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Development of the PARTNER model: A service delivery model to implement optimal primary care management of people with knee osteoarthritis

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Abstract

Objective: Implementation strategies, such as new models of service delivery, are needed to address evidence-practice gaps. This paper describes the process of developing a new model (PARTNER) to deliver recommended care to people with knee OA in the Australian primary care setting.

Methods: Three development stages occurred concurrently and iteratively. Each stage considered the Australian healthcare context and was informed by stakeholder input. Stage 1 involved the design of a new model of service delivery. Stage 2 developed a behaviour change intervention targeting general practitioners (GPs) using the Behaviour Change Wheel framework. In Stage 3, the 'Care Support Team' was operationalized.

Results: The new service provides patients with education, exercise and/or weight loss advice, and facilitates effective self-management through behaviour change support. Stage 1 Model Design - Based on clinical practice guidelines, known evidence-practice gaps in current care, chronic disease management frameworks, input from stakeholders, and the opportunities and constraints afforded by the Australian primary care context, we developed the PARTNER model. The key components are: i) an effective GP consultation, and ii) follow-up and ongoing care provided remotely (telephone/email/online resources) by a 'Care Support Team'. Stage 2 GP Behaviour Change Intervention – A multi-modal behaviour change intervention was developed comprising a self-audit/feedback activity, online professional development and desktop software to provide decision support, patient information resources and a referral mechanism to the 'Care Support Team'. Stage 3 Operationalizing the 'Care Support Team' - Staff recruited to provide the care support were trained in evidence-based knee OA management and behaviour change methodology.

Conclusion: The PARTNER model is the result of a comprehensive implementation strategy development process utilizing evidence, behaviour change theory and intervention development guidelines. Technologies for scalable delivery were harnessed and new primary evidence was generated as part of the process. A randomized control trial and process evaluation will follow.

Article Summary

Strengths and limitations of this study

- A systematic development process was undertaken, involving extensive gathering of evidence and using theory and existing frameworks to inform the various development stages and intervention components, and harnessing available technologies, while remaining mindful of the local context and stakeholder views.
- A limitation of the development process was the degree of subjectivity that remained, as the members of the development group made decisions based on their own research and clinical practice experiences, beliefs and preconceptions.

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Competing interests

DJH provides consulting advice to Pfizer, Lilly, Merck Serono and TLC bio. The remaining authors declare that they have no competing interests.

Key Words

Knee, osteoarthritis, implementation, model of care, behaviour change, primary care, pain, general practice

Introduction

Osteoarthritis (OA) is a prevalent chronic joint condition, often resulting in pain, impaired physical function, psychological impairments, lowered quality-of-life and higher health care costs. While OA has no cure, there are ways it can be managed to minimize its individual and societal impact. Clinically, OA should be diagnosed based on history and physical examination with imaging investigations generally unnecessary [1-3]. Holistic assessment of the individual's medical, social and psychological needs enables a tailored approach to treatment formulated in partnership with the patient. Exercise and weight loss are recommended as first-line, core treatments [1 3-7], in addition to education and analgesic/non-steroidal anti-inflammatory medication with due consideration of potential harms [4 6 7]. Arthroscopy for knee OA pain is ineffective [8] and thus not recommended [9], while joint replacement surgery is advised only when conservative measures fail [10].

In Australia, general practitioners (GP) are the first contact practitioners for most people with knee OA. Studies have demonstrated that this primary care is often inconsistent with clinical guideline recommendations [11-13]. Evidence-practice gaps lead to inappropriate care [11 12], poorer outcomes [14] and increased costs to the health system, primarily due to increased disability and surgical rates. The need for effective primary care models was identified as the research priority most likely to alleviate the Australian OA burden by over 50 OA researchers/stakeholders at the 2012 Australian OA Summit [15]. The need was also recognized in the National Osteoarthritis Strategy following extensive stakeholder consultation [16]. These and other reports, e.g. [17], highlight the failings of the current system to adequately address the problem and support the need for service redesign. Thus, a new, theory-informed and evidence-based implementation strategy involving a new model of service delivery is needed. The model should be flexible and scalable, able to be integrated into Australian GP practice, allow individualized management - including a comprehensive patient-centred assessment, non-drug, non-surgical treatment options, lifestyle behaviour change and self-management support - and address other health issues that can exacerbate chronic pain [18]. In this

article, we describe the design of a new model of service delivery that aimed to deliver recommended OA care and fully integrate with existing primary care systems.

Methods

The development process is described as three stages. Consistent with the UK Medical Research Council (MRC) guidance on complex intervention development, these stages occurred concurrently and iteratively [19]. The article was prepared following the TIDieR and StaRI guidelines as applicable [20] [21].

Stage 1. Designing the model of service delivery

A first step was identifying and prioritizing 'optimal care' for people with knee OA. We also gathered evidence of existing models of OA care delivery and initiatives from Australia and internationally, plus empirical research on alternative methods of delivering core components of knee OA care. We developed a set of key features important for optimal delivery, and core principles to underpin care. With stakeholder input and cognizant of the Australian primary care health setting, we designed the PARTNER model. This aimed to reduce the evidence-practice gap in primary care by augmenting existing GP care and integrating a new add-on service that could further address care shortfalls. A theory of the causal links between the features of the new model, effective self-management behaviours and desired patient outcomes was developed to demonstrate the hypothesized capability of the model.

Stage 2. General practitioner behaviour change intervention

The Behaviour Change Wheel (BCW) methodology [22] [23] was used to design an intervention to facilitate practice behaviour changes by GPs in the PARTNER model. The first step was to generate a comprehensive list of ideal GP behaviours. This was narrowed to a shortlist of 'target' behaviours based on: 1) known shortfalls in current GP management, 2) stakeholder opinion on the likely impact

of the behaviour, the ease of performing the behaviour, the broader consequences of the behaviour (both positive and negative), and the measurability of the behaviour, and 3) the GPs' roles within the PARTNER model. The next step was to develop an in-depth understanding of each target behaviour to help identify what needed to change in order for these behaviours to occur. This was aided by our own qualitative research [24-26]. Finally, interventions were developed to address as many of the barriers as was feasible and facilitate the desired behaviours.

Stage 3. Operationalizing the new service

As part of the PARTNER model, a new service was designed and operationalized with the aim of being feasible, practicable, acceptable, effective and sustainable within the context, while remaining adaptable to individual patient needs and preferences, and new research findings. To do this we firstly gathered evidence on barriers and facilitators to the key patient behaviours identified in Stage 1, conducted focus groups with patients and experts, utilized our own knowledge and experience of delivering care remotely using technology [27-29], and, as much as possible, utilized and/or modified existing services and resources. We also conducted research to maximize the acceptability and engagement of local GPs [30].

Patient and Public Involvement

The study was supported by a consumer group and other individual consumers who provided input to the design of the new model at several stages. This consumer group and individual consumers were involved in online surveys, a focus group and interviews. Members of a consumer advocacy organisation were also involved at several stages including with the scoping of existing educational materials.

Results

Stage 1. Model design

Identifying and prioritizing optimal care components:

Core components of optimal knee OA care were identified from clinical practice guidelines. Based on a systematic review of clinical guidelines of knee OA [4], five guidelines were considered up-to-date at the time (published since 2012) and scored highly in terms of quality [31 32]: i) Osteoarthritis Research Society International (2014) [33], ii) European League against Rheumatology (2013) [5], iii) American Academy of Orthopaedic Surgeons (2013) [9], iv) National Institute for Health and Care Excellence (2014) [3], and v) American College of Rheumatology (2012) [34]. Recommendations from these guidelines were extracted and pooled. We focussed on 'strong recommendations' as determined by the specific rating scale used by the guideline. We also incorporated relevant 'quality indicators' [35-37]. The resulting list of the 36 practice recommendations/quality indicators that constitute optimal care for people with knee OA are provided in Additional file 1.

Key features of high-quality services from other models of delivering OA care:

We examined several existing national and international models/initiatives [4 38-43]. A scoping exercise for Australian OA care showed variation across jurisdictions, but with most services providing care in tertiary hospital orthopaedic clinics [44]. Quality improvement projects within local primary care services exist but are not widely implementable. Key features of a new implementation strategy that were identified from existing models and published systematic reviews [45-47] suggest services should include self-management support which comprises patient education, behaviour change support, goal-setting, shared decision-making and problem-solving. Lifestyle changes often require support over long periods of time by providers with specialist skills and ideally, expert knowledge of the condition. In addition, delivery service design should consider flexible team roles, task-shifting, care co-ordination, and proactive patient review.

Other features include that treatments, delivery methods and behaviour change interventions (BCIs) used in the service should be evidence-based. Clinicians should have high-level communication skills for facilitating health literacy and behaviour change. The service should be cost-efficient and be able to attract sustainable long-term funding. Finally, it should be harmonious with the local health service organisation.

Core principles to underpin of the care delivery:

Wagner's theoretical framework for the management of chronic disease is a well-recognized and accepted model of chronic care [48]. It is a broad theoretical framework that describes the elements needed to effectively care for people with chronic conditions such as knee OA. The model describes how health systems need to consider the design of service delivery to include self-management support and decision support for patients. The model highlights the importance of patients being informed and activated and health practitioners being adequately prepared. The service should adopt a biopsychosocial approach, whereby activity and participation are seen as the mechanism for achieving better symptom control [49]. The service should also be underpinned by patient-centred care principles and thus be responsive to individual needs and preferences and allow flexibility and individualisation of treatment plans.

Methods of delivery:

Various options for delivery of care include primary versus tertiary settings, public and/or private community services, single and multi-profession services (e.g. practice nurses, physiotherapists, health coaches), and remote (e.g. telephone, web-based) versus individual in-person versus group in-person delivery options. Remote models are effective, can improve access to care and can reduce cultural, language, socioeconomic and geographical inequities [50 51]. A systematic review supports the efficacy of telephone-delivered interventions for improving physical activity levels in people with chronic disease [52]. A recent study showed physiotherapy management of knee OA can be effectively

delivered remotely by skype [53] and via telephone [54]. Importantly, outcomes are equivalent between remotely and conventionally-delivered services [55 56], but with additional cost saving and time saving benefits [57]. Other potential advantages of remote-delivery models are their ability to overcome issues of quality control, adapt to future changes in both content and delivery due to the small number of staff involved, being more easily scaled up or down, and having potential to improve equity of service (accessible to remote/rural patients and those with mobility or language barriers). The theoretical technological divide is a potential disadvantage both in terms of availability of equipment (all patients need a telephone at the very least), and the need for patients and providers to engage with a non-traditional form of healthcare delivery.

Stakeholder involvement:

A development group and several working groups of interested stakeholders (including representatives from consumer advocacy organisations, consumers, GPs, physiotherapists, rheumatologists, nurses, behaviour change experts, policy makers, and health insurers) informed the service design. We organized several online surveys, meetings and a focus group including patients [58]. Sourcing the opinions of the stakeholders in this way had advantages and disadvantages. The feedback highlighted parts of our planned intervention that were not intuitively beneficial to some and flagged important barriers to acceptance and uptake early in the development process. However, some of the suggestions of lay participants were inappropriate as they were based on inaccurate knowledge of recommended care.

Understanding the context:

Any implementation strategy is constrained by the local context [19]. A new model of service delivery needs to be feasible and sustainable within current systems. In Australia, management of knee OA tends mostly to occur in primary care settings [59], with 75% of people with knee OA visiting a GP [60]. GPs work in a fee for service system within practices that are privately owned and run as small

businesses. In Australia, as elsewhere, GPs predominantly practice within a biomedical framework [48]. Care is less often patient-centred and there is less opportunity for facilitating shared decision-making and supporting effective self-management [61]. GPs experience multi-level barriers to implementing optimal care [62], in particular with regard their confidence and attitudes towards OA care [63]. In addition, the rebate structure restricts expansion of their role and limits the duration of consultations. GPs themselves recognize there are system barriers to providing optimal care [25 64]. A report by Arthritis Australia highlighted that GPs describe time constraints and a lack of skill and confidence in behavioural counselling as key factors constraining better OA care [65]. GPs also feel hampered by lack of access to services that support lifestyle changes [25 65]. In Australia, other primary healthcare professions are often difficult to access due to cost, location or availability. GPs [65], and others [66], have called for new models for delivering OA care that allow multi-disciplinary input to help support lifestyle change and self-management since the current model of relying predominantly on GPs is failing patients.

The new model to deliver optimal care (the PARTNER Model):

Since substantial changes to GP practice behaviour or the health system are not feasible, it is evident that the bulk of care for people with knee OA needs to be provided by health professionals other than GPs. Several alternatives were considered, including models using community physiotherapists or practice nurses. Both models have major practical barriers to implementation and large-scale roll-out. Thus, a model where care is provided remotely by a team of highly-skilled, multi-disciplinary health professionals was considered the most practical and sustainable method of delivering optimal care in the Australian healthcare context.

The PARTNER model (Figure 1) was proposed as a solution to address the known shortfalls in current knee OA care and deliver optimal care. The proposed model also has the potential to provide continuous, long term support, empower patients by raising health literacy, and incorporate a range

of behaviour change techniques (BCTs) to support long term effective self-management. It uses remote-delivery options (telephone and internet) to provide ongoing 'care support'. In the proposed model, the GP refers the patient to the 'Care Support Team' (CST) following a brief initial consultation emphasizing the importance of exercise, physical activity and weight loss. The health care professionals in the CST have skills in communication, patient education and health behaviour change, plus expertise in current best practice for knee OA management.

Theoretical causal pathway:

A proposed theory of the causal pathway between the features of the new model, effective self-management behaviours and desired patient outcomes was developed to demonstrate the hypothesized capability of the model (Figure 2).

Stage 2. General practitioner behaviour change intervention

There are two distinct parts of the PARTNER model implementation strategy: 1) a brief initial consultation with the GP who provides care consistent with guideline recommendations; and 2) ongoing care provided by the CST. The model therefore requires some degree of practice behaviour change by GPs. The BCW [22] methodology for developing BCIs was used to develop an intervention targeting GPs (the PARTNER GP BCI). The BCW Step 1 is to focus the aims and identify a small number of behaviours to target.

BCW Step 1 - Clearly describe the problem and what needs to change

We examined research highlighting evidence-practice gaps in GP management of knee OA with a focus on the Australian context. The Bettering the Evaluation and Care of Health (BEACH) program included 489,900 cross-sectional GP encounters where OA was managed from 2005-2010 [13]. Results showed that rates of using core non-pharmacologic treatments as first-line management were low, and surgical referral rates were high. Medication management was mostly concordant with

recommended practice apart from the overuse of opioids. Our earlier surveys of people with hip or knee OA found that use of core treatments was generally low [67], and that only 10% were prescribed exercise during GP consultations [60]. In addition, rates of referral for arthroscopic surgery for the management of knee OA pain were high [68 69] despite evidence showing it is ineffective [8] and guidelines advising against its use [9]. Finally, there was a tendency for patients to have arthroplasty surgery without severe disease or without an adequate trial of conservative interventions [18 70-72].

BCW Step 2 - Select and specify the target behaviours

A convenience sample of nine GPs (GP Advisory Group) were surveyed about which of the 36 CPG recommendations/quality indicators (Additional File 1) they believed need to be targeted. The GPs were asked to rate each behaviour on four criteria: Impact of changing the behaviour on the desired outcome (patient pain, function, quality of life and/or healthcare costs); likelihood of changing the behaviour; potential for spill-over, i.e. the positive or negative impact of that behaviour on other desired behaviours; and ease of measurement [22]. Survey respondents were asked to choose their top five recommendations based on their ratings. The top 20 ranked items are shown in Table 1.

The PARTNER model development group including researchers and stakeholders discussed these as possible behaviours to target. The list was refined to nine target behaviours (Table 1). Behaviours to *not* do something were excluded because they are much harder to change than behaviours to do something [73]. Behaviours were also excluded if they were considered too ambiguous to target, such as if it was unclear when the behaviour should and/or should not be performed or if the recommendation was controversial or likely to be revised in the future. Finally, behaviours were excluded if evidence for a gap between the recommendation and current clinical practice was lacking. With the goal of having fewer than five behaviours to target [22], our expert group rated the nine remaining behaviours using the same four criteria to arrive at a short-list of three target

behaviours. An additional behaviour was added which was essential to the operation of the PARTNER model - referral to the CST.

Table 2 details the four 'target' behaviours. These target behaviours were thought to address, either directly or indirectly, the most important evidence-practice gaps in relation to the GPs role in the PARTNER model. We speculated that spending more time conversing about exercise/physical activity and weight loss, and discussing referral to the CST, might have a spill-over effect of reducing undesirable practices including inappropriate imaging, prescribing stronger pain medications, and referring for arthroscopy and arthroplasty. We determined it was unrealistic to expect all GPs to develop skills to competently and confidently devise and deliver individualized exercise and/or weight loss programs in the available consultation time, thus their role for target behaviours #2 and #3 was to give generic information that exercise and weight loss are important for the long-term management knee OA symptoms and disease progression, and refer on to the CST (behaviour #4).

BCW Step 3 - Identify what needs to change (behavioural analysis)

A core component of the BCW is the theoretical model used to describe behaviour and guide intervention planning. The model, COM-B, hypothesizes that behaviour occurs as a result of the interaction between one's capability (both psychological and physical), opportunity (social and physical), and motivation (reflective and automatic) and that changing behaviour involves changing one or more of these. The BCW identifies different intervention options that can be applied to shift the COM-B components and provides a systematic way of determining which intervention options are most likely to achieve the behaviour change(s) sought.

We conducted a systematic review and qualitative evidence synthesis of barriers and enablers to recommended management of OA [24 25] and our own qualitative study to identify GPs' perspectives on providing exercise and weight loss advice to patients with knee OA [26]. In addition, we re-surveyed our

GP Advisory Group for their perspectives on the feasibility of the target behaviours (Additional file 2). We amalgamated and organized the findings using the COM-B model as a framework for the behavioural analysis. Key findings were GPs' tendency to see the knee OA problem as relatively low importance and/or easy to manage, using a biomedical approach to explain and manage the condition, and a lack of knowledge and communication skills for effective discussions about the diagnosis, prognosis and non-drug, non-surgical treatment options. A belief that patients would or could not adopt the advice to exercise and lose weight, plus a lack of belief in the effectiveness of these interventions were also drivers of sub-optimal practice. Further, the constraints on changing practice afforded by the system (time and resources) and practice habits were identified as major barriers. Potential enablers included the professional requirement for continuing education, availability of desktop software and the normal practice routine of referring on to other health professionals and services.

BCW Step 4 - Identify appropriate intervention options

The next step in the BCW was to identify the intervention options that would be most likely to effect behavioural change in GPs given the identified barriers. This process involved iterative discussion within the development team according to the APEASE criteria (Affordability, Practicability, Effectiveness and cost-effectiveness, Acceptability, Side effects/safety and Equity) [22]. Since all COM-B components, except physical capability, were relevant to our target behaviours, all nine intervention options were considered for the PARTNER GP BCI, however the three intervention options most applicable were: education, training and environmental restructuring.

