“Acupuncture is not something I do. I do dry needling, particularly into trigger points or into their ITB.” (5)

“Acupuncture I’ll use, I think, if there’s aspects to the presentation to do with chronicity or other factors, sleep issues, hormonal issues, sometimes good for people who are maybe hyperalgesic” (4)

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Massage

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Massage use and effects

“Massage, probably along with some of the stretches, such as hamstring and hips, I’d probably go less towards, because I really struggle to see how they’re adding value to the situation.” (13)

“I think it’s more palliative, I don’t think it really gets at the underlying cause.” (16)

“Massage. I don’t think there is a place in the Patellofemoral joint for it.” (17)

“I would use massage for release of tight tissues, particularly ITB and lateral retinaculum. I think it’s also

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very good for those people who might have some Patellofemoral pain post-op, or might have some more kind of neurally-central sensitisation type processes going on.” (5)

“I do massage if people are tight through their lateral structures or calf or hamstrings, because I think that local massage or acupuncture often works better than stretching.” (7)

“(If there is) a very tilted patella, such that the lateral border is very close to the femur would benefit from soft tissue massage around the lateral structures.” (9)

“I do soft tissue massage on the lateral retinaculum, looking at deep and superficial fibres, particularly if it’s tilted. I will do soft tissue massage around the knee, particularly if they’re got an effusion, and that is usually quite helpful and patients like it.” (10)

“I think massage plays a big role and people underestimate the effective of massage, just in terms of getting – I would say massage is far more effective than have somebody stretch their IT band or even do fascial lengthening, that’s rolling. So, more times than not, we actually recommend one or two massage therapy visits, in combination with our home programme.” (15)

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## Ultrasound

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### Ultrasound use and effects

“Ultrasound, yeah, don’t use it, don’t like it, don’t think it works.” (5)

“I don’t use ultrasound at all.” (7)

“Ultrasound, oh God, I wouldn’t bother with that, personally..... I’ve generally found that electrotherapy is a complete waste of time for Patellofemoral pain.” (8)

“I never used ultrasound, but that’s just me.” (10)

“I would never use ultrasound.” (11)

“I don’t overly see where it adds to value within the patient management of these sort of patients.” (13)

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“If somebody’s doing ultrasound on a Patellofemoral joint, that’s bad medicine.” (15)

“I don’t do any ultrasound at all. I don’t know that there’s a lot of good evidence for ultrasound.” (16)

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## Supplementary File 2.7 Gaps in evidence and priorities for future research

FINDINGS	ILLUSTRATIVE QUOTES
Pain and pathology	
Understanding risk factors and developing prevention programs	<p>“looking at people who don’t have pain tracking over time, and identifying whether biomechanics differ in those who develop pain. There’s very little research on that, so that’s an area that needs to be explored a lot more.” (1)</p> <p>“Prevention’s probably the holy grail.” (4)</p> <p>“We don’t have a lot of prevention studies.” (7)</p> <p>“We need a lot more risk factor data..... We have lot of theories but there’s not a lot of evidence.” (9)</p> <p>“We need to discriminate a lot more as to cause and effect, rather than just an association.” (13)</p>
The source of pain	<p>“We don’t actually know the source of the pain in Patellofemoral Pain.” (1)</p> <p>“What’s the generator of the pain?” (8)</p> <p>“What structure’s causing the pain? ..... Because once we actually find that out, I think then we can actually be much more targeted in decreasing someone’s pain.” (10)</p> <p>“Priority, try and understand what causes the pain and where does it come from ... because if we understand that, then we can design better intervention and prevention strategies.” (12)</p>

Identifying those likely to become chronic

“I think the evidence is kind of lacking in identifying those that don’t get better, and finding a way in which to get them better or trying to find a slightly longer-term solution to the problem.” (2)

“We need to better understand what it is that makes the condition become chronic.” (5)

“There’s some evidence that a quarter of the people that get it when they’re young can still have it many years later. So, being able to identify them is probably something that we also need to be able to do.” (6)