BCW Step 5 - Identify the behaviour change techniques to achieve the desired intervention options

Informed by the development group and by literature for effective techniques to achieve behavioural change in GPs, specific BCTs that could be used to achieve the desired intervention options were selected. There are numerous BCTs that can be used to deliver the intervention options we

prioritized; however, many were unsuitable or impractical for our context and purpose. BCTs included in the PARTNER GP BCI were self-monitoring of behaviours, feedback on behaviour, provide information on where and when to perform behaviours, instruction on how to perform the behaviours, model/demonstrate the behaviours, credible source, prompts/cues, restructuring the physical environment, habit formation, and adding objects to the environment.

BCW Step 6 - Determine the mode of delivery of the BCTs / intervention options

The final step was to develop each intervention option and associated BCTs into the BCIs. For this we considered the current systems for continuing professional education for GPs and the GP practice software. The PARTNER GP BCI includes an online professional development training package, a self-audit/feedback tool and a desktop support platform for decision and referral support. For the online training package, we enlisted the help of educational experts and used feedback from our GP Advisory Group. Behaviour change theory and contemporary pedagogy for online education and adult learning were incorporated into the design and delivery of the content. The package consists of an online professional development module about management of knee OA created and delivered in collaboration with the Royal Australian College of General Practitioners (RACGP). Completers attain RACGP Continuing Medical Education (CME) points. An additional PARTNER model-specific education and training module was created and managed by the PARTNER team incorporating brief training on communication techniques and how to deliver advice to patients about exercise/physical activity and weight loss. The self-audit/feedback tool involved the summarizing of clinical performance (audit) over time, provision of that summary (feedback) to individual GPs with the aim of motivating behaviour change, and links to resources to facilitate change. Audit/feedback is one of the most widely used and effective interventions in implementation research [74]. The self-audit/feedback component of the PARTNER GP BCI incorporated recommended features [75] and was developed according to RACGP guidance to accrue CME points for incentivisation. All professional development

and audit/feedback activities were available wholly online to enable cost-effective large-scale roll-out.

For the decision and referral support, we identified an existing electronic care planning and medical record software platform already operating in many GP practices with the capability to adapt a care plan for decision support for knee OA management consistent with the PARTNER model, enable referral to the CST and facilitate communication with the CST staff. A one-sheet printable patient education resource was also embedded in the care planning tool. The content of the information sheet was developed with wide stakeholder input including patients and a lay language expert. A summary of the content of each of the components is provided in Additional file 3.

Stage 3. Operationalizing the new service (Care Support Team)

For people with knee OA, failure to achieve optimal outcomes is primarily due to: (i) limited uptake and adherence to lifestyle behaviours such as exercise and weight loss [76-78]; and (ii) overuse of non-evidence-based, low-value or high-risk treatments such as complementary and alternative medicines, opioid medications and arthroscopy surgery [79-81]. The CST role was to address these behaviours with a biopsychosocial, patient-centred approach to care planning and behavioural change support. Table 3 shows the features of the CST mapped to our list of the 36 CPG recommendations/quality indicators that constitute optimal care (from Stage 1).

The main tasks in the operationalisation of the CST service were: i) identifying and training clinicians in OA management, communication and health behaviour change skills, ii) developing the service delivery procedures and setting up the remote-delivery hardware and software, iii) developing patient resources to promote health literacy and effective self-management, iv) sourcing adjunct services, and v) designing patient and GP engagement strategies.

Staff recruitment and training

Staff with allied health backgrounds recruited for the CST were trained in evidence-based knee OA management via bespoke online modules and face-to-face sessions, and in communication and behaviour change with HealthChange Australia™ methodology via 2.5 days of face-to-face workshops and supported practice [82].

Care Support Team service procedures and delivery systems

Patients referred to the CST by their GP receive 2-12 contacts in a 12-month period, with most of the contact expected to occur in the first 6 months. The number and timing are flexible and depend on patient needs and preferences. The population targeted by the intervention is heterogeneous with respect to factors such as age, disease severity, socioeconomic level, geography, employment status, health literacy and culture. The PARTNER model allows the CST service to be responsive to new evidence and facilitates quality control through ongoing training and peer support. Consultations are delivered by telephone, supported by email communication and websites, and with consultation data recorded digitally using REDCap (Research Electronic Data Capture) [83].

Patient resources

We conducted a comprehensive audit of available resources (websites and printed material) with help from Arthritis Australia. Most resources did not provide information consistent with the PARTNER model. The resulting patient education resources for the PARTNER model consisted of the guidebook for managing knee OA developed by Arthritis UK [84] and modified to suit the Australian context and two websites (Table 3). The home-based PARTNER muscle strengthening exercise program was developed by physiotherapists with expertise in developing and evaluating exercise interventions for knee OA [85] and is available in both web-based and print formats.

Adjunct services

Evidence-based adjunct services were identified and embedded in the management options as part of the CST service. Adjunct services included online cognitive behavioural therapy-based programs for pain coping skills training, and managing depression, anxiety or sleep problems; and a weight loss/healthy eating program [86].

Engagement strategies

We conducted empirical qualitative research to ascertain factors that would enhance or inhibit GP engagement with the CST [30]. Our findings highlighted that GPs had concerns about confusion caused by incongruence of information and advice, the possibility of the service conflicting with other schemes/initiatives, and perceived loss of control of patient care. Many did not believe there was a need for the proposed service or that there would be benefits, disclosed resistance to change, and expressed reluctance to trust in the skills and abilities of the health professionals providing the care support. In contrast, some GPs recognized the potential benefits of the model. Responding to these findings, we embedded regular reporting to the patient's GP into the service protocols and created an information brochure for GPs that addressed many of their concerns. Patient engagement was facilitated by a bespoke brochure about the CST that could be printed from the GP's desktop electronic medical record software.

Discussion

This project aimed to address the current shortfalls in primary care management of people with knee OA, firstly by developing a new model of service delivery (the PARTNER model) to deliver recommended care, then planning a BCI targeting GPs, and finally operationalizing the new CST service. This paper describes the systematic and comprehensive approach to developing this complex implementation strategy including both a novel service delivery model and a clinician BCI [19 22 87]. Embedded in the process was consideration of stakeholder views and the contextual constraints of

our setting, and empirical investigation of general practitioner behaviour and barriers to engagement with the new model. We harnessed technologies to provide efficiency and overcome access issues. The project was undertaken by a multi-site, multi-disciplinary group with broad stakeholder input at several stages. The PARTNER model addresses many of the identified barriers to recommended practice and incorporates evidence-based components of chronic disease models of care [13 46 48] and knowledge translation interventions [23 88].

Behaviour Change Wheel

The BCW was developed to integrate a number of behaviour change theories and frameworks with the purpose of simplifying the process and addressing the challenges experienced by intervention developers facing a confusing array of theory options [23 89]. The sequential steps in the BCW provided a systematic and transparent approach to developing an intervention which facilitated subsequent implementation and evaluation. It was hypothesized to improve the chance of successfully achieving the desired change [23]. Since the BCW approach is relatively novel, this report also provides an example of the application of the approach as an opportunity for further evaluation and refinement.

Challenges and strengths of the PARTNER model

The project targets a heterogeneous patient population with a wide range of needs. The PARTNER model allows for a high degree of flexibility and individual tailoring of management, necessary for both engagement and efficacy. However, the model involves GPs, CST staff and patients all interacting with each other, which leads to potential for conflict of agendas and expectations. The inherent complexity also comes from the difficulty in achieving many of the behaviours required by both those delivering and receiving the care. The GPs are required to make a small number of changes but these are a significant shift from typical current practice [12 90]. The CST are also required to perform behaviours outside their traditional practice. They are required to incorporate health behaviour change skills, tailor broad management options to the heterogeneous needs of patients

and deliver the care remotely. Patients are required to undertake new behaviours around exercise, physical activity, weight loss and self-management, and these lifestyle changes are notoriously difficult for most people to achieve. Making explicit use of theory and following an established BCI development framework is hoped to result in an effective implementation strategy design [19].

One of the strengths of the PARTNER model is that it requires only relatively small changes by GPs with most of the change to patient care occurring because of the addition of the CST. Apart from the one-off training, there are no alterations to the amount of GP time or resources used in the PARTNER model from current clinical practice.

Limitations and strengths of the development process

An important limitation of the development process we undertook was that it was lengthy and resource intensive. However, the end result should have a greater chance of success than if a less systematic and comprehensive approach had been used. Secondly, there was still a degree of subjectivity in the development process as the members of the development group made decisions at various stages that were based on their own research and clinical practice experiences, beliefs and preconceptions.

Limitations related to the BCI targeting GPs include the possibility of barriers that we have not identified or addressed. Participating in the education and training component is a behaviour in itself and we did not undertake a process to ensure this behaviour occurs. Programs requiring GP behaviour change are often unsuccessful [73 91] especially if autonomy is threatened [30] and we do not yet know whether the GPs will accept and engage with the CST as intended. Further, many GPs did not perceive there was an evidence-practice gap that needed addressing [26]. Even some members of our GP Advisory Group believed that advice about exercise, self-management, and weight loss, and

referral to physiotherapy, are currently occurring routinely and effectively in general practice. These issues may lead to a failure to achieve GP behavioural change.

Limitations related to the CST component of the PARTNER model include the possible technology divide and other issues impeding engagement with the remotely-delivered service by patients. In addition, new non-traditional services and practitioner roles can be politically charged if major resource reallocation or threats to work patterns are the result [92]. However, both these limitations can become strengths of the model in time.

In terms of strengths, the systematic, comprehensive and theory-driven process, we believe, will increase our chances of the model being implemented as planned and being effective in improving patient outcomes. Stakeholder involvement at several stages of the process kept the development team grounded in reality and cognisant of context. A further strength is the focussing on a few target behaviours and properly addressing them, rather than trying to change too much [93]. We believe the behaviours we have targeted will achieve important spill-over to some of the other practice behaviours that are currently frequently sub-optimally performed.

The MRC guidance for developing complex interventions asserts the importance of creating new evidence where gaps exist. As part of the PARTNER development process, we recognized there were gaps in our understanding of the target GP behaviours. New knowledge of the problems faced by GPs was generated and resulting in a better understanding of the reasons for their management behaviours. In undertaking our qualitative evidence synthesis [24 25], our own qualitative interview studies [26 30], and consulting with our GP Advisory Group through surveys and focus groups, we have generated much needed knowledge to inform the specific content of our education and training interventions and the desktop software support for care planning.

Conclusion

This implementation project developed a new strategy to address known evidence-practice gaps in managing people with knee OA. The resulting PARTNER model included the development of two interventions: i) a GP BCI (professional development including online education and audit/feedback activities, and desktop software to support decision-making, referral and provision of related educational resources), and ii) the new CST service (remotely-delivered biopsychosocial assessment, education, treatment planning and care coordination by skilled multidisciplinary healthcare professionals). The interventions are based on existing and purposively generated new evidence, were developed following a systematic approach to intervention design and underpinned by theory. The resulting implementation strategy has been tested in a pilot study. Effectiveness of the PARTNER model will be fully evaluated in a cluster randomized trial currently underway [86], and a process evaluation that will investigate the effect of the GP BCI on GP practice behaviour and the fidelity of the CST in delivering the PARTNER model service [94].

Abbreviations

BCI	Behaviour change intervention
BCT	Behaviour change technique
BCW	Behaviour Change Wheel
CST	Care Support Team
CME	Continuing Medical Education
COM-B	Capability/Opportunity/Motivation - Behaviour
GP	General practitioner
MRC	UK Medical Research Council
OA	Osteoarthritis
RACGP	Royal Australian College of General Practitioners

Authors' contributions

KLB, RSH and DJH conceived the study and all authors were involved in carrying out the work described in the paper and in revising the manuscript. TE wrote the initial manuscript draft and revisions. All authors have given final approval of the version to be published and agree to be accountable for all aspects of the work.

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References

1. Bannuru RR, Osani MC, Vaysbrot EE, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2019;27(11):1578-89. doi: 10.1016/j.joca.2019.06.011 [published Online First: 2019/07/07]
2. Sakellariou G, Conaghan PG, Zhang W, et al. EULAR recommendations for the use of imaging in the clinical management of peripheral joint osteoarthritis. *Annals of the rheumatic diseases* 2017;76(9):1484-94. doi: 10.1136/annrheumdis-2016-210815
3. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.
4. Nelson AE, Allen KD, Golightly YM, et al. A systematic review of recommendations and guidelines for the management of osteoarthritis: The chronic osteoarthritis management initiative of

the U.S. bone and joint initiative. *Seminars in arthritis and rheumatism* 2014;43(6):701-12. doi: 10.1016/j.semarthrit.2013.11.012

5. Fernandes L, Hagen KB, Bijlsma JW, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Annals of the rheumatic diseases* 2013;72(7):1125-35. doi: 10.1136/annrheumdis-2012-202745

6. Royal Australian College of General Practitioners. Guideline for the management of knee and hip osteoarthritis, 2nd edition: Royal Australian Collage of General Practitioners, 2018.

7. Kolasinski SL, Neogi T, Hochberg MC, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2020;72(2):149-62. doi: 10.1002/acr.24131 [published Online First: 2020/01/08]

8. Thorlund JB, Juhl CB, Roos EM, et al. Arthroscopic surgery for degenerative knee: Systematic review and meta-analysis of benefits and harms. *British journal of sports medicine* 2015;49(19):1229-35. doi: 10.1136/bjsports-2015-h2747rep

9. American Academy of Orthopaedic Surgeons. Treatment of Osteoarthritis of the Knee: Evidence-Based Guideline 2nd Edition. Rosemont, IL, USA, 2013.

10. Buchbinder R, Richards B, Harris I. Knee osteoarthritis and role for surgical intervention: Lessons learned from randomized clinical trials and population-based cohorts. *Current opinion in rheumatology* 2014;26(2):138-44. doi: 10.1097/BOR.0000000000000022

11. Basedow M, Esterman A. Assessing appropriateness of osteoarthritis care using quality indicators: A systematic review. *Journal of evaluation in clinical practice* 2015;21(5):782-9. doi: 10.1111/jep.12402

12. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. *The Medical journal of Australia* 2012;197(2):100-5.

13. Brand CA, Harrison C, Tropea J, et al. Management of osteoarthritis in general practice in Australia. *Arthritis Care Res* 2014;66(4):551-8. doi: 10.1002/acr.22197

14. Arthritis Australia. The Ignored Majority. The Voice of Arthritis. A National survey to discover the impact of arthritis on Australians, 2011.

15. Australian Osteoarthritis Summit. White paper: Developing strategic priorities in osteoarthritis research: Proceedings and recommendations arising from the inaugural Australian Osteoarthritis Summit, 2012:1-36.

16. National Osteoarthritis Strategy Project Group. National Osteoarthritis Strategy. Sydney: University of Sydney, 2018.

17. National Health Priority Action Council (NHPAC). National Service Improvement Framework for Osteoarthritis, Rheumatoid Arthritis and Osteoporosis. Canberra: Australian Government Department of Health and Ageing, 2006.

18. Brand CA, Ackerman IN, Bohensky MA, et al. Chronic disease management: A review of current performance across quality of care domains and opportunities for improving osteoarthritis care. *Rheumatic diseases clinics of North America* 2013;39(1):123-43. doi: 10.1016/j.rdc.2012.10.005

19. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *International journal of nursing studies* 2013;50(5):587-92. doi: 10.1016/j.ijnurstu.2012.09.010

20. Pinnock H, Barwick M, Carpenter CR, et al. Standards for Reporting Implementation Studies (StaRI): explanation and elaboration document. *BMJ open* 2017;7(4):e013318. doi: 10.1136/bmjopen-2016-013318 [published Online First: 2017/04/05]

21. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *Bmj* 2014;348:g1687. doi: 10.1136/bmj.g1687 [published Online First: 2014/03/13]

22. Michie S, Atkins LS, West R. The Behaviour Change Wheel: A guide to designing interventions. UK: Silverback Publishing 2014.

23. Michie S, van Stralen MM, West R. The Behaviour Change Wheel: A new method for characterising and designing behaviour change interventions. *Implementation science : IS* 2011;6:42. doi: 10.1186/1748-5908-6-42

24. Egerton T, Diamond L, Buchbinder R, et al. Barriers and enablers in primary care clinicians' management of osteoarthritis: Protocol for a systematic review and qualitative evidence synthesis. *BMJ open* 2016;6(5):e011618. doi: 10.1136/bmjopen-2016-011618

25. Egerton T, Diamond LE, Buchbinder R, et al. A systematic review and evidence synthesis of qualitative studies to identify primary care clinicians' barriers and enablers to the management of osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;25(5):625-38. doi: 10.1016/j.joca.2016.12.002 [published Online First: 2016/12/13]

26. Egerton T, Nelligan RK, Setchell J, et al. General practitioners' views on managing knee osteoarthritis: A thematic analysis of factors influencing clinical practice guideline implementation in primary care. *BMC rheumatology* 2018;2:30. doi: 10.1186/s41927-018-0037-4

27. Hinman RS, Nelligan RK, Bennell KL, et al. "Sounds a bit crazy, but it was almost more personal:" A qualitative study of patient and clinician experiences of physical therapist-prescribed exercise for knee osteoarthritis via skype. *Arthritis Care Res* 2017;69(12):1834-44. doi: 10.1002/acr.23218 [published Online First: 2017/02/22]

28. Lawford BJ, Delany C, Bennell KL, et al. "I was really pleasantly surprised": Firsthand experience and shifts in physical therapist perceptions of telephone-delivered exercise therapy for knee osteoarthritis - A qualitative study. *Arthritis Care Res* 2019;71(4):545-57. doi: 10.1002/acr.23618 [published Online First: 2018/06/10]

29. Lawford BJ, Delany C, Bennell KL, et al. "I was really sceptical...But it worked really well": A qualitative study of patient perceptions of telephone-delivered exercise therapy by physiotherapists for people with knee osteoarthritis. *Osteoarthritis and cartilage / OARS,*

Osteoarthritis Research Society 2018;26(6):741-50. doi: 10.1016/j.joca.2018.02.909 [published Online First: 2018/03/25]

30. Egerton T, Nelligan R, Setchell J, et al. General practitioners' perspectives on a proposed new model of service delivery for primary care management of knee osteoarthritis: A qualitative study. *BMC family practice* 2017;18(1):85. doi: 10.1186/s12875-017-0656-7
31. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, Part 1: Performance, usefulness and areas for improvement. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne* 2010;182(10):1045-52. doi: 10.1503/cmaj.091714
32. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, Part 2: Assessment of validity of items and tools to support application. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne* 2010;182(10):E472-8. doi: 10.1503/cmaj.091716
33. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2014;22(3):363-88. doi: 10.1016/j.joca.2014.01.003
34. Hochberg MC, Altman RD, April KT, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2012;64(4):465-74.
35. Edwards JJ, Khanna M, Jordan KP, et al. Quality indicators for the primary care of osteoarthritis: A systematic review. *Annals of the rheumatic diseases* 2015;74(3):490-8. doi: 10.1136/annrheumdis-2013-203913
36. Australian Commission on Safety and Quality in Health Care. Practice-level indicators of safety and quality for primary health care specification, Version 1.0. Sydney: ACSQHC, 2012.

37. Schmittdiel J, Mosen DM, Glasgow RE, et al. Patient Assessment of Chronic Illness Care (PACIC) and improved patient-centered outcomes for chronic conditions. *Journal of general internal medicine* 2008;23(1):77-80. doi: 10.1007/s11606-007-0452-5

38. Agency for Clinical Innovation Musculoskeletal Network. Osteoarthritis chronic care program model of care. Chatswood, NSW, Australia: Agency for Clinical Innovation, 2012.

39. Arthritis Alliance of Canada. Tool for developing and evaluating models of care. Canada: Arthritis Alliance of Canada, 2012.

40. Dziedzic KS, Healey EL, Porcheret M, et al. Implementing core NICE guidelines for osteoarthritis in primary care with a model consultation (MOSAICS): A cluster randomised controlled trial. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;26(1):43-53. doi: 10.1016/j.joca.2017.09.010

41. Jordan KP, Edwards JJ, Porcheret M, et al. Effect of a model consultation informed by guidelines on recorded quality of care of osteoarthritis (MOSAICS): A cluster randomised controlled trial in primary care. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;25(10):1588-97. doi: 10.1016/j.joca.2017.05.017

42. Skou ST, Roos EM. Good Life with osteoArthritis in Denmark (GLA:D): Evidence-based education and supervised neuromuscular exercise delivered by certified physiotherapists nationwide. *BMC musculoskeletal disorders* 2017;18(1):72. doi: 10.1186/s12891-017-1439-y

43. Østerås N, van Bodegom-Vos L, Dziedzic K, et al. Implementing international osteoarthritis treatment guidelines in primary health care: Study protocol for the SAMBA stepped wedge cluster randomized controlled trial. *Implementation science : IS* 2015;10(1):165. doi: 10.1186/s13012-015-0353-7

44. Speerin R, Slater H, Li L, et al. Moving from evidence to practice: Models of care for the prevention and management of musculoskeletal conditions. *Best practice & research Clinical rheumatology* 2014;28(3):479-515. doi: 10.1016/j.berh.2014.07.001

45. Brand CA, Ackerman IN, Tropea J. Chronic disease management: Improving care for people with osteoarthritis. *Best practice & research Clinical rheumatology* 2014;28(1):119-42. doi: 10.1016/j.berh.2014.01.011

46. Zwar N, Harris M, Griffiths R, et al. A systematic review of chronic disease management. Sydney, Australia.: Australian Primary Health Care Research Institute: The University of New South Wales School of Public Health and Community Medicine, 2006.

47. Briggs AM, Chan M, Slater H. Models of Care for musculoskeletal health: Moving towards meaningful implementation and evaluation across conditions and care settings. *Best practice & research Clinical rheumatology* 2016;30(3):359-74. doi: 10.1016/j.berh.2016.09.009

48. Wagner EH. Chronic disease management: What will it take to improve care for chronic illness? *Eff Clin Pract* 1998;1(1):2-4.

49. Hunt MA, Birmingham TB, Skarakis-Doyle E, et al. Towards a biopsychosocial framework of osteoarthritis of the knee. *Disability and rehabilitation* 2008;30(1):54-61. doi: 10.1080/09638280701189960

50. Ackerman IN, Buchbinder R, Osborne RH. Factors limiting participation in arthritis self-management programmes: An exploration of barriers and patient preferences within a randomized controlled trial. *Rheumatology* 2013;52(3):472-9. doi: 10.1093/rheumatology/kes295

51. Cuperus N, Hoogeboom TJ, Kersten CC, et al. Randomized trial of the effectiveness of a non-pharmacological multidisciplinary face-to-face treatment program on daily function compared to a telephone-based treatment program in patients with generalized osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2015;23(8):1267-75. doi: 10.1016/j.joca.2015.04.007

52. Goode AD, Reeves MM, Eakin EG. Telephone-delivered interventions for physical activity and dietary behavior change: An updated systematic review. *American journal of preventive medicine* 2012;42(1):81-8. doi: 10.1016/j.amepre.2011.08.025

53. Bennell KL, Nelligan R, Dobson F, et al. Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: A randomized trial. *Annals of internal medicine* 2017;166(7):453-62. doi: 10.7326/M16-1714

54. Hinman RS, Campbell PK, Lawford BJ, et al. Does telephone-delivered exercise advice and support by physiotherapists improve pain and/or function in people with knee osteoarthritis? Telecare randomised controlled trial. *British journal of sports medicine* 2019 doi: 10.1136/bjsports-2019-101183 [published Online First: 2019/11/22]

55. Russell TG, Buttrum P, Wootton R, et al. Internet-based outpatient telerehabilitation for patients following total knee arthroplasty: A randomized controlled trial. *The Journal of bone and joint surgery American volume* 2011;93(2):113-20. doi: 10.2106/JBJS.I.01375

56. Salisbury C, Montgomery AA, Hollinghurst S, et al. Effectiveness of PhysioDirect telephone assessment and advice services for patients with musculoskeletal problems. *British journal of sports medicine* 2014;48(18):1391. doi: 10.1136/bjsports-2014-f43rep

57. Hollinghurst S, Coast J, Busby J, et al. A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and advice services for patients with musculoskeletal problems: Economic evaluation. *BMJ open* 2013;3(10):e003406. doi: 10.1136/bmjopen-2013-003406

58. Mason P, Barnes M. Constructing theories of change: Methods and sources. *Evaluation* 2007;13(2):151-70.

59. Arthritis Australia. Time to Move: Ostearthritis: Arthritis Australia, 2014.

60. Nicolson PJA, Hinman RS, French SD, et al. Improving adherence to exercise: Do people with knee osteoarthritis and physical therapists agree on the behavioral approaches likely to succeed? *Arthritis Care Res* 2018;70(3):388-97. doi: 10.1002/acr.23297 [published Online First: 2017/06/03]

61. Holden MA, Nicholls EE, Young J, et al. UK-based physical therapists' attitudes and beliefs regarding exercise and knee osteoarthritis: Findings from a mixed-methods study. *Arthritis and rheumatism* 2009;61(11):1511-21. doi: 10.1002/art.24829

62. Briggs AM, Houlding E, Hinman RS, et al. Health professionals and students encounter multi-level barriers to implementing high-value osteoarthritis care: A multi-national study. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2019;27(5):788-804. doi: 10.1016/j.joca.2018.12.024 [published Online First: 2019/01/23]

63. Briggs AM, Hinman RS, Darlow B, et al. Confidence and attitudes toward osteoarthritis care among the current and emerging health workforce: A multinational interprofessional study. *ACR Open Rheumatol* 2019;1(4):219-35. doi: 10.1002/acr2.1032 [published Online First: 2019/11/30]

64. Rosemann T, Wensing M, Joest K, et al. Problems and needs for improving primary care of osteoarthritis patients: The views of patients, general practitioners and practice nurses. *BMC musculoskeletal disorders* 2006;7(1):48. doi: 10.1186/1471-2474-7-48

65. Arthritis Australia. Whose problem is it anyway? The voice of GP's on Arthritis.: Arthritis Australia, 2012.

66. Briggs AM, Towler SC, Speerin R, et al. Models of care for musculoskeletal health in Australia: Now more than ever to drive evidence into health policy and practice. *Aust Health Rev* 2014;38(4):401-5. doi: 10.1071/AH14032

67. Hinman RS, Nicolson PJ, Dobson FL, et al. Use of nondrug, nonoperative interventions by community-dwelling people with hip and knee osteoarthritis. *Arthritis Care Res* 2015;67(2):305-9. doi: 10.1002/acr.22395

68. Buchbinder R, Harris IA. Arthroscopy to treat osteoarthritis of the knee? *The Medical journal of Australia* 2012;197(7):364-5.

69. Bohensky MA, Sundararajan V, Andrianopoulos N, et al. Trends in elective knee arthroscopies in a population-based cohort, 2000-2009. *The Medical journal of Australia* 2012;197(7):399-403.

70. Porcheret M, Jordan K, Jinks C, et al. Primary care treatment of knee pain - A survey in older adults. *Rheumatology* 2007;46(11):1694-700. doi: 10.1093/rheumatology/kem232

71. Hunter DJ. Quality of osteoarthritis care for community-dwelling older adults. *Clinics in geriatric medicine* 2010;26(3):401-17. doi: 10.1016/j.cger.2010.03.003

72. Ackerman IN, Bohensky MA, de Steiger R, et al. Substantial rise in the lifetime risk of primary total knee replacement surgery for osteoarthritis from 2003 to 2013: An international, population-level analysis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2016;25(4):455-61. doi: 10.1016/j.joca.2016.11.005

73. Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. *Medical care* 2001;39(8 Suppl 2):II46-54.

74. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: Effects on professional practice and healthcare outcomes. *The Cochrane database of systematic reviews* 2012(6):CD000259. doi: 10.1002/14651858.CD000259.pub3

75. Ivers NM, Sales A, Colquhoun H, et al. No more 'business as usual' with audit and feedback interventions: Towards an agenda for a reinvigorated intervention. *Implementation science : IS* 2014;9(1):14. doi: 10.1186/1748-5908-9-14

76. Conaghan PG, Porcheret M, Kingsbury SR, et al. Impact and therapy of osteoarthritis: The Arthritis Care OA Nation 2012 survey. *Clinical rheumatology* 2015;34(9):1581-8. doi: 10.1007/s10067-014-2692-1

77. Howarth D, Inman D, Lingard E, et al. Barriers to weight loss in obese patients with knee osteoarthritis. *Annals of the Royal College of Surgeons of England* 2010;92(4):338-40. doi: 10.1308/003588410X12628812458653

78. Holden MA, Nicholls EE, Young J, et al. Role of exercise for knee pain: What do older adults in the community think? *Arthritis Care Res* 2012;64(10):1554-64. doi: 10.1002/acr.21700

79. Basedow M, Runciman WB, March L, et al. Australians with osteoarthritis; the use of and beliefs about complementary and alternative medicines. *Complement Ther Clin Pract* 2014;20(4):237-42. doi: 10.1016/j.ctcp.2014.08.002

80. Lapane KL, Sands MR, Yang S, et al. Use of complementary and alternative medicine among patients with radiographic-confirmed knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2012;20(1):22-8. doi: 10.1016/j.joca.2011.10.005

81. Yang S, Dube CE, Eaton CB, et al. Longitudinal use of complementary and alternative medicine among older adults with radiographic knee osteoarthritis. *Clin Ther* 2013;35(11):1690-702. doi: 10.1016/j.clinthera.2013.09.022

82. Gale J. HealthChange(TM) Methodology: For patient-centred care and behaviour change support. www.healthchange.com: HealthChange Australia, 2014.

83. Pa H, Taylor R, Thielke R, et al. Research electronic data capture (REDCap) - a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Informatics* 2009;42:377-81.

84. Arthritis Research UK. Osteoarthritis of the knee 2027/OAK/13. Chesterfield, UK: Arthritis Research UK 2013.

85. Bennell KL, Hinman RS. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. *Journal of science and medicine in sport* 2011;14(1):4-9. doi: 10.1016/j.jsams.2010.08.002

86. Hunter DJ, Hinman RS, Bowden JL, et al. Effectiveness of a new model of primary care management on knee pain and function in patients with knee osteoarthritis: Protocol for THE PARTNER STUDY. *BMC musculoskeletal disorders* 2018;19(1):132. doi: 10.1186/s12891-018-2048-0

87. French SD, Green SE, O'Connor DA, et al. Developing theory-informed behaviour change interventions to implement evidence into practice: A systematic approach using the Theoretical Domains Framework. *Implementation science : IS* 2012;7:38. doi: 10.1186/1748-5908-7-38

88. Grol R, Berwick DM, Wensing M. On the trail of quality and safety in health care. *Bmj* 2008;336(7635):74-6. doi: 10.1136/bmj.39413.486944.AD

89. Davidoff F, Dixon-Woods M, Leviton L, et al. Demystifying theory and its use in improvement. *BMJ Qual Saf* 2015;24(3):228-38. doi: 10.1136/bmjqs-2014-003627

90. Basedow M, Williams H, Shanahan EM, et al. Australian GP management of osteoarthritis following the release of the RACGP guideline for the non-surgical management of hip and knee osteoarthritis. *BMC research notes* 2015;8:536. doi: 10.1186/s13104-015-1531-z

91. Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health technology assessment* 2004;8(6):1-72.

92. De Silva MJ, Breuer E, Lee L, et al. Theory of Change: A theory-driven approach to enhance the Medical Research Council's framework for complex interventions. *Trials* 2014;15:267. doi: 10.1186/1745-6215-15-267

93. Smith SM, Soubhi H, Fortin M, et al. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *The Cochrane database of systematic reviews* 2012(4):CD006560. doi: 10.1002/14651858.CD006560.pub2

94. Bowden JL, Egerton T, Hinman RS, et al. Protocol for the process and feasibility evaluations of a new model of primary care service delivery for managing pain and function in patients with knee osteoarthritis (PARTNER) using a mixed methods approach. *BMJ open* 2020;10(2):e034526. doi: 10.1136/bmjopen-2019-034526

Tables

Table 1. The 20 highest ranked behaviours from the PARTNER GP Advisory Group survey to identify the GP behaviours to target. The GPs were asked "Of all the behaviours presented which would you consider the top five to target?" The bold items are the nine remaining after stakeholder group discussion.

Ranking	Behaviour
1	GP determines patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage
2	**GP does not refer patients for arthroscopy of the joint to manage OA pain**
3	GP provides education/advice to patients about the importance of general physical activity in the consultation and reinforced as appropriate
4	**GP provides advice/education to patients about the use of self-management strategies such as appropriate footwear, gait aids, thermal treatments as appropriate**
5	GP does not refer the patient for an x-ray or MRI unless this is necessary to exclude other differential diagnoses
6	**GP manages mood disorders (depression/anxiety) according to guidelines and provides referral as appropriate**
7	GP only offers intra-articular corticosteroid injections as an adjunct to non-drug conservative management if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs
8	**GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 or over and has activity related joint pain and has no morning stiffness lasting no longer than 30 minutes**
9	**GP refers to an orthopaedic surgeon for consideration of joint replacement surgery: i) if the patient has severe pain or substantially impaired function and quality of life despite course of non-surgical treatment, and ii) it is the patient preference after they have been provided with detailed information about benefits and risks of surgery and the potential consequences of not having or having surgery and recovery and rehabilitation after surgery.**
10	GP provides a referral to a formal weight loss program or dietician when patient has a BMI ☐☐
11	GP assesses patient's pain
12	**GP provides education/advice to patients about the importance of regular strengthening and/or aerobic exercise in the consultation and reinforced as appropriate**
13	**GP provides education/advice to patients about the importance of maintaining a healthy weight or weight loss in the consultation and reinforces as appropriate**
14	**GP assesses the patient's body mass index (BMI)**
15	**GP provides information and education about the nature of OA, its causes and consequences including pain and prognosis**

16	GP offers a short course opioid prescription only if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs and joint replacement surgery is contraindicated or delayed. *Note: This recommendation is likely to be revised in future due to increased concerns related to opioid toxicity and abuse.*
17	GP does not recommend glucosamine or chondroitin. *Note: Since this recommendation remains controversial, it was suggested that the behaviour be worded: GP provides evidence-based advice regarding use of complementary/ alternative medicine.*
18	GP offers paracetamol as the first option for pain relief medication.
19	GP can offer topical non-steroidal anti-inflammatory drugs (NSAIDs) when patients have joint symptoms (pain/swelling).
20	In patients with pain despite more conservative interventions GP offers oral NSAIDs and in patients with gastrointestinal risk factors these are co-prescribed with a PPI or a COX-2 specific inhibitor.

Table 2. Final list of four target behaviours with a summary of the majority of ratings and comments. GPs were asked to rate each behaviour as 'very promising', 'promising', 'unpromising but worth considering' or 'not worth considering' for each of the four criteria.

Evidence of gap in current practice	Impact on outcomes	Likelihood of change	Potential for positive spill-over	Ease of measurement
1. GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 years or over and has activity related joint pain and has morning stiffness lasting no longer than 30 minutes.	Very promising. Making and giving diagnosis may lead to better management overall and consequently improved pain and function, as well as cost and time savings and reduction in harms from using x-rays to explain OA.	Promising. Likely to be some barriers to this behaviour change, including habit, GP confidence, patient acceptance of a clinical diagnosis, GP attending education and accepting the CPG recommendation.	Very promising. Positive spill-over to less inappropriate use of imaging, patient being given specific diagnosis leading to better understanding of prognosis and more likely to engage with interventions.	Very promising. Imaging referrals or chart audit.
2. *GP provides education/advice to patients about the importance of general physical activity and regular strengthening and/or aerobic exercise during the consultation which is reinforced at later opportunities.*	Very promising.	Promising. Able to be incorporated into short appointment time. GPs can be supplied with written material to provide to patients during consultation. Able to utilize prompts. Requires change of GP habit. Potential barrier is GP confidence in giving individualized advice.	Very promising. Positive spill-over to less time spent prescribing or discussing surgical interventions.	Promising. Self-audit or patient-reported questionnaire.
3. *GP provides education/advice to patients either about the importance of maintaining a healthy weight or weight loss in the initial consultation which is reinforced at later opportunities.*	Very promising.	Promising. Requires significant education and training. GPs can be supplied with written material to provide to patients during consultation. Able to utilize prompts.	Very promising. Positive spill-over to less time spent prescribing or discussing surgical interventions.	Promising. Self-audit or patient-reported questionnaire.
4. GP refers patients with a diagnosis of knee osteoarthritis to the Care Support Team which will provide further assessment, advice,	Promising.	Promising. Requires education. Able to easily be incorporated into a short appointment time. Potential to utilize prompts and desktop software.	Very promising. Spill-over to other behaviour such as reduced referral for invasive procedures, more support for patients to engage in	Very promising. Chart audit or referrals received.

and behaviour change and self-management support.	exercise and weight loss. Reduced passive mindset that occurs with referral for surgery consult to 'fix' the knee.

Table 3. The Care Support Team service features to provide best-practice primary care for people with knee osteoarthritis mapped to the 36 key recommendations formulated in Stage 1.

Components of optimal care (key recommendations)	Care Support Team service features
Diagnosis, assessment and general management:	
1. Diagnosis is reached clinically without use of imaging or other investigations unless history or physical examination suggest alternative diagnosis	Focus on improving health literacy in relation to knee OA with verbal and written education material. Patients understand how the disease can be diagnosed based on clinical findings. Education resources included a modified version of the Guidebook for Managing Knee OA developed by Arthritis UK, the Arthritis Australia My Joint Pain website (www.MyJointPain.com.au), and the painHEALTH website (www.painHEALTH.csse.uwa.edu.au)
2. Patient receives information and education about the nature of OA, its causes and consequences including pain and prognosis	Focus on improving health literacy in relation to knee OA with verbal and written education material
3-5. Pain, function, and body mass index are assessed	Patient given survey to complete before first consultation including assessment of pain, function and BMI
6. Fatigue levels, sleep and mood are assessed using reliable self-reported instruments	Patient given survey to complete before first consultation including validated fatigue, sleep and mood scales
7. A comprehensive initial biopsychosocial assessment including participation (work/education, leisure, social roles), health education needs, health beliefs and motivation and self-efficacy to self-manage	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences, and to explore health beliefs and education needs before delivering education
8. Physical status (eg joint status, mobility, strength, joint alignment, proprioception, posture) is assessed	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences
9. Patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage are assessed	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences
10. A written personalized management plan including SMART goals and treatment options is formulated with the patient and a copy is provided to the patient	A 'Patient Self-Management Plan' is completed in collaboration with the patient and a copy emailed to the patient
11. The patient has regular review appointments with a health professional scheduled	Patient has access to the CST for up to 12 consultations in one year
Non-drug, conservative management:	
12. Information/advice is provided to the patient about the importance of muscle strengthening exercise and general physical activity	Focus on improving health literacy in relation to knee OA with verbal and written education material
13. A referral to a physiotherapist is provided when physiotherapy is indicated	CST can suggest seeing a local physiotherapist if patient has difficulty with adherence or has special exercise needs
14. Strategies to assist the patient to adhere to exercise/physical activity behaviours (e.g. health coaching) are employed	CST trained in supporting health behavior change by HealthChange™ Australia
15. Information/advice is provided to patients about the importance of maintaining a healthy weight or weight loss if overweight or obese	Focus on improving health literacy in relation to knee OA with verbal and written education material

16. A formal weight loss program or referral to dietician is provided when patient has a body mass index ▯▯	Access to a commercial remotely-delivered weight loss or healthy eating program - the CSIRO Total Wellbeing Diet (https://www.totalwellbeingdiet.com/au/)
17. Strategies to assist the patient to adhere to dietary modifications or weight loss program are employed	CST trained in supporting health behavior change in accordance with care plan
18. Advice about activity pacing is provided	Focus on improving health literacy in relation to knee OA with verbal and written education material
19. A patient-centred approach should be adopted and secondary problems including co-morbidities, mood disorders, sleep disturbance, and fatigue, should be managed, consistent with a biopsychosocial approach to managing chronic pain conditions.	Patient encouraged to explore other areas for change in addition to core options of exercise and weight loss, including managing other healthy lifestyle factors, monitoring and managing symptoms and triggers, accessing relevant services and information, and managing OA medications effectively. If PROMISE Sleep Score ▯▯ patients suggested the cognitive behavioural therapy (CBT)-based insomnia course from 'This Way Up' (https://thiswayup.org.au/)
20. Mood disorders (depression/anxiety) are assessed using a valid screening tool and, when indicated, management is provided according to recommended practice.	Mood is assessed using the PHQ Depression subscale. A score of ▯▯ will trigger an urgent referral to GP. Patients who identify low mood or anxiety as a priority problem will have access to the CBT-based online depression and anxiety course from 'This Way Up' (https://thiswayup.org.au/)
21. Support and advice is provided to patients to facilitate self-management and on the use of self-treatment strategies such as appropriate footwear, TENS, and thermal agents as appropriate	Focus on improving health literacy in relation to knee OA with verbal and written education material
22. Walking aids and assistive devices to improve activities of daily living are recommended as indicated	Focus on improving health literacy in relation to knee OA with verbal and written education material. Appropriate patients directed to a leaflet on the correct use of a cane for people with knee OA
23. For those at risk of work disability or who want to start/return to work, vocational rehabilitation is provided	Patients who identify work productivity as a significant issue on the Work Productivity and Activity Impairment Questionnaire will be given information and support for contacting their local vocational rehabilitation counsellor
24. Patient is recommended psychological treatments to aid pain management when indicated	Patient with pain score ▯▯ on the NRS or severe pain reported as a priority problem will be offered access to the CBT-based online pain coping skills training course: 'PainTrainer' (www.paintrainer.org)
Drug recommendations:	
25-31. Appropriate and evidence-based medication recommendations	Patients who identify suboptimal effectiveness of pain medications or unacceptable side effects will be referred to GP for medication review
Surgical management:	
32-36. Appropriate and evidence-based surgical interventions	Patients considering arthroplasty will be offered decision support based on the Arthritis Australia's My Joint Pain website information (www.myjointpain.com)

Figures

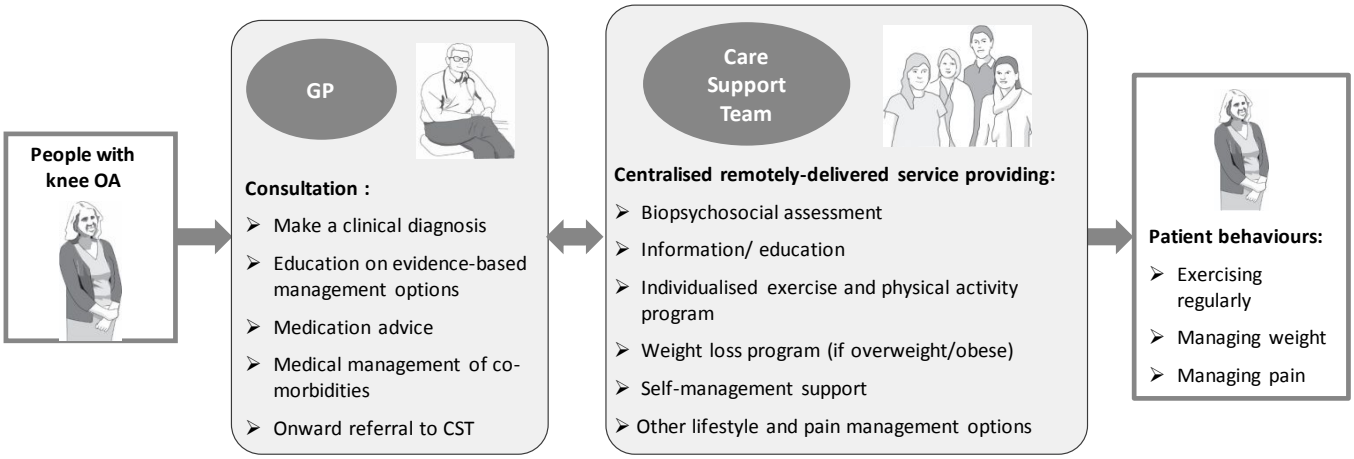

Figure 1. The new implementation strategy: PARTNER model of service delivery. The model includes a focus on core lifestyle interventions (exercise, physical activity, and weight loss, if overweight), incorporating the key features (specialized, evidence-based, sustainable, cost-efficient, flexible, and able to be tailored to individual needs and preferences) and the core principles (biopsychosocial approach, patient-centred care), and compatible within the local context.

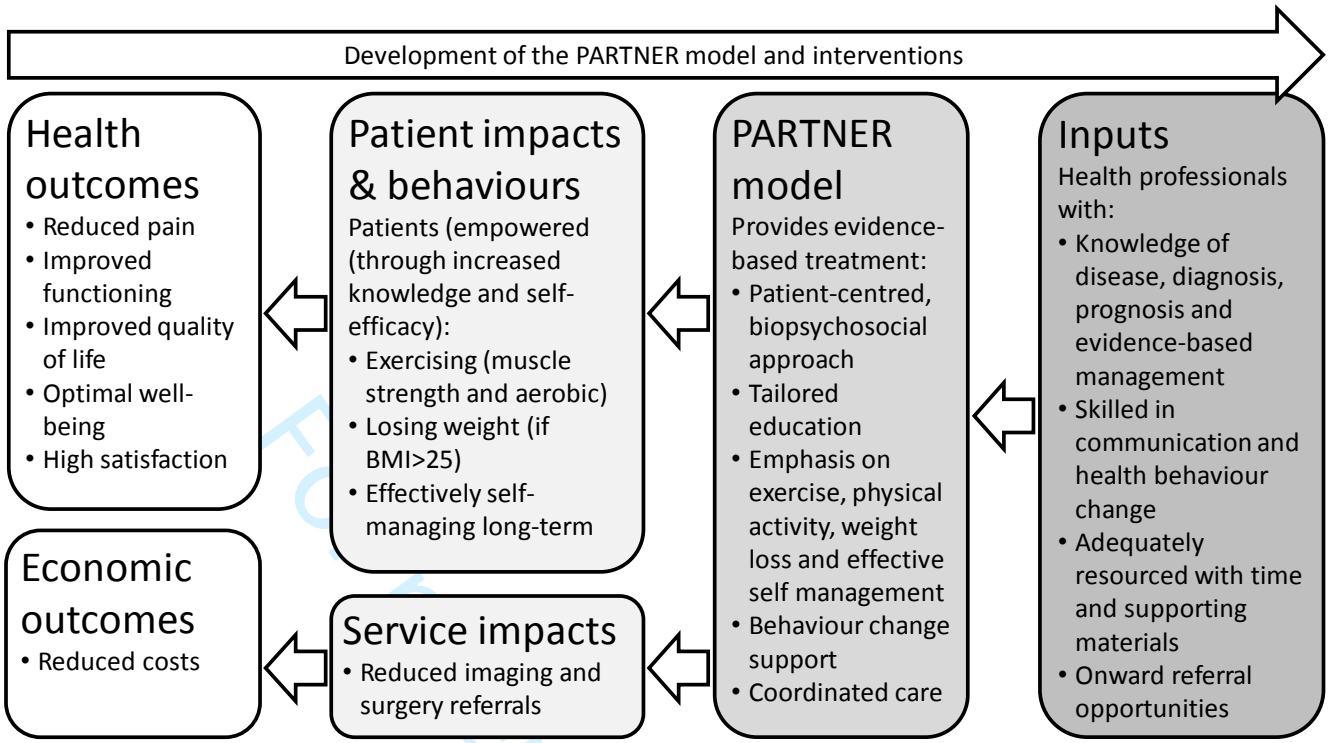

Figure 2. Causal pathway underpinning the PARTNER model. In the pathway, the key 'active ingredients' of the optimal evidence-based intervention for knee OA are patient behaviours including participating in exercise and physical activity, losing weight (if overweight or obese), and effectively self-managing. The 'active ingredients' in the implementation strategy (the PARTNER model), are the roles and behaviours of GPs and the CST.

Additional Files

File name: Additional file 1.
Format: Additional file 1_Egerton.pdf
Title: Key recommendations from five clinical practice guidelines (OARSI, NICE, ACR, EULAR and AAOS) and quality indicators for OA care and chronic disease management.
Description: Text in a table

File name: Additional file 2.
Format: Additional file 2_Egerton.pdf
Title: Main findings from the survey of PARTNER GP Advisory Group. GPs were asked their opinions on the four target behaviours. Survey items were: 1) Do you agree that it is important that GPs do them?, 2) Do you believe that significant change to current practice would be required?, and 3) Do you foresee major barriers to the behaviour taking place in clinical practice?
Description: Text in a table

File name: Additional file 3.
Format: Additional file 3_Egerton.pdf
Title: Content and details of each of the components of the PARTNER GP BCI.
Description: Text in a table

Additional file 1.

Key recommendations from five clinical practice guidelines (OARSI, NICE, ACR, EULAR and AAOS)[1-5] and quality indicators for OA care and chronic disease management [6-8].

Optimal care for management of person with knee OA in primary care setting

1. Diagnosis is reached clinically without use of imaging or other investigations unless history or physical examination suggest alternative diagnosis
2. Patient receives information and education about the nature of OA, its causes and consequences including pain and prognosis
3. Pain is assessed
4. Function is assessed
5. Body mass index is assessed
6. Fatigue levels, sleep and mood are assessed using reliable self-reported instruments
7. A comprehensive initial biopsychosocial assessment including participation (work/education, leisure, social roles), health education needs, health beliefs and motivation and self-efficacy to self-manage
8. Physical status (eg joint status, mobility, strength, joint alignment, proprioception, posture) is assessed
9. Patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage are assessed
10. A written personalized management plan including SMART goals and treatment options is formulated with the patient and a copy is provided to the patient
11. The patient has regular review appointments with a health professional scheduled

12. Information/advice is provided to the patient about the importance of muscle strengthening exercise and general physical activity
13. A referral to a physiotherapist is provided when physiotherapy is indicated
14. Strategies to assist the patient to adhere to exercise/physical activity behaviours (e.g. health coaching) are employed
15. Information/advice is provided to patients about the importance of maintaining a healthy weight or weight loss if overweight or obese
16. A formal weight loss program or referral to dietician is provided when patient has a body mass index ≥25
17. Strategies to assist the patient to adhere to dietary modifications or weight loss program are employed
18. Advice about activity pacing is provided
19. A patient-centred approach should be adopted and secondary problems including co-morbidities, mood disorders, sleep disturbance, and fatigue, should be managed, consistent with a biopsychosocial approach to managing chronic pain conditions.
20. Mood disorders (depression/anxiety) are assessed using a valid screening tool and, when indicated, management is provided according to recommended practice.

21. Support and advice is provided to patients to facilitate self-management and on the use of self-treatment strategies such as appropriate footwear, TENS, and thermal agents as appropriate
22. Walking aids and assistive devices to improve activities of daily living are recommended as indicated
23. For those at risk of work disability or who want to start/return to work, vocational rehabilitation is provided
24. Patient is recommended psychological treatments to aid pain management when indicated

25. When considering drug therapies, patient is screened for potential risk factors for gastrointestinal, cardiovascular, renal and hepatic toxicity
26. When considering drug therapies, the patient is provided with information about the effects and possible side effects
27. Topical non-steroidal anti-inflammatory drugs (NSAIDs) are offered when patients have joint symptoms (pain/swelling)
28. Paracetamol is offered as the first option for oral pain relief
29. Patients with pain despite more conservative interventions are offered oral NSAIDs, and in patients with gastrointestinal risk factors these are co-prescribed with a PPI or a COX-2 specific inhibitor
30. A short course opioid prescription is offered only if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs and joint replacement surgery is contraindicated or delayed
31. Glucosamine/chondroitin are not recommended

32. Intra-articular corticosteroid injections are offered as an adjunct to non-drug conservative management if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs
33. Intra-articular hyaluronan injections are not offered
34. Patients are not referred for arthroscopy of the knee to manage OA pain
35. Referral to an orthopaedic surgeon for consideration of joint replacement surgery only occurs if the patient: i) has severe pain or substantially impaired function and quality of life despite course of non-surgical treatment, and ii) it is the patient's preference after they have been provided with detailed information about benefits and risks of surgery, the potential consequences of not having or having surgery and expected recovery and rehabilitation after surgery
36. Referral to an orthopaedic surgeon for consideration of osteotomy only occurs if patient has a mal-aligned knee and uni-compartmental involvement and is too young for a joint replacement

AAOS = American Academy of Orthopaedic Surgeons, ACR = American College of Rheumatology, EULAR = European League against Rheumatism, NICE = National Institute for Health and Care Excellence, OARSI = Osteoarthritis Research Society International.

References

1. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.
2. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society 2014;22(3):363-88. doi: 10.1016/j.joca.2014.01.003
3. Zhang W, Doherty M, Peat G, et al. EULAR evidence-based recommendations for the diagnosis of knee osteoarthritis. Annals of the rheumatic diseases 2010;69(3):483-9. doi: 10.1136/ard.2009.113100
4. Hochberg MC, Altman RD, April KT, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care Res 2012;64(4):465-74.
5. American Academy of Orthopaedic Surgeons. Treatment of Osteoarthritis of the Knee: Evidence-Based Guideline 2nd Edition. Rosemont, IL, USA, 2013.
6. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. The Medical journal of Australia 2012;197(2):100-5.
7. Østerås N, Garratt A, Grotle M, et al. Patient-reported quality of care for osteoarthritis: Development and testing of the osteoarthritis quality indicator questionnaire. Arthritis Care Res 2013;65(7):1043-51. doi: 10.1002/acr.21976
8. Edwards JJ, Khanna M, Jordan KP, et al. Quality indicators for the primary care of osteoarthritis: A systematic review. Annals of the rheumatic diseases 2015;74(3):490-8. doi: 10.1136/annrheumdis-2013-203913

Additional file 2

Main findings from the survey of PARTNER GP Advisory Group. GPs were asked their opinions on the four target behaviours. Survey items were: 1) Do you agree that it is important that GPs do them?, 2) Do you believe that significant change to current practice would be required?, and 3) Do you foresee major barriers to the behaviour taking place in clinical practice?

1. GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 years or over and has activity related joint pain and has morning stiffness lasting no longer than 30 minutes	"[There is a] Lot of pressure for investigation from patients along with referral to specialist" "I can see a tension though between saving health dollars and reassuring patients (and maybe their GP) that there is nothing more serious in their painful knee."
2. GP provides education/advice to patients about the importance of general physical activity and regular strengthening and/or aerobic exercise during the consultation	"We know that 'telling' will not change behaviour, so it should be about understanding where the patient is at." "Not all GP's would be confident on specific exercise advice"
3. GP provides education/advice to patients either about the importance of maintaining a healthy weight or weight loss	"This step is routine for the majority of GP's - but weight loss is not an easy behavioural change."
4. GP explains PARTNER model and refers patient to the Care Support Team	"This presumes that there is only one pathway within this model of care? I think there should always be options for GPs and practices to navigate decision making pathway about referrals – both if there is a need and where to refer. There may already be mechanisms established in practices for the functions of the CST, so change will be hard to implement." "This assumes this is the only way forward. GPs will have many options they already use such as using their existing networks of therapists with or without an EPC plan." "The issue is whether GPs see value in this, and our job is to convince practices and GPs that CST will add value, rather than impose it" "This follows the diabetic model so is familiar to GP's. Will take some work but should be a concept that can take hold over time." "I think the main issue will be that GPs will need to feel that their existing expertise is being respected while they are also being offered additional assistance to improve their patients' outcomes"
Other comments	"I think pain management – specifically pharmacological advice about pain management should be a focus – as this is often the reason patients present to GPs in their journey with knee OA, and also failure to manage pain is often the trigger for referral to surgeons." "BMI, education and advice about exercise and weight management will universally be said to be already occurring in general practices

	(whether it's by GPs or practice staff, is another issue), so it's more about systematizing these, rather than change practice behaviour." "If approached in the wrong way, GPs' may get offended and not participate." "GPs in general feel they have a special connection to their patients and in their role as gatekeepers to other services. If they feel this role is threatened this may also be a barrier to uptake of the PARTNER model and CST referral." "Key to this is GP's seeing it as an area where they can make a big difference, where they become prepared to devote time towards supervising patient management and feel empowered with the knowledge and self-belief to do it."

Additional file 3

Content and details of each of the components of the PARTNER GP BCI.

Component	Description	Supporting evidence
Audit/feedback tool	Identify records for five patients with probable knee OA. Self-audit 20 items in six sections: (1) Diagnosis and assessment (2) Education and promotion of active participation in management (3) Non-drug, non-surgical treatment options (4) Medication management (5) Surgical options (6) Ongoing support and review Feedback: Number of items where all patients received recommended management Planning: Reflect on barriers to optimal practice and enablers including learning needs Selection of learning activities and planning for local system changes Implementation of plans Re-audit and feedback Evaluation and conferral of RACGP Continuing Medical Education points.	'Best practice' features to enhance the effectiveness of audit/feedback interventions [1] included: x The target performance is provided x Data are based on recent performance x Data are about the individual's own behaviour x Delivery comes from a trusted and respected source x Recipients are capable and responsible for improvement x Goals for target behaviour are specific, measurable, achievable, relevant, time-bound x Goals set for the target behaviours are aligned with organizational priorities (in this case, the PARTNER model) x A clear action plan in provided when discrepancies are evident Questionnaire items were derived from the literature [2-4]. An expert panel modified the wording and selected the 20 priority items that reflect the aim of the audit activity on best practice diagnosis and management of knee OA with a focus on the target behaviours for GPs in the PARTNER model.
GP professional development	Training module part 1 was developed and delivered in conjunction with Royal Australian College of General Practitioners (RACGP) and confers Continuing Medical Education points: x Evidenced based management of knee OA focussing on diagnosis without imaging and non-drug, non-surgical treatment options x Duration including quiz completion approximately 1 hour	Behaviour change requires effective communication and support from health professionals to facilitate vital self-belief and motivation [5]. In addition, patients need accurate knowledge about consequences and positive beliefs about their prospects and capabilities [6].

	Training module part 2 is a bespoke online training course focussing on: x Communicating with positive language to facilitate effective patient self-management x General skills for improving patient health literacy including 'TeachBack' x Specific communication strategies for conversations about increasing physical activity, losing weight and explaining diagnosis	Widespread explicit and implicit negative weight biases have been shown in large samples of physicians, even in health professionals who specialize in the treatment of obesity (ref Schwartz). Such weight biases impair the quality of healthcare delivery [7]. Thus, methods and resources are needed to reduce weight bias in care delivery. Clinicians should be taught to recognize the complexity of overweight and obesity in terms of behaviour and the influence of mood and mental health disorders [7 8].
Decision support (prompts)	A desktop electronic chronic disease care planning support and medical record software that integrates with the most common GP practice software was customized to be used at the point-of-patient care in a routine clinical consultation. The modified care plan includes prompts to: (1) Include pain, function, sleep, fatigue and mood in assessment (2) Prioritize education of patients on exercise, activity and weight loss as treatment options (3) Refer to the CST (4) Print PARTNER patient education resource and CST brochure	The assessment prompting should facilitate biopsychosocial approach to the problem [9 10]. To be effective, decision support systems need to be [11]: x Automatically provided as part of workflow x Provide recommendations rather than assessments/instructions x Be provided at the point (time and location) of decision making x Be computer based
Facilitated referral process	The desktop electronic care planning tool was also customized to facilitate easy referral to the CST with options for communication with CST from within the patient's record.	Referral processes need to be simple and efficient [12]
Patient education resource	One-sheet printable education resources included: x How a diagnosis is reached x Impacts of knee OA x What causes the pain x What will happen over time x What treatments there are for managing the pain	Evidence for why patients have difficulty up-taking and sustaining the lifestyle behaviours recommended for long term management of their knee OA, and what they perceive they need from their interaction with GPs, informed the content of the resource.

References

1. Ivers NM, Sales A, Colquhoun H, et al. No more 'business as usual' with audit and feedback interventions: Towards an agenda for a reinvigorated intervention. Implementation science : IS 2014;9(1):14. doi: 10.1186/1748-5908-9-14
2. Porcheret M, Grime J, Main C, et al. Developing a model osteoarthritis consultation: A Delphi consensus exercise. BMC musculoskeletal disorders 2013;14:25. doi: 10.1186/1471-2474-14-25
3. Blackburn S, Higginbottom A, Taylor R, et al. Patient-reported quality indicators for osteoarthritis: A patient and public generated self-report measure for primary care. Research involvement and engagement 2016;2:5. doi: 10.1186/s40900-016-0019-x
4. Australian Commission on Safety and Quality in Health Care. Osteoarthritis of the knee clinical care standard. Sydney: ACSQHC, 2017.
5. Ng JY, Ntoumanis N, Thogersen-Ntoumani C, et al. Self-determination theory applied to health contexts: A meta-analysis. Perspectives on psychological science : a journal of the Association for Psychological Science 2012;7(4):325-40. doi: 10.1177/1745691612447309
6. Dobson F, Bennell KL, French SD, et al. Barriers and facilitators to exercise participation in people with hip and/or knee osteoarthritis: Synthesis of the literature using behavior change theory. American journal of physical medicine & rehabilitation / Association of Academic Physiatrists 2016;95(5):372-89. doi: 10.1097/PHM.0000000000000404
7. Massetti GM, Dietz WH, Richardson LC. Excessive weight gain, obesity, and cancer: Opportunities for clinical intervention. Jama 2017;318(20):1975-76. doi: 10.1001/jama.2017.15519
8. Dietz WH. Obesity and excessive weight gain in young adults: New targets for prevention. Jama 2017;318(3):241-42. doi: 10.1001/jama.2017.6119
9. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.
10. Fernandes L, Hagen KB, Bijlsma JW, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Annals of the rheumatic diseases 2013;72(7):1125-35. doi: 10.1136/annrheumdis-2012-202745
11. Kawamoto K, Houlihan CA, Balas EA, et al. Improving clinical practice using clinical decision support systems: A systematic review of trials to identify features critical to success. Bmj 2005;330(7494):765. doi: 10.1136/bmj.38398.500764.8F
12. Egerton T, Nelligan R, Setchell J, et al. General practitioners' perspectives on a proposed new model of service delivery for primary care management of knee osteoarthritis: A qualitative study. BMC family practice 2017;18(1):85. doi: 10.1186/s12875-017-0656-7

The TIDieR (Template for Intervention Description and Replication) Checklist*:

Information to include when describing an intervention and the location of the information

	BRIEF NAME		
1.	Provide the name or a phrase that describes the intervention.	Title	
	WHY		
2.	Describe any rationale, theory, or goal of the elements essential to the intervention.	Figure 2	
	WHAT		
3.	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (e.g. online appendix, URL).	GP audit p15 GP education p15 (can be accessed online by RACGP members) Patient resources p15 & 17	Also see the protocol[a]
4.	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.	Figure 1 & Table 3 P10 & 16	Also see the protocol[a]
	WHO PROVIDED		
5.	For each category of intervention provider (e.g. psychologist, nursing assistant), describe their expertise, background and any specific training given.	GPs receive training and desktop support (p15) CST described p10 CST receive training (p16)	Also see the protocol[a]
	HOW		
6.	Describe the modes of delivery (e.g. face-to-face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a	Figure 1 & Table 3 P10	Also see the protocol[a]

	group.		
	WHERE		
7.	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.	P17	Also see the protocol[a]
	WHEN and HOW MUCH		
8.	Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity or dose.	P17	Also see the protocol[a]
	TAILORING		
9.	If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how.	Table 3	Also see the protocol[a]
	MODIFICATIONS		
10.‡	If the intervention was modified during the course of the study, describe the changes (what, why, when, and how).	N/A	
	HOW WELL		
11.	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.	N/A	
12.‡	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.	N/A	

[a] Protocol published in ANZCTR (ACTRN12617001595303) and

** **Authors** - use N/A if an item is not applicable for the intervention being described. **Reviewers** – use '?' if information about the element is not reported/not sufficiently reported.

† If the information is not provided in the primary paper, give details of where this information is available. This may include locations such as a published protocol or other published papers (provide citation details) or a website (provide the URL).
Æ completing the TIDieR checklist for a protocol, these items are not relevant to the protocol and cannot be described until the study is complete.

* We strongly recommend using this checklist in conjunction with the TIDieR guide (see BMJ 2014;348:g1687) which contains an explanation and elaboration for each item.

* The focus of TIDieR is on reporting details of the intervention elements (and where relevant, comparison elements) of a study. Other elements and methodological features of studies are covered by other reporting statements and checklists and have not been duplicated as part of the TIDieR checklist. When a randomised trial is being reported, the TIDieR checklist should be used in conjunction with the CONSORT statement (see www.consort-statement.org) as an extension of Item 5 of the CONSORT 2010 Statement. When a clinical trial protocol is being reported, the TIDieR checklist should be used in conjunction with the SPIRIT statement as an extension of Item 11 of the SPIRIT 2013 Statement (see www.spirit-statement.org). For alternate study designs, TIDieR can be used in conjunction with the appropriate checklist for that study design (see www.equator-network.org).

Standards for Reporting Implementation Studies: the StaRI checklist for completion

The StaRI standard should be referenced as: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths CJ, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor SJC for the StaRI Group. Standards for Reporting Implementation Studies (StaRI) statement. BMJ 2017;356:i6795

The detailed Explanation and Elaboration document, which provides the rationale and exemplar text for all these items is: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths C, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor S, for the StaRI group. Standards for Reporting Implementation Studies (StaRI). Explanation and Elaboration document. BMJ Open 2017 2017;7:e013318

Notes: A key concept of the StaRI standards is the dual strands of describing, on the one hand, the implementation strategy and, on the other, the clinical, healthcare, or public health intervention that is being implemented. These strands are represented as two columns in the checklist.

The StaRI standard refers to the broad range of study designs employed in implementation science. Authors should refer to other reporting standards for advice on reporting specific methodological features. Conversely, whilst all items are worthy of consideration, not all items will be applicable to, or feasible within every study.

			"Implementation strategy" refers to how the intervention was implemented		"Intervention" refers to the healthcare or public health intervention that is being implemented.
Title	1		Identification as an implementation study, and description of the methodology in the title and/or keywords		
Abstract	2		Identification as an implementation study, including a description of the implementation strategy to be tested, the evidence-based intervention being implemented, and defining the key implementation and health outcomes.		
Introduction	3		Description of the problem, challenge or deficiency in healthcare or public health that the intervention being implemented aims to address.		
Rationale	4		The scientific background and rationale for the implementation strategy (including any underpinning		The scientific background and rationale for the intervention being implemented (including evidence

			theory/framework/model, how it is expected to achieve its effects and any pilot work).		about its effectiveness and how it is expected to achieve its effects).
Aims and objectives	5		The aims of the study, differentiating between implementation objectives and any intervention objectives.		
Design	6		The design and key features of the evaluation, (cross referencing to any appropriate methodology reporting standards) and any changes to study protocol, with reasons		
Context	7		The context in which the intervention was implemented. (Consider social, economic, policy, healthcare, organisational barriers and facilitators that might influence implementation elsewhere).		
Targeted 'sites'	8		The characteristics of the targeted 'site(s)' (e.g locations/personnel/resources etc.) for implementation and any eligibility criteria.		The population targeted by the intervention and any eligibility criteria.
Description	9		A description of the implementation strategy		A description of the intervention
Sub-groups	10		Any sub-groups recruited for additional research tasks, and/or nested studies are described		
Outcomes	11		Defined pre-specified primary and other outcome(s) of the implementation strategy, and how they were assessed. Document any pre-determined targets		Defined pre-specified primary and other outcome(s) of the intervention (if assessed), and how they were assessed. Document any pre-determined targets
Process evaluation	12		Process evaluation objectives and outcomes related to the mechanism by which the strategy is expected to work		
Economic evaluation	13		Methods for resource use, costs, economic outcomes and analysis for the implementation strategy		Methods for resource use, costs, economic outcomes and analysis for the intervention
Sample size	14		Rationale for sample sizes (including sample size calculations, budgetary constraints, practical considerations, data saturation, as appropriate)		
Analysis	15		Methods of analysis (with reasons for that choice)		

Sub-group analyses	16		Any a priori sub-group analyses (e.g. between different sites in a multicentre study, different clinical or demographic populations), and sub-groups recruited to specific nested research tasks		
Characteristics	17		Proportion recruited and characteristics of the recipient population for the implementation strategy		Proportion recruited and characteristics (if appropriate) of the recipient population for the intervention
Outcomes	18		Primary and other outcome(s) of the implementation strategy		Primary and other outcome(s) of the Intervention (if assessed)
Process outcomes	19		Process data related to the implementation strategy mapped to the mechanism by which the strategy is expected to work		
Economic evaluation	20		Resource use, costs, economic outcomes and analysis for the implementation strategy		Resource use, costs, economic outcomes and analysis for the intervention
Sub-group analyses	21		Representativeness and outcomes of subgroups including those recruited to specific research tasks		
Fidelity/ adaptation	22		Fidelity to implementation strategy as planned and adaptation to suit context and preferences		Fidelity to delivering the core components of intervention (where measured)
Contextual changes	23		Contextual changes (if any) which may have affected outcomes		
Harms	24		All important harms or unintended effects in each group		
Structured discussion	25		Summary of findings, strengths and limitations, comparisons with other studies, conclusions and implications		
Implications	26		Discussion of policy, practice and/or research implications of the implementation strategy (specifically including scalability)		Discussion of policy, practice and/or research implications of the intervention (specifically including sustainability)
Statements	27		Include statement(s) on regulatory approvals (including, as appropriate, ethical approval, confidential use of routine data, governance approval), trial/study registration (availability of protocol), funding and conflicts of interest		

[a] The study to evaluate the effectiveness of the designed implementation strategy has been described in:

1) The clinical trials registry – ANZCTR ACTRN12617001595303
2) Cluster randomised controlled trial protocol paper: Hunter, D. J., Hinman, R. S., Bowden, J. L., Egerton, T., Briggs, A. M., Bunker, S. J., ... & Schofield, D. J. (2018). Effectiveness of a new model of primary care management on knee pain and function in patients with knee osteoarthritis: Protocol for THE PARTNER STUDY. BMC musculoskeletal disorders, 19(1), 132.
3) Process evaluation protocol paper: Bowden, J. L., Egerton, T., Hinman, R. S., Bennell, K. L., Briggs, A. M., Bunker, S. J., ... & Zwar, N. A. (2020). Protocol for the process and feasibility evaluations of a new model of primary care service delivery for managing pain and function in patients with knee osteoarthritis (PARTNER) using a mixed methods approach. BMJ open, 10(2).

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PARTNER - A service delivery model to implement optimal primary care management of people with knee osteoarthritis: Description of Development

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PARTNER - A service delivery model to implement optimal primary care management of people with knee osteoarthritis: Description of Development

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Abstract

Objective: Implementation strategies, such as new models of service delivery, are needed to address evidence-practice gaps. This paper describes the process of developing and operationalising a new model of service delivery to implement recommended care for people with knee osteoarthritis in a primary-care setting.

Methods: Three development stages occurred concurrently and iteratively. Each stage considered the healthcare context and was informed by stakeholder input. Stage 1 involved the design of a new model of service delivery (PARTNER). Stage 2 developed a behaviour change intervention targeting general practitioners (GPs) using the Behaviour Change Wheel framework. In Stage 3, the 'Care Support Team' component of the service delivery model was operationalized.

Results: The focus of PARTNER is to provide patients with education, exercise and/or weight loss advice, and facilitate effective self-management through behaviour change support. Stage 1 Model Design - Based on clinical practice guidelines, known evidence-practice gaps in current care, chronic disease management frameworks, input from stakeholders, and the opportunities and constraints afforded by the Australian primary care context, we developed the PARTNER service-delivery model. The key components are: i) an effective GP consultation, and ii) follow-up and ongoing care provided remotely (telephone/email/online resources) by a 'Care Support Team'. Stage 2 GP Behaviour Change Intervention – A multi-modal behaviour change intervention was developed comprising a self-audit/feedback activity, online professional development and desktop software to provide decision support, patient information resources and a referral mechanism to the 'Care Support Team'. Stage 3 Operationalizing the 'Care Support Team' - Staff recruited and trained in evidence-based knee OA management and behaviour change methodology.

Conclusion: The PARTNER model is the result of a comprehensive implementation strategy development process utilizing evidence, behaviour change theory and intervention development guidelines. Technologies for scalable delivery were harnessed and new primary evidence was generated as part of the process.

Article Summary

Strengths and limitations of this study

- A systematic development process was undertaken, involving extensive gathering of evidence and using theory and existing frameworks to inform the various development stages and intervention components, and harnessing available technologies.
- Throughout the process, developers were attentive to the local context and stakeholder views.
- A limitation of the development process was the degree of subjectivity that remained, as the members of the development group made decisions based on their own research and clinical practice experiences, beliefs and preconceptions.

Key Words

Knee, osteoarthritis, implementation, model of care, behaviour change, primary care, pain, general practice

Introduction

Osteoarthritis (OA) is a prevalent chronic joint condition, often resulting in pain, impaired physical function, psychological impairments, lowered quality-of-life and higher health care costs. While OA has no cure, there are ways it can be managed to minimize its individual and societal impact. Clinically, OA should be diagnosed based on history and physical examination with imaging investigations generally unnecessary [1-3]. Holistic assessment of the individual's medical, social and psychological needs enables a tailored approach to treatment formulated in partnership with the patient. Exercise and weight loss are recommended as first-line, core treatments [1 3-7], in addition to education and analgesic/non-steroidal anti-inflammatory medication with due consideration of potential harms [4 6 7]. Arthroscopy for knee OA pain is ineffective [8] and thus not recommended [9], while joint replacement surgery is advised only when conservative measures fail [10].

In Australia, general practitioners (GP) are the first contact practitioners for most people with knee OA. Studies have demonstrated that this primary care is often inconsistent with clinical guideline recommendations [11-13]. Evidence-practice gaps lead to inappropriate care [11 12], poorer outcomes [14] and increased costs to the health system, primarily due to increased disability and surgical rates. The need for effective primary care models was identified as the research priority most likely to alleviate the Australian OA burden by over 50 OA researchers/stakeholders at the 2012 Australian OA Summit [15]. The need was also recognized in the National Osteoarthritis Strategy following extensive stakeholder consultation [16]. These and other reports, e.g. [17], highlight the failings of the current system to adequately address the problem and support the need for service redesign. Thus, a new, theory-informed and evidence-based implementation strategy involving a new model of service delivery is needed. The model should be flexible and scalable, able to be integrated into Australian GP practice, allow individualized management - including a comprehensive patient-centred assessment, non-drug, non-surgical treatment options, lifestyle behaviour change and self-management support - and address other health issues that can exacerbate chronic pain [18]. In this

article, we describe the process of developing and operationalising a new model of service delivery to implement recommended care for people with knee OA and fully integrate with existing primary care systems.

Methods

The development process is described as three stages. Consistent with the UK Medical Research Council guidance on complex intervention development, these stages occurred concurrently and iteratively [19]. The article was prepared following the TIDieR and StaRI guidelines as applicable [20 21].

Stage 1. Designing the model of service delivery

A first step was identifying and prioritizing 'optimal care' for people with knee OA. Core components of optimal knee OA care were identified from clinical practice guidelines. Based on a systematic review of clinical guidelines of knee OA [4], five guidelines were considered up-to-date at the time (published since 2012) and scored highly in terms of quality [22 23]: i) Osteoarthritis Research Society International (2014) [24], ii) European League against Rheumatology (2013) [5], iii) American Academy of Orthopaedic Surgeons (2013) [9], iv) National Institute for Health and Care Excellence (2014) [3], and v) American College of Rheumatology (2012) [25]. Recommendations from these guidelines were extracted and pooled to produce a list of recommendations grouped under key clinical areas: Diagnosis, assessment and general management, non-drug conservative interventions, drug recommendations and surgical management. We focussed on 'strong recommendations' as determined by the specific rating scale used by the relevant guideline. We also incorporated relevant 'quality indicators' [26-28].

We also gathered evidence of existing models of OA care delivery and initiatives from Australia and internationally, plus empirical research on alternative methods of delivering core components of knee OA care. Existing models were identified through literature searching and personal contacts.

Several existing national and international models/initiatives were examined [4 29-34] from which a set of key features important for optimal delivery, and a set of core principles to underpin care, were produced. With stakeholder input and cognizant of the Australian primary care health setting, we designed the PARTNER model. This aimed to reduce the evidence-practice gap in primary care by augmenting existing GP care and integrating a new add-on service that could further address care shortfalls. A theory of the causal links between the features of the new model, effective self-management behaviours and desired patient outcomes was developed to demonstrate the hypothesized capability of the model.

Stage 2. General practitioner behaviour change intervention

The Behaviour Change Wheel (BCW) methodology [35 36] was used to design an intervention to facilitate practice behaviour changes by GPs in the PARTNER model. The first step was to generate a comprehensive list of ideal GP behaviours. This was narrowed to a shortlist of 'target' behaviours based on: 1) known shortfalls in current GP management, 2) stakeholder opinion on the likely impact of the behaviour, the ease of performing the behaviour, the broader consequences of the behaviour (both positive and negative), and the measurability of the behaviour, and 3) the GPs' roles within the PARTNER model. The next step was to develop an in-depth understanding of each target behaviour to help identify what needed to change in order for these behaviours to occur. This was aided by our own qualitative research [37-39]. Finally, interventions were developed to address as many of the barriers as was feasible and facilitate the desired behaviours.

Stage 3. Operationalizing the new service

As part of the PARTNER model, a new service was designed and operationalized with the aim of being feasible, practicable, acceptable, effective and sustainable within the context, while remaining adaptable to individual patient needs and preferences, and new research findings. To do this we firstly gathered evidence on barriers and facilitators to the key patient behaviours identified in Stage

1 by searching the literature for quantitative and/or qualitative studies on patient experiences, beliefs and preferences related to these identified behaviours. We also conducted informal discussions with patients and experts (unpublished), utilized our own knowledge and experience of delivering care remotely using technology [40-42], and, as much as possible, utilized and/or modified existing services and resources. Finally, we also conducted research to maximize the acceptability and engagement of local GPs [43].

Patient and Public Involvement

The study was supported by a consumer group and other individual consumers who provided input to the design of the new model at several stages. This consumer group and individual consumers were involved in online surveys, a focus group and interviews. Members of a consumer advocacy organisation were also involved at several stages including with the scoping of existing educational materials.

Results

Stage 1. Model design

Identifying and prioritizing optimal care components:

Identifying and prioritizing core components of optimal knee OA care and quality indicators resulted in 36 practice recommendations that constitute optimal care for people with knee OA. These are provided in Additional file 1.

Key features of high-quality services from other models of delivering OA care:

The scoping exercise on current Australian OA care services found variation across jurisdictions, but most were providing care in tertiary hospital orthopaedic clinics [44]. Quality improvement projects within local primary care services exist, but in the opinion of the research team are not widely implementable due to their focus on local contextual issues. Important findings from our

examination of existing national and international models [4 29-34] and published systematic reviews [45-47] included that patient education , behaviour change support, goal-setting, shared decision-making and problem-solving skill-building are all helpful for facilitating effective self-management. A further finding was that lifestyle changes often require support over long periods of time by providers with specialist skills and ideally, expert knowledge of the condition [29 33 45 46]. Therefore, proactive patient review was considered an important feature to include in a new service. In addition, delivery service design should consider flexible team roles [45-47], opportunities for task-sharing among staff [45 47], and efficient care co-ordination [29 30 45-47].

Other features include that treatments, delivery methods and behaviour change interventions used in the service should be evidence-based. Clinicians should have high-level communication skills for facilitating health literacy and behaviour change. The service should be cost-efficient and be able to attract sustainable long-term funding. Finally, it should be harmonious with the local health service organisation.

Core principles to underpin of the care delivery:

Core principles incorporated into the design included Wagner's theoretical framework for the management of chronic disease, the biopsychosocial model of healthcare and patient-centredness. Wagner's theoretical framework is a well-recognized and accepted model of chronic care [48]. It is a broad theoretical framework that describes the elements needed to effectively care for people with chronic conditions such as knee OA. The model describes how health systems need to consider the design of service delivery to include self-management support and decision support for patients. The model highlights the importance of patients being informed and 'activated' (a measure of self-management capabilities), and health practitioners being adequately prepared. The service should adopt a biopsychosocial approach, whereby activity and participation are seen as the mechanism for achieving better symptom control [49]. The service should also be underpinned by patient-centred care

principles and thus be responsive to individual needs and preferences and allow flexibility and individualisation of treatment plans.

Methods of delivery:

Various options for delivery of care include primary versus tertiary settings, public and/or private community services, single and multi-profession services (e.g. practice nurses, physiotherapists, health coaches), and remote (e.g. telephone, web-based) versus individual in-person versus group in-person delivery options. Remote models are effective, can improve access to care and can reduce cultural, language, socioeconomic and geographical inequities [50 51]. A systematic review supports the efficacy of telephone-delivered interventions for improving physical activity levels in people with chronic disease [52]. A recent study showed physiotherapy management of knee OA can be effectively delivered remotely by skype [53] and via telephone [54]. Importantly, outcomes are equivalent between remotely and conventionally-delivered services [55 56], but with additional cost saving and time saving benefits [57]. Other potential advantages of remote-delivery models are their ability to overcome issues of quality control, adapt to future changes in both content and delivery due to the small number of staff involved, being more easily scaled up or down, and having potential to improve equity of service (accessible to remote/rural patients and those with mobility or language barriers). The theoretical technological divide is a potential disadvantage both in terms of availability of equipment (all patients need a telephone at the very least), and the need for patients and providers to engage with a non-traditional form of healthcare delivery.

Stakeholder involvement:

A development group and several working groups of interested stakeholders (including representatives from consumer advocacy organisations, consumers, GPs, physiotherapists, rheumatologists, nurses, behaviour change experts, policy makers, and health insurers) informed the service design. We organized several online surveys, meetings and a focus group including patients

[58]. The feedback highlighted parts of our planned intervention that were not intuitively beneficial to some and flagged important barriers to acceptance and uptake early in the development process. However, some of the suggestions of lay participants were inappropriate as they were based on inaccurate knowledge of care recommended in high-quality clinical practice guidelines.

Understanding the context:

Any implementation strategy is constrained by the local context [19]. A new model of service delivery needs to be feasible and sustainable within current systems. In Australia, management of knee OA tends mostly to occur in primary care settings [59], with 75% of people with knee OA visiting a GP [60]. GPs work in a fee for service system within practices that are privately owned and run as small businesses. In Australia, as elsewhere, GPs predominantly practice within a biomedical framework [48]. Care is less often patient-centred and there is less opportunity for facilitating shared decision-making and supporting effective self-management [61]. GPs experience multi-level barriers to implementing optimal care [62], in particular with regard to their confidence and attitudes towards OA care [63]. In addition, the rebate structure restricts expansion of their role and limits the duration of consultations. GPs themselves recognize there are system barriers to providing optimal care [38 64]. A report by Arthritis Australia highlighted that GPs describe time constraints and a lack of skill and confidence in behavioural counselling as key factors constraining better OA care [65]. GPs also feel hampered by lack of access to services that support lifestyle changes [38 65]. In Australia, other primary healthcare professions are often difficult to access due to cost, location or availability. GPs [65], and others [66], have called for new models for delivering OA care that allow multi-disciplinary input to help support lifestyle change and self-management since the current model of relying predominantly on GPs is failing patients.

The new model to deliver optimal care (the PARTNER Model):

Since substantial changes to GP practice behaviour, or the health system, were not feasible, it was evident that in order for people with knee OA to receive the care they need, the bulk of care would have to be provided by health professionals other than GPs. Several alternative models were discussed by the development team, including models using community physiotherapists or practice nurses. Both these models were considered to have major practical barriers to implementation and large-scale roll-out. Thus, we decided that a model where care is provided remotely by a small team of highly-skilled, multi-disciplinary health professionals would be the most practical and sustainable method of delivering optimal care in the Australian healthcare context.

The PARTNER model (Figure 1) was proposed as a solution to address the known shortfalls in current knee OA care and deliver optimal care. The proposed model also has the potential to provide continuous, long term support, empower patients by raising health literacy, and incorporate a range of behaviour change techniques to support long term effective self-management. It uses remote-delivery options (telephone and internet) to provide ongoing 'care support'. In the proposed model, the GP refers the patient to the 'Care Support Team' (CST) following a brief initial consultation emphasizing the importance of exercise, physical activity and weight loss. The health care professionals in the CST have skills in communication, patient education and health behaviour change, plus expertise in current best practice for knee OA management.

Theoretical causal pathway:

A proposed theory of the causal pathway between the features of the new model, effective self-management behaviours and desired patient outcomes was developed to demonstrate the hypothesized capability of the model (Figure 2).

Stage 2. General practitioner behaviour change intervention

There are two distinct parts of the PARTNER model implementation strategy: 1) a brief initial consultation with the GP who provides care consistent with guideline recommendations; and 2) ongoing care provided by the CST. The model therefore requires some degree of practice behaviour change by GPs. The BCW [35] methodology for developing behaviour change interventions was used to develop an intervention targeting GPs (the PARTNER GP behaviour change intervention). The BCW Step 1 is to focus the aims and identify a small number of behaviours to target.

BCW Step 1 - Clearly describe the problem and what needs to change

We examined research highlighting evidence-practice gaps in GP management of knee OA with a focus on the Australian context. The Bettering the Evaluation and Care of Health (BEACH) program included 489,900 cross-sectional GP encounters where OA was managed from 2005-2010 [13]. Results showed that rates of using core non-pharmacologic treatments as first-line management were low, and surgical referral rates were high. Medication management was mostly concordant with recommended practice apart from the overuse of opioids. Our earlier surveys of people with hip or knee OA found that use of core treatments was generally low [67], and that only 10% were prescribed exercise during GP consultations [60]. In addition, rates of referral for arthroscopic surgery for the management of knee OA pain were high [68 69] despite evidence showing it is ineffective [8] and guidelines advising against its use [9]. Finally, there was a tendency for patients to have arthroplasty surgery without severe disease or without an adequate trial of conservative interventions [18 70-72].

BCW Step 2 - Select and specify the target behaviours

A convenience sample of nine GPs (GP Advisory Group) were surveyed about which of the 36 CPG recommendations/quality indicators (Additional File 1) they believed need to be targeted. The GPs were asked to rate each behaviour on four criteria: Impact of changing the behaviour on the desired outcome (patient pain, function, quality of life and/or healthcare costs); likelihood of changing the

behaviour; potential for spill-over, i.e. the positive or negative impact of that behaviour on other desired behaviours; and ease of measurement [35]. Survey respondents were asked to choose their top five recommendations based on their ratings. The top 20 ranked items are shown in Table 1.

The PARTNER model development group including researchers and stakeholders discussed these as possible behaviours to target. The list was refined to nine target behaviours (Table 1). Behaviours to *not* do something were excluded because they are much harder to change than behaviours to do something [73]. Behaviours were also excluded if they were considered too ambiguous to target, such as if it was unclear when the behaviour should and/or should not be performed or if the recommendation was controversial or likely to be revised in the future. Finally, behaviours were excluded if evidence for a gap between the recommendation and current clinical practice was lacking. With the goal of having fewer than five behaviours to target [35], our expert group rated the nine remaining behaviours using the same four criteria to arrive at a short-list of three target behaviours. An additional behaviour was added which was essential to the operation of the PARTNER model - referral to the CST.

Table 2 details the four 'target' behaviours. These target behaviours were thought to address, either directly or indirectly, the most important evidence-practice gaps in relation to the GPs role in the PARTNER model. We speculated that spending more time conversing about exercise/physical activity and weight loss, and discussing referral to the CST, might have a spill-over effect of reducing undesirable practices including inappropriate imaging, prescribing stronger pain medications, and referring for arthroscopy and arthroplasty. We determined it was unrealistic to expect all GPs to develop skills to competently and confidently devise and deliver individualized exercise and/or weight loss programs in the available consultation time, thus their role for target behaviours #2 and #3 was to give generic information that exercise and weight loss are important for the long-term management knee OA symptoms and disease progression, and refer on to the CST (behaviour #4).

BCW Step 3 - Identify what needs to change (behavioural analysis)

A core component of the BCW is the theoretical model used to describe behaviour and guide intervention planning. The model, COM-B, hypothesizes that behaviour occurs as a result of the interaction between one's capability (both psychological and physical), opportunity (social and physical), and motivation (reflective and automatic) and that changing behaviour involves changing one or more of these. The BCW identifies different intervention options that can be applied to shift the COM-B components and provides a systematic way of determining which intervention options are most likely to achieve the behaviour change(s) sought.

We conducted a systematic review and qualitative evidence synthesis of barriers and enablers to recommended management of OA [37 38] and our own qualitative study to identify GPs' perspectives on providing exercise and weight loss advice to patients with knee OA [39]. In addition, we re-surveyed our GP Advisory Group for their perspectives on the feasibility of the target behaviours (Additional file 2). We amalgamated and organized the findings using the COM-B model as a framework for the behavioural analysis. Key findings were GPs' tendency to see the knee OA problem as relatively low importance and/or easy to manage, using a biomedical approach to explain and manage the condition, and a lack of knowledge and communication skills for effective discussions about the diagnosis, prognosis and non-drug, non-surgical treatment options. A belief that patients would or could not adopt the advice to exercise and lose weight, plus a lack of belief in the effectiveness of these interventions were also drivers of sub-optimal practice. Further, the constraints on changing practice afforded by the system (time and resources) and practice habits were identified as major barriers. Potential enablers included the professional requirement for continuing education, availability of desktop software and the normal practice routine of referring on to other health professionals and services.

BCW Step 4 - Identify appropriate intervention options

The next step in the BCW was to identify the intervention options that would be most likely to effect behavioural change in GPs given the identified barriers. This process involved iterative discussion within the development team according to the APEASE criteria (Affordability, Practicability, Effectiveness and cost-effectiveness, Acceptability, Side effects/safety and Equity) [35]. Since all COM-B components, except physical capability, were relevant to our target behaviours, all nine intervention options were considered for the PARTNER GP behaviour change intervention, however the three intervention options most applicable were: education, training and environmental restructuring.

BCW Step 5 - Identify the behaviour change techniques to achieve the desired intervention options

Informed by the development group and by literature for effective techniques to achieve behavioural change in GPs, specific behaviour change techniques that could be used to achieve the desired intervention options were selected. There are numerous behaviour change techniques that can be used to deliver the intervention options we prioritized; however, many were unsuitable or impractical for our context and purpose. Behaviour change techniques included in the PARTNER GP behaviour change intervention were self-monitoring of behaviours, feedback on behaviour, provide information on where and when to perform behaviours, instruction on how to perform the behaviours, model/demonstrate the behaviours, credible source, prompts/cues, restructuring the physical environment, habit formation, and adding objects to the environment.

BCW Step 6 - Determine the mode of delivery of the behaviour change techniques / intervention options

The final step was to develop each intervention option and associated behaviour change techniques into the behaviour change interventions. For this we considered the current systems for continuing professional education for GPs and the GP practice software. The PARTNER GP behaviour change

intervention includes an online professional development training package, a self-audit/feedback tool and a desktop support platform for decision and referral support. For the online training package, we enlisted the help of educational experts and used feedback from our GP Advisory Group. Behaviour change theory and contemporary pedagogy for online education and adult learning were incorporated into the design and delivery of the content. The package consists of an online professional development module about management of knee OA created and delivered in collaboration with the Royal Australian College of General Practitioners (RACGP). Completers attain RACGP Continuing Medical Education points. An additional PARTNER model-specific education and training module was created and managed by the PARTNER team incorporating brief training on communication techniques and how to deliver advice to patients about exercise/physical activity and weight loss. The self-audit/feedback tool involved the summarizing of clinical performance (audit) over time, provision of that summary (feedback) to individual GPs with the aim of motivating behaviour change, and links to resources to facilitate change. Audit/feedback is one of the most widely used and effective interventions in implementation research [74]. The self-audit/feedback component of the PARTNER GP behaviour change intervention incorporated recommended features [75] and was developed according to RACGP guidance to accrue Continuing Medical Education points for incentivisation. All professional development and audit/feedback activities were available wholly online to enable cost-effective large-scale roll-out.

For the decision and referral support, we identified an existing electronic care planning and medical record software platform already operating in many GP practices with the capability to adapt a care plan for decision support for knee OA management consistent with the PARTNER model, enable referral to the CST and facilitate communication with the CST staff. A one-sheet printable patient education resource was also embedded in the care planning tool. The content of the information sheet was developed with wide stakeholder input including patients and a lay language expert. A summary of the content of each of the components is provided in Additional file 3.

Stage 3. Operationalizing the new service (Care Support Team)

For people with knee OA, failure to achieve optimal outcomes is primarily due to: (i) limited uptake and adherence to lifestyle behaviours such as exercise and weight loss [76-78]; and (ii) overuse of non-evidence-based, low-value or high-risk treatments such as complementary and alternative medicines, opioid medications and arthroscopy surgery [79-81]. The CST role was to address these behaviours with a biopsychosocial, patient-centred approach to care planning and behavioural change support. Table 3 shows the features of the CST mapped to our list of the 36 CPG recommendations/quality indicators that constitute optimal care (from Stage 1).

The main tasks in the operationalisation of the CST service were: i) identifying and training clinicians in OA management, communication and health behaviour change skills, ii) developing the service delivery procedures and setting up the remote-delivery hardware and software, iii) developing patient resources to promote health literacy and effective self-management, iv) sourcing adjunct services, and v) designing patient and GP engagement strategies.

Staff recruitment and training

Staff with allied health backgrounds recruited for the CST were trained in evidence-based knee OA management via bespoke online modules and face-to-face sessions, and in communication and behaviour change with HealthChange Australia™ methodology via 2.5 days of face-to-face workshops and supported practice [82].

Care Support Team service procedures and delivery systems

Patients referred to the CST by their GP receive 2-12 contacts in a 12-month period, with most of the contact expected to occur in the first 6 months. The number and timing are flexible and depend on patient needs and preferences. The population targeted by the intervention is heterogeneous with respect to factors such as age, disease severity, socioeconomic level, geography, employment status,

health literacy and culture. The PARTNER model allows the CST service to be responsive to new evidence and facilitates quality control through ongoing training and peer support. Consultations are delivered by telephone, supported by email communication and websites, and with consultation data recorded digitally using REDCap (Research Electronic Data Capture) [83].

Patient resources

We conducted a comprehensive audit of available resources (websites and printed material) with help from Arthritis Australia. Most resources did not provide information consistent with the PARTNER model. The resulting patient education resources for the PARTNER model consisted of the guidebook for managing knee OA developed by Arthritis UK [84] and modified to suit the Australian context and two websites (Table 3). The home-based PARTNER muscle strengthening exercise program was developed by physiotherapists with expertise in developing and evaluating exercise interventions for knee OA [85] and is available in both web-based and print formats.

Adjunct services

Evidence-based adjunct services were identified and embedded in the management options as part of the CST service. Adjunct services included online cognitive behavioural therapy-based programs for pain coping skills training, and managing depression, anxiety or sleep problems; and a weight loss/healthy eating program [86].

Engagement strategies

We conducted empirical qualitative research to ascertain factors that would enhance or inhibit GP engagement with the CST [43]. Our findings highlighted that GPs had concerns about confusion caused by incongruence of information and advice, the possibility of the service conflicting with other schemes/initiatives, and perceived loss of control of patient care. Many did not believe there was a need for the proposed service or that there would be benefits, disclosed resistance to change, and

expressed reluctance to trust in the skills and abilities of the health professionals providing the care support. In contrast, some GPs recognized the potential benefits of the model. Responding to these findings, we embedded regular reporting to the patient's GP into the service protocols and created an information brochure for GPs that addressed many of their concerns. Patient engagement was facilitated by a bespoke brochure about the CST that could be printed from the GP's desktop electronic medical record software.

Discussion

This project aimed to address the current shortfalls in primary care management of people with knee OA, firstly by developing a new model of service delivery (the PARTNER model) to deliver recommended care, then planning a behaviour change intervention targeting GPs, and finally operationalizing the new CST service. This paper describes the systematic and comprehensive approach to developing this complex implementation strategy including both a novel service delivery model and a clinician behaviour change intervention [19 35 87]. Embedded in the process was consideration of stakeholder views and the contextual constraints of our setting, and empirical investigation of general practitioner behaviour and barriers to engagement with the new model. We harnessed technologies to provide efficiency and overcome access issues. The project was undertaken by a multi-site, multi-disciplinary group with broad stakeholder input at several stages. The PARTNER model addresses many of the identified barriers to recommended practice and incorporates evidence-based components of chronic disease models of care [13 46 48] and knowledge translation interventions [36 88].

Behaviour Change Wheel

The BCW was developed to integrate a number of behaviour change theories and frameworks with the purpose of simplifying the process and addressing the challenges experienced by intervention developers facing a confusing array of theory options [36 89]. The sequential steps in the BCW provided

a systematic and transparent approach to developing an intervention which facilitated subsequent implementation and evaluation. It was hypothesized to improve the chance of successfully achieving the desired change [36]. Since the BCW approach is relatively novel, this report also provides an example of the application of the approach as an opportunity for further evaluation and refinement.

Challenges and strengths of the PARTNER model

The project targets a heterogeneous patient population with a wide range of needs. The PARTNER model allows for a high degree of flexibility and individual tailoring of management, necessary for both engagement and efficacy. However, the model involves GPs, CST staff and patients all interacting with each other, which leads to potential for conflict of agendas and expectations. The inherent complexity also comes from the difficulty in achieving many of the behaviours required by both those delivering and receiving the care. The GPs are required to make a small number of changes but these are a significant shift from typical current practice [12 90]. The CST are also required to perform behaviours outside their traditional practice. They are required to incorporate health behaviour change skills, tailor broad management options to the heterogeneous needs of patients and deliver the care remotely. Patients are required to undertake new behaviours around exercise, physical activity, weight loss and self-management, and these lifestyle changes are notoriously difficult for most people to achieve. Making explicit use of theory and following an established behaviour change intervention development framework is hoped to result in an effective implementation strategy design [19].

One of the strengths of the PARTNER model is that it requires only relatively small changes by GPs with most of the change to patient care occurring because of the addition of the CST. Apart from the one-off training, there are no alterations to the amount of GP time or resources used in the PARTNER model from current clinical practice.

Limitations and strengths of the development process

An important limitation of the development process we undertook was that it was lengthy and resource intensive. However, the end result should have a greater chance of success than if a less systematic and comprehensive approach had been used. Secondly, there was still a degree of subjectivity in the development process as the members of the development group made decisions at various stages that were based on their own research and clinical practice experiences, beliefs and preconceptions. Similarly, gaining the opinions through focus groups and surveys of a wide range of stakeholders sourced from the community had some disadvantages. This was mainly due to some stakeholders holding beliefs inconsistent with research evidence and current recommended practice.

Limitations related to the behaviour change intervention targeting GPs include the possibility of barriers that we have not identified or addressed. Participating in the education and training component is a behaviour in itself and we did not undertake a process to ensure this behaviour occurs. Programs requiring GP behaviour change are often unsuccessful [73 91] especially if autonomy is threatened [43] and we do not yet know whether the GPs will accept and engage with the CST as intended. Further, many GPs did not perceive there was an evidence-practice gap that needed addressing [39]. Even some members of our GP Advisory Group believed that advice about exercise, self-management, and weight loss, and referral to physiotherapy, are currently occurring routinely and effectively in general practice. These issues may lead to a failure to achieve GP behavioural change.

Limitations related to the CST component of the PARTNER model include the possible technology divide and other issues impeding engagement with the remotely-delivered service by patients. In addition, new non-traditional services and practitioner roles can be politically charged if major resource reallocation or threats to work patterns are the result [92]. However, both these limitations can become strengths of the model in time.

In terms of strengths, the systematic, comprehensive and theory-driven process, we believe, will increase our chances of the model being implemented as planned and being effective in improving patient outcomes. Stakeholder involvement at several stages of the process kept the development team grounded in reality and cognisant of context. A further strength is the focussing on a few target behaviours and properly addressing them, rather than trying to change too much [93]. We believe the behaviours we have targeted will achieve important spill-over to some of the other practice behaviours that are currently frequently sub-optimally performed.

The UK Medical Research Council guidance for developing complex interventions asserts the importance of creating new evidence where gaps exist. As part of the PARTNER development process, we recognized there were gaps in our understanding of the target GP behaviours. New knowledge of the problems faced by GPs was generated and resulting in a better understanding of the reasons for their management behaviours. In undertaking our qualitative evidence synthesis [37 38], our own qualitative interview studies [39 43], and consulting with our GP Advisory Group through surveys and focus groups, we have generated much needed knowledge to inform the specific content of our education and training interventions and the desktop software support for care planning.

Conclusion

This implementation project developed a new strategy to address known evidence-practice gaps in managing people with knee OA. The resulting PARTNER model included the development of two interventions: i) a GP behaviour change intervention (professional development including online education and audit/feedback activities, and desktop software to support decision-making, referral and provision of related educational resources), and ii) the new CST service (remotely-delivered biopsychosocial assessment, education, treatment planning and care coordination by skilled

multidisciplinary healthcare professionals). The interventions are based on existing and purposively generated new evidence, were developed following a systematic approach to intervention design and underpinned by theory. The resulting implementation strategy has been tested in a pilot study. Effectiveness of the PARTNER model will be fully evaluated in a cluster randomized trial currently underway [86], and a process evaluation that will investigate the effect of the GP behaviour change intervention on GP practice behaviour and the fidelity of the CST in delivering the PARTNER model service [94]. This article has served to demonstrate the application of current best practice methods for developing and operationalising a complex implementation strategy.

Abbreviations

BCW	Behaviour Change Wheel
CST	Care Support Team
COM-B	Capability/Opportunity/Motivation - Behaviour
GP	General practitioner
OA	Osteoarthritis
RACGP	Royal Australian College of General Practitioners

Authors' contributions

KLB, RSH and DJH conceived the study. All authors (TE, RSH, DJH, JLB, PJAN, LA, MP, KLB) were involved in the planning and conduct of the work described in the paper and in revising the manuscript. TE wrote the initial manuscript draft and revisions. All authors have given final approval of the version to be published and agree to be accountable for all aspects of the work.

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Ethics statement

Ethical approval not required as article describes a design process utilising published literature and stakeholder input. Primary research studies conducted as part of this information gathering are reported separately and had ethical approval.

Data sharing statement

Additional data provided as 'Additional Files', in companion articles or is publicly available (see References). Further information provided on reasonable request.

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Competing interests

DJH provides consulting advice to Pfizer, Lilly, Merck Serono and TLC bio. The remaining authors declare that they have no competing interests.

References

1. Bannuru RR, Osani MC, Vaysbrot EE, et al. OARSI guidelines for the non-surgical management of knee, hip, and polyarticular osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2019;27(11):1578-89. doi: 10.1016/j.joca.2019.06.011 [published Online First: 2019/07/07]

2. Sakellariou G, Conaghan PG, Zhang W, et al. EULAR recommendations for the use of imaging in the clinical management of peripheral joint osteoarthritis. *Annals of the rheumatic diseases* 2017;76(9):1484-94. doi: 10.1136/annrheumdis-2016-210815

3. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.

4. Nelson AE, Allen KD, Golightly YM, et al. A systematic review of recommendations and guidelines for the management of osteoarthritis: The chronic osteoarthritis management initiative of the U.S. bone and joint initiative. *Seminars in arthritis and rheumatism* 2014;43(6):701-12. doi: 10.1016/j.semarthrit.2013.11.012

5. Fernandes L, Hagen KB, Bijlsma JW, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Annals of the rheumatic diseases* 2013;72(7):1125-35. doi: 10.1136/annrheumdis-2012-202745

6. Royal Australian College of General Practitioners. Guideline for the management of knee and hip osteoarthritis, 2nd edition: Royal Australian Collage of General Practitioners, 2018.

7. Kolasinski SL, Neogi T, Hochberg MC, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the management of osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2020;72(2):149-62. doi: 10.1002/acr.24131 [published Online First: 2020/01/08]

8. Thorlund JB, Juhl CB, Roos EM, et al. Arthroscopic surgery for degenerative knee: Systematic review and meta-analysis of benefits and harms. *British journal of sports medicine* 2015;49(19):1229-35. doi: 10.1136/bjsports-2015-h2747rep

9. American Academy of Orthopaedic Surgeons. Treatment of Osteoarthritis of the Knee: Evidence-Based Guideline 2nd Edition. Rosemont, IL, USA, 2013.

10. Buchbinder R, Richards B, Harris I. Knee osteoarthritis and role for surgical intervention: Lessons learned from randomized clinical trials and population-based cohorts. *Current opinion in rheumatology* 2014;26(2):138-44. doi: 10.1097/BOR.0000000000000022

11. Basedow M, Esterman A. Assessing appropriateness of osteoarthritis care using quality indicators: A systematic review. *Journal of evaluation in clinical practice* 2015;21(5):782-9. doi: 10.1111/jep.12402

12. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. *The Medical journal of Australia* 2012;197(2):100-5.

13. Brand CA, Harrison C, Tropea J, et al. Management of osteoarthritis in general practice in Australia. *Arthritis Care Res* 2014;66(4):551-8. doi: 10.1002/acr.22197

14. Arthritis Australia. The Ignored Majority. The Voice of Arthritis. A National survey to discover the impact of arthritis on Australians, 2011.

15. Australian Osteoarthritis Summit. White paper: Developing strategic priorities in osteoarthritis research: Proceedings and recommendations arising from the inaugural Australian Osteoarthritis Summit, 2012:1-36.

16. National Osteoarthritis Strategy Project Group. National Osteoarthritis Strategy. Sydney: University of Sydney, 2018.

17. National Health Priority Action Council (NHPAC). National Service Improvement Framework for Osteoarthritis, Rheumatoid Arthritis and Osteoporosis. Canberra: Australian Government Department of Health and Ageing, 2006.

18. Brand CA, Ackerman IN, Bohensky MA, et al. Chronic disease management: A review of current performance across quality of care domains and opportunities for improving osteoarthritis care. *Rheumatic diseases clinics of North America* 2013;39(1):123-43. doi: 10.1016/j.rdc.2012.10.005

19. Craig P, Dieppe P, Macintyre S, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *International journal of nursing studies* 2013;50(5):587-92. doi: 10.1016/j.ijnurstu.2012.09.010

20. Pinnock H, Barwick M, Carpenter CR, et al. Standards for Reporting Implementation Studies (StaRI): explanation and elaboration document. *BMJ open* 2017;7(4):e013318. doi: 10.1136/bmjopen-2016-013318 [published Online First: 2017/04/05]

21. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *Bmj* 2014;348:g1687. doi: 10.1136/bmj.g1687 [published Online First: 2014/03/13]

22. Michie S, Atkins LS, West R. The Behaviour Change Wheel: A guide to designing interventions. UK: Silverback Publishing 2014.

23. Michie S, van Stralen MM, West R. The Behaviour Change Wheel: A new method for characterising and designing behaviour change interventions. *Implementation science : IS* 2011;6:42. doi: 10.1186/1748-5908-6-42

24. Egerton T, Diamond L, Buchbinder R, et al. Barriers and enablers in primary care clinicians' management of osteoarthritis: Protocol for a systematic review and qualitative evidence synthesis. *BMJ open* 2016;6(5):e011618. doi: 10.1136/bmjopen-2016-011618

25. Egerton T, Diamond LE, Buchbinder R, et al. A systematic review and evidence synthesis of qualitative studies to identify primary care clinicians' barriers and enablers to the management of osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;25(5):625-38. doi: 10.1016/j.joca.2016.12.002 [published Online First: 2016/12/13]

26. Egerton T, Nelligan RK, Setchell J, et al. General practitioners' views on managing knee osteoarthritis: A thematic analysis of factors influencing clinical practice guideline implementation in primary care. *BMC rheumatology* 2018;2:30. doi: 10.1186/s41927-018-0037-4

27. Hinman RS, Nelligan RK, Bennell KL, et al. "Sounds a bit crazy, but it was almost more personal:" A qualitative study of patient and clinician experiences of physical therapist-prescribed exercise for knee osteoarthritis via skype. *Arthritis Care Res* 2017;69(12):1834-44. doi: 10.1002/acr.23218 [published Online First: 2017/02/22]

28. Lawford BJ, Delany C, Bennell KL, et al. "I was really pleasantly surprised": Firsthand experience and shifts in physical therapist perceptions of telephone-delivered exercise therapy for knee osteoarthritis - A qualitative study. *Arthritis Care Res* 2019;71(4):545-57. doi: 10.1002/acr.23618 [published Online First: 2018/06/10]

29. Lawford BJ, Delany C, Bennell KL, et al. "I was really sceptical...But it worked really well": A qualitative study of patient perceptions of telephone-delivered exercise therapy by physiotherapists for people with knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2018;26(6):741-50. doi: 10.1016/j.joca.2018.02.909 [published Online First: 2018/03/25]

30. Egerton T, Nelligan R, Setchell J, et al. General practitioners' perspectives on a proposed new model of service delivery for primary care management of knee osteoarthritis: A qualitative study. *BMC family practice* 2017;18(1):85. doi: 10.1186/s12875-017-0656-7

31. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, Part 1: Performance, usefulness and areas for improvement. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne* 2010;182(10):1045-52. doi: 10.1503/cmaj.091714

32. Brouwers MC, Kho ME, Browman GP, et al. Development of the AGREE II, Part 2: Assessment of validity of items and tools to support application. *CMAJ : Canadian Medical Association*

journal = journal de l'Association medicale canadienne 2010;182(10):E472-8. doi: 10.1503/cmaj.091716

33. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2014;22(3):363-88. doi: 10.1016/j.joca.2014.01.003

34. Hochberg MC, Altman RD, April KT, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2012;64(4):465-74.

35. Edwards JJ, Khanna M, Jordan KP, et al. Quality indicators for the primary care of osteoarthritis: A systematic review. *Annals of the rheumatic diseases* 2015;74(3):490-8. doi: 10.1136/annrheumdis-2013-203913

36. Australian Commission on Safety and Quality in Health Care. Practice-level indicators of safety and quality for primary health care specification, Version 1.0. Sydney: ACSQHC, 2012.

37. Schmittdiel J, Mosen DM, Glasgow RE, et al. Patient Assessment of Chronic Illness Care (PACIC) and improved patient-centered outcomes for chronic conditions. *Journal of general internal medicine* 2008;23(1):77-80. doi: 10.1007/s11606-007-0452-5

38. Agency for Clinical Innovation Musculoskeletal Network. Osteoarthritis chronic care program model of care. Chatswood, NSW, Australia: Agency for Clinical Innovation, 2012.

39. Arthritis Alliance of Canada. Tool for developing and evaluating models of care. Canada: Arthritis Alliance of Canada, 2012.

40. Dziedzic KS, Healey EL, Porcheret M, et al. Implementing core NICE guidelines for osteoarthritis in primary care with a model consultation (MOSAICS): A cluster randomised controlled trial. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;26(1):43-53. doi: 10.1016/j.joca.2017.09.010

41. Jordan KP, Edwards JJ, Porcheret M, et al. Effect of a model consultation informed by guidelines on recorded quality of care of osteoarthritis (MOSAICS): A cluster randomised controlled trial

in primary care. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2017;25(10):1588-97. doi: 10.1016/j.joca.2017.05.017

42. Skou ST, Roos EM. Good Life with osteoArthritis in Denmark (GLA:D): Evidence-based education and supervised neuromuscular exercise delivered by certified physiotherapists nationwide. *BMC musculoskeletal disorders* 2017;18(1):72. doi: 10.1186/s12891-017-1439-y

43. Østerås N, van Bodegom-Vos L, Dziedzic K, et al. Implementing international osteoarthritis treatment guidelines in primary health care: Study protocol for the SAMBA stepped wedge cluster randomized controlled trial. *Implementation science : IS* 2015;10(1):165. doi: 10.1186/s13012-015-0353-7

44. Speerin R, Slater H, Li L, et al. Moving from evidence to practice: Models of care for the prevention and management of musculoskeletal conditions. *Best practice & research Clinical rheumatology* 2014;28(3):479-515. doi: 10.1016/j.berh.2014.07.001

45. Brand CA, Ackerman IN, Tropea J. Chronic disease management: Improving care for people with osteoarthritis. *Best practice & research Clinical rheumatology* 2014;28(1):119-42. doi: 10.1016/j.berh.2014.01.011

46. Zwar N, Harris M, Griffiths R, et al. A systematic review of chronic disease management. Sydney, Australia.: Australian Primary Health Care Research Institute: The University of New South Wales School of Public Health and Community Medicine, 2006.

47. Briggs AM, Chan M, Slater H. Models of Care for musculoskeletal health: Moving towards meaningful implementation and evaluation across conditions and care settings. *Best practice & research Clinical rheumatology* 2016;30(3):359-74. doi: 10.1016/j.berh.2016.09.009

48. Wagner EH. Chronic disease management: What will it take to improve care for chronic illness? *Eff Clin Pract* 1998;1(1):2-4.

49. Hunt MA, Birmingham TB, Skarakis-Doyle E, et al. Towards a biopsychosocial framework of osteoarthritis of the knee. *Disability and rehabilitation* 2008;30(1):54-61. doi: 10.1080/09638280701189960

50. Ackerman IN, Buchbinder R, Osborne RH. Factors limiting participation in arthritis self-management programmes: An exploration of barriers and patient preferences within a randomized controlled trial. *Rheumatology* 2013;52(3):472-9. doi: 10.1093/rheumatology/kes295

51. Cuperus N, Hoogeboom TJ, Kersten CC, et al. Randomized trial of the effectiveness of a non-pharmacological multidisciplinary face-to-face treatment program on daily function compared to a telephone-based treatment program in patients with generalized osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2015;23(8):1267-75. doi: 10.1016/j.joca.2015.04.007

52. Goode AD, Reeves MM, Eakin EG. Telephone-delivered interventions for physical activity and dietary behavior change: An updated systematic review. *American journal of preventive medicine* 2012;42(1):81-8. doi: 10.1016/j.amepre.2011.08.025

53. Bennell KL, Nelligan R, Dobson F, et al. Effectiveness of an internet-delivered exercise and pain-coping skills training intervention for persons with chronic knee pain: A randomized trial. *Annals of internal medicine* 2017;166(7):453-62. doi: 10.7326/M16-1714

54. Hinman RS, Campbell PK, Lawford BJ, et al. Does telephone-delivered exercise advice and support by physiotherapists improve pain and/or function in people with knee osteoarthritis? Telecare randomised controlled trial. *British journal of sports medicine* 2019 doi: 10.1136/bjsports-2019-101183 [published Online First: 2019/11/22]

55. Russell TG, Buttrum P, Wootton R, et al. Internet-based outpatient telerehabilitation for patients following total knee arthroplasty: A randomized controlled trial. *The Journal of bone and joint surgery American volume* 2011;93(2):113-20. doi: 10.2106/JBJS.I.01375

56. Salisbury C, Montgomery AA, Hollinghurst S, et al. Effectiveness of PhysioDirect telephone assessment and advice services for patients with musculoskeletal problems. *British journal of sports medicine* 2014;48(18):1391. doi: 10.1136/bjsports-2014-f43rep

57. Hollinghurst S, Coast J, Busby J, et al. A pragmatic randomised controlled trial of 'PhysioDirect' telephone assessment and advice services for patients with musculoskeletal problems: Economic evaluation. *BMJ open* 2013;3(10):e003406. doi: 10.1136/bmjopen-2013-003406

58. Mason P, Barnes M. Constructing theories of change: Methods and sources. *Evaluation* 2007;13(2):151-70.

59. Arthritis Australia. Time to Move: Ostearthritis: Arthritis Australia, 2014.

60. Nicolson PJA, Hinman RS, French SD, et al. Improving adherence to exercise: Do people with knee osteoarthritis and physical therapists agree on the behavioral approaches likely to succeed? *Arthritis Care Res* 2018;70(3):388-97. doi: 10.1002/acr.23297 [published Online First: 2017/06/03]

61. Holden MA, Nicholls EE, Young J, et al. UK-based physical therapists' attitudes and beliefs regarding exercise and knee osteoarthritis: Findings from a mixed-methods study. *Arthritis and rheumatism* 2009;61(11):1511-21. doi: 10.1002/art.24829

62. Briggs AM, Houlding E, Hinman RS, et al. Health professionals and students encounter multi-level barriers to implementing high-value osteoarthritis care: A multi-national study. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2019;27(5):788-804. doi: 10.1016/j.joca.2018.12.024 [published Online First: 2019/01/23]

63. Briggs AM, Hinman RS, Darlow B, et al. Confidence and attitudes toward osteoarthritis care among the current and emerging health workforce: A multinational interprofessional study. *ACR Open Rheumatol* 2019;1(4):219-35. doi: 10.1002/acr2.1032 [published Online First: 2019/11/30]

64. Rosemann T, Wensing M, Joest K, et al. Problems and needs for improving primary care of osteoarthritis patients: The views of patients, general practitioners and practice nurses. *BMC musculoskeletal disorders* 2006;7(1):48. doi: 10.1186/1471-2474-7-48

65. Arthritis Australia. Whose problem is it anyway? The voice of GP's on Arthritis.: Arthritis Australia, 2012.

66. Briggs AM, Towler SC, Speerin R, et al. Models of care for musculoskeletal health in Australia: Now more than ever to drive evidence into health policy and practice. *Aust Health Rev* 2014;38(4):401-5. doi: 10.1071/AH14032

67. Hinman RS, Nicolson PJ, Dobson FL, et al. Use of nondrug, nonoperative interventions by community-dwelling people with hip and knee osteoarthritis. *Arthritis Care Res* 2015;67(2):305-9. doi: 10.1002/acr.22395

68. Buchbinder R, Harris IA. Arthroscopy to treat osteoarthritis of the knee? *The Medical journal of Australia* 2012;197(7):364-5.

69. Bohensky MA, Sundararajan V, Andrianopoulos N, et al. Trends in elective knee arthroscopies in a population-based cohort, 2000-2009. *The Medical journal of Australia* 2012;197(7):399-403.

70. Porcheret M, Jordan K, Jinks C, et al. Primary care treatment of knee pain - A survey in older adults. *Rheumatology* 2007;46(11):1694-700. doi: 10.1093/rheumatology/kem232

71. Hunter DJ. Quality of osteoarthritis care for community-dwelling older adults. *Clinics in geriatric medicine* 2010;26(3):401-17. doi: 10.1016/j.cger.2010.03.003

72. Ackerman IN, Bohensky MA, de Steiger R, et al. Substantial rise in the lifetime risk of primary total knee replacement surgery for osteoarthritis from 2003 to 2013: An international, population-level analysis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2016;25(4):455-61. doi: 10.1016/j.joca.2016.11.005

73. Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. *Medical care* 2001;39(8 Suppl 2):II46-54.

74. Ivers N, Jamtvedt G, Flottorp S, et al. Audit and feedback: Effects on professional practice and healthcare outcomes. *The Cochrane database of systematic reviews* 2012(6):CD000259. doi: 10.1002/14651858.CD000259.pub3

75. Ivers NM, Sales A, Colquhoun H, et al. No more 'business as usual' with audit and feedback interventions: Towards an agenda for a reinvigorated intervention. *Implementation science : IS* 2014;9(1):14. doi: 10.1186/1748-5908-9-14

76. Conaghan PG, Porcheret M, Kingsbury SR, et al. Impact and therapy of osteoarthritis: The Arthritis Care OA Nation 2012 survey. *Clinical rheumatology* 2015;34(9):1581-8. doi: 10.1007/s10067-014-2692-1

77. Howarth D, Inman D, Lingard E, et al. Barriers to weight loss in obese patients with knee osteoarthritis. *Annals of the Royal College of Surgeons of England* 2010;92(4):338-40. doi: 10.1308/003588410X12628812458653

78. Holden MA, Nicholls EE, Young J, et al. Role of exercise for knee pain: What do older adults in the community think? *Arthritis Care Res* 2012;64(10):1554-64. doi: 10.1002/acr.21700

79. Basedow M, Runciman WB, March L, et al. Australians with osteoarthritis; the use of and beliefs about complementary and alternative medicines. *Complement Ther Clin Pract* 2014;20(4):237-42. doi: 10.1016/j.ctcp.2014.08.002

80. Lapane KL, Sands MR, Yang S, et al. Use of complementary and alternative medicine among patients with radiographic-confirmed knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2012;20(1):22-8. doi: 10.1016/j.joca.2011.10.005

81. Yang S, Dube CE, Eaton CB, et al. Longitudinal use of complementary and alternative medicine among older adults with radiographic knee osteoarthritis. *Clin Ther* 2013;35(11):1690-702. doi: 10.1016/j.clinthera.2013.09.022

82. Gale J. HealthChange(TM) Methodology: For patient-centred care and behaviour change support. www.healthchange.com: HealthChange Australia, 2014.

83. Pa H, Taylor R, Thielke R, et al. Research electronic data capture (REDCap) - a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Informatics* 2009;42:377-81.

84. Arthritis Research UK. Osteoarthritis of the knee 2027/OAK/13. Chesterfield, UK: Arthritis Research UK 2013.

85. Bennell KL, Hinman RS. A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. *Journal of science and medicine in sport* 2011;14(1):4-9. doi: 10.1016/j.jsams.2010.08.002

86. Hunter DJ, Hinman RS, Bowden JL, et al. Effectiveness of a new model of primary care management on knee pain and function in patients with knee osteoarthritis: Protocol for THE PARTNER STUDY. *BMC musculoskeletal disorders* 2018;19(1):132. doi: 10.1186/s12891-018-2048-0

87. French SD, Green SE, O'Connor DA, et al. Developing theory-informed behaviour change interventions to implement evidence into practice: A systematic approach using the Theoretical Domains Framework. *Implementation science : IS* 2012;7:38. doi: 10.1186/1748-5908-7-38

88. Grol R, Berwick DM, Wensing M. On the trail of quality and safety in health care. *Bmj* 2008;336(7635):74-6. doi: 10.1136/bmj.39413.486944.AD

89. Davidoff F, Dixon-Woods M, Leviton L, et al. Demystifying theory and its use in improvement. *BMJ Qual Saf* 2015;24(3):228-38. doi: 10.1136/bmjqs-2014-003627

90. Basedow M, Williams H, Shanahan EM, et al. Australian GP management of osteoarthritis following the release of the RACGP guideline for the non-surgical management of hip and knee osteoarthritis. *BMC research notes* 2015;8:536. doi: 10.1186/s13104-015-1531-z

91. Grimshaw JM, Thomas RE, MacLennan G, et al. Effectiveness and efficiency of guideline dissemination and implementation strategies. *Health technology assessment* 2004;8(6):1-72.

92. De Silva MJ, Breuer E, Lee L, et al. Theory of Change: A theory-driven approach to enhance the Medical Research Council's framework for complex interventions. *Trials* 2014;15:267. doi: 10.1186/1745-6215-15-267

93. Smith SM, Soubhi H, Fortin M, et al. Interventions for improving outcomes in patients with multimorbidity in primary care and community settings. *The Cochrane database of systematic reviews* 2012(4):CD006560. doi: 10.1002/14651858.CD006560.pub2

94. Bowden JL, Egerton T, Hinman RS, et al. Protocol for the process and feasibility evaluations of a new model of primary care service delivery for managing pain and function in patients with knee osteoarthritis (PARTNER) using a mixed methods approach. *BMJ open* 2020;10(2):e034526. doi: 10.1136/bmjopen-2019-034526

Tables

Table 1. The 20 highest ranked behaviours from the PARTNER GP Advisory Group survey to identify the GP behaviours to target. The GPs were asked "Of all the behaviours presented which would you consider the top five to target?" The bold items are the nine remaining after stakeholder group discussion.

Ranking	Behaviour
1	GP determines patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage
2	**GP does not refer patients for arthroscopy of the joint to manage OA pain**
3	GP provides education/advice to patients about the importance of general physical activity in the consultation and reinforced as appropriate
4	**GP provides advice/education to patients about the use of self-management strategies such as appropriate footwear, gait aids, thermal treatments as appropriate**
5	GP does not refer the patient for an x-ray or MRI unless this is necessary to exclude other differential diagnoses
6	**GP manages mood disorders (depression/anxiety) according to guidelines and provides referral as appropriate**
7	GP only offers intra-articular corticosteroid injections as an adjunct to non-drug conservative management if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs
8	**GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 or over and has activity related joint pain and has no morning stiffness lasting no longer than 30 minutes**
9	**GP refers to an orthopaedic surgeon for consideration of joint replacement surgery: i) if the patient has severe pain or substantially impaired function and quality of life despite course of non-surgical treatment, and ii) it is the patient preference after they have been provided with detailed information about benefits and risks of surgery and the potential consequences of not having or having surgery and recovery and rehabilitation after surgery.**
10	GP provides a referral to a formal weight loss program or dietician when patient has a BMI ≥25
11	GP assesses patient's pain
12	**GP provides education/advice to patients about the importance of regular strengthening and/or aerobic exercise in the consultation and reinforced as appropriate**
13	**GP provides education/advice to patients about the importance of maintaining a healthy weight or weight loss in the consultation and reinforces as appropriate**
14	**GP assesses the patient's body mass index (BMI)**
15	**GP provides information and education about the nature of OA, its causes and consequences including pain and prognosis**

16	GP offers a short course opioid prescription only if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs and joint replacement surgery is contraindicated or delayed. *Note: This recommendation is likely to be revised in future due to increased concerns related to opioid toxicity and abuse.*
17	GP does not recommend glucosamine or chondroitin. *Note: Since this recommendation remains controversial, it was suggested that the behaviour be worded: GP provides evidence-based advice regarding use of complementary/ alternative medicine.*
18	GP offers paracetamol as the first option for pain relief medication.
19	GP can offer topical non-steroidal anti-inflammatory drugs (NSAIDs) when patients have joint symptoms (pain/swelling).
20	In patients with pain despite more conservative interventions GP offers oral NSAIDs and in patients with gastrointestinal risk factors these are co-prescribed with a PPI or a COX-2 specific inhibitor.

Table 2. Final list of four target behaviours with a summary of the majority of ratings and comments. GPs were asked to rate each behaviour as 'very promising', 'promising', 'unpromising but worth considering' or 'not worth considering' for each of the four criteria.

Evidence of gap in current practice	**Impact on outcomes**	**Likelihood of change**	**Potential for positive spill-over**	**Ease of measurement**
1. GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 years or over and has activity related joint pain and has morning stiffness lasting no longer than 30 minutes.	Very promising. Making and giving diagnosis may lead to better management overall and consequently improved pain and function, as well as cost and time savings and reduction in harms from using x-rays to explain OA.	Promising. Likely to be some barriers to this behaviour change, including habit, GP confidence, patient acceptance of a clinical diagnosis, GP attending education and accepting the CPG recommendation.	Very promising. Positive spill-over to less inappropriate use of imaging, patient being given specific diagnosis leading to better understanding of prognosis and more likely to engage with interventions.	Very promising. Imaging referrals or chart audit.
2. *GP provides education/advice to patients about the importance of general physical activity and regular strengthening and/or aerobic exercise during the consultation which is reinforced at later opportunities.*	Very promising.	Promising. Able to be incorporated into short appointment time. GPs can be supplied with written material to provide to patients during consultation. Able to utilize prompts. Requires change of GP habit. Potential barrier is GP confidence in giving individualized advice.	Very promising. Positive spill-over to less time spent prescribing or discussing surgical interventions.	Promising. Self-audit or patient-reported questionnaire.
3. *GP provides education/advice to patients either about the importance of maintaining a healthy weight or weight loss in the initial consultation which is reinforced at later opportunities.*	Very promising.	Promising. Requires significant education and training. GPs can be supplied with written material to provide to patients during consultation. Able to utilize prompts.	Very promising. Positive spill-over to less time spent prescribing or discussing surgical interventions.	Promising. Self-audit or patient-reported questionnaire.
4. GP refers patients with a diagnosis of knee osteoarthritis to the Care Support Team which will provide further assessment, advice,	Promising.	Promising. Requires education. Able to easily be incorporated into a short appointment time. Potential to utilize prompts and desktop software.	Very promising. Spill-over to other behaviour such as reduced referral for invasive procedures, more support for patients to engage in	Very promising. Chart audit or referrals received.

and behaviour change and self-management support.	exercise and weight loss. Reduced passive mindset that occurs with referral for surgery consult to 'fix' the knee.

Table 3. The Care Support Team service features to provide best-practice primary care for people with knee osteoarthritis mapped to the 36 key recommendations formulated in Stage 1.

Components of optimal care (key recommendations)	Care Support Team service features
Diagnosis, assessment and general management:	
1. Diagnosis is reached clinically without use of imaging or other investigations unless history or physical examination suggest alternative diagnosis	Focus on improving health literacy in relation to knee OA with verbal and written education material. Patients understand how the disease can be diagnosed based on clinical findings. Education resources included a modified version of the Guidebook for Managing Knee OA developed by Arthritis UK, the Arthritis Australia My Joint Pain website (www.MyJointPain.com.au), and the painHEALTH website (www.painHEALTH.csse.uwa.edu.au)
2. Patient receives information and education about the nature of OA, its causes and consequences including pain and prognosis	Focus on improving health literacy in relation to knee OA with verbal and written education material
3-5. Pain, function, and body mass index are assessed	Patient given survey to complete before first consultation including assessment of pain, function and BMI
6. Fatigue levels, sleep and mood are assessed using reliable self-reported instruments	Patient given survey to complete before first consultation including validated fatigue, sleep and mood scales
7. A comprehensive initial biopsychosocial assessment including participation (work/education, leisure, social roles), health education needs, health beliefs and motivation and self-efficacy to self-manage	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences, and to explore health beliefs and education needs before delivering education
8. Physical status (eg joint status, mobility, strength, joint alignment, proprioception, posture) is assessed	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences
9. Patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage are assessed	CST trained in delivering biopsychosocial assessment and management guided by patient's needs and preferences
10. A written personalized management plan including SMART goals and treatment options is formulated with the patient and a copy is provided to the patient	A 'Patient Self-Management Plan' is completed in collaboration with the patient and a copy emailed to the patient
11. The patient has regular review appointments with a health professional scheduled	Patient has access to the CST for up to 12 consultations in one year
Non-drug, conservative management:	
12. Information/advice is provided to the patient about the importance of muscle strengthening exercise and general physical activity	Focus on improving health literacy in relation to knee OA with verbal and written education material
13. A referral to a physiotherapist is provided when physiotherapy is indicated	CST can suggest seeing a local physiotherapist if patient has difficulty with adherence or has special exercise needs
14. Strategies to assist the patient to adhere to exercise/physical activity behaviours (e.g. health coaching) are employed	CST trained in supporting health behavior change by HealthChange™ Australia
15. Information/advice is provided to patients about the importance of maintaining a healthy weight or weight loss if overweight or obese	Focus on improving health literacy in relation to knee OA with verbal and written education material

16. A formal weight loss program or referral to dietician is provided when patient has a body mass index ≥25	Access to a commercial remotely-delivered weight loss or healthy eating program - the CSIRO Total Wellbeing Diet (https://www.totalwellbeingdiet.com/au/)
17. Strategies to assist the patient to adhere to dietary modifications or weight loss program are employed	CST trained in supporting health behavior change in accordance with care plan
18. Advice about activity pacing is provided	Focus on improving health literacy in relation to knee OA with verbal and written education material
19. A patient-centred approach should be adopted and secondary problems including co-morbidities, mood disorders, sleep disturbance, and fatigue, should be managed, consistent with a biopsychosocial approach to managing chronic pain conditions.	Patient encouraged to explore other areas for change in addition to core options of exercise and weight loss, including managing other healthy lifestyle factors, monitoring and managing symptoms and triggers, accessing relevant services and information, and managing OA medications effectively. If PROMISE Sleep Score ≥20 patients suggested the cognitive behavioural therapy (CBT)-based insomnia course from 'This Way Up' (https://thiswayup.org.au/)
20. Mood disorders (depression/anxiety) are assessed using a valid screening tool and, when indicated, management is provided according to recommended practice.	Mood is assessed using the PHQ Depression subscale. A score of ≥20 will trigger an urgent referral to GP. Patients who identify low mood or anxiety as a priority problem will have access to the CBT-based online depression and anxiety course from 'This Way Up' (https://thiswayup.org.au/)
21. Support and advice is provided to patients to facilitate self-management and on the use of self-treatment strategies such as appropriate footwear, TENS, and thermal agents as appropriate	Focus on improving health literacy in relation to knee OA with verbal and written education material
22. Walking aids and assistive devices to improve activities of daily living are recommended as indicated	Focus on improving health literacy in relation to knee OA with verbal and written education material. Appropriate patients directed to a leaflet on the correct use of a cane for people with knee OA
23. For those at risk of work disability or who want to start/return to work, vocational rehabilitation is provided	Patients who identify work productivity as a significant issue on the Work Productivity and Activity Impairment Questionnaire will be given information and support for contacting their local vocational rehabilitation