The potential relationship between PFP and PFJ OA

“(We need to) work out the relationship between Patellofemoral pain and Patella Osteoarthritis.” (7)

“Trying to understand does Patellofemoral pain lead to osteoarthritis later in life? I think that’s a huge area that hasn’t been touched on..... it would really help to show why it’s so important to help individuals that have Patellofemoral pain or even prevent it from developing in the first place.” (9)

“(It would be) interesting is to see if Patellofemoral pain gives a higher chance of Patellofemoral arthritis.” (17)

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## Treatment principles

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Approaches to patient specific advice and activity modification

“It would be great to have a sort of smorgasbord of patient-specific advice, so you can pick out the right bits.” (4)

“Having some guidelines on that (activity modification), I think, would be quite useful.” (8)

“How you reload these individuals, in terms of the rate of reloading and the nature of that reloading, which is probably more critical than the offloading.” (13)

Sub-groups and tailoring interventions	<p>“I think we need to try and develop research around identifying subgroups that are likely to benefit (from various interventions). That’s probably where the biggest gap lies.” (1)</p> <p>“We don’t know how best to combine different approaches for different patients.” (2)</p> <p>“We could do with more work on predictors of outcome, predictors of success.” (4)</p> <p>“Our ability to target individual patients with an evidence-based approach, I think is an area which is most lacking ... The priority has definitely got to be looking for predictors of outcomes for different treatments.” (6)</p> <p>“The priority is, now, how to work out how to subgroup people, so that we can provide better interventions.” (7)</p> <p>“Developing a system whereby we can categorise patients in subgroups and then develop specifically targeted interventions for those subgroups, for me, that’s the way ahead.” (8)</p> <p>“The evidence is still about a scattergun approach, giving patients everything because one of them is likely to work... I think to identify subgroups, I think that’s important.” (11)</p>
The effectiveness of longer term interventions (i.e. > 6 weeks)	<p>“Most of the interventions have been quite short, and I think that, in clinical practise, we tend to treat people for longer. And so I think that we need to evaluate whether a longer intervention will provide better results..... I think the six week intervention is too short.” (7)</p>
Improving our understanding of the impact of psychosocial factors on PFP	<p>“Nobody’s really looked at the psychosocial aspect of whether that predicts whether someone will get Patellofemoral pain.” (5)</p> <p>“The psycho-social aspects of having had chronic pain and fear of movement, catastrophising, those sorts of things have not been looked at.” (7)</p>

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“We know there are some psycho-social factors for injury in general, that play a role, and individuals getting injured, there is evidence for that. So, it’s a possible area that could be further investigated.” (9)

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Specific interventions

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The relationship of the foot, footwear and orthoses to pathology

We don’t have strong evidence for a relationship between the foot and the knee ..... that’s not because there’s not a relationship, I think it’s because we may not be looking at the right mechanics.” (16)

“We don’t really know how foot orthoses change the biomechanics of the Patellofemoral joint..... we know nothing about customised foot orthoses, both with respect to biomechanics or efficacy.” (7)

“Footwear would be interesting, both from an efficacy and from a biomechanics point of view.” (7)

“I think we need to understand a little bit more about what’s going on with the foot, up.” (16)

The value of proximal strengthening

“The gaps are clearly in hip strengthening. And I also said earlier, I think there are gaps in trunk strengthening.” (7)

“People are going to start moving in to the core and the trunk also.” (9)

“Looking at the hip, and the way in which the hip contributes to Patellofemoral pain, is an area we need to look at more..... looking at hip forces in non-arthritis Patellofemoral pain, might also be a useful thing.” (11)

The value of gait retraining

“Gait retraining is an emerging area which requires further evaluation.” (1)

“There’s good stuff that’s looking at retraining movement patterns and retraining the way in which people move, to try and modify their pain. I think that’s something that needs more support and needs more work.”

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(2)

“More gait retraining and sort of instruction on proper movement patterns.” (9)

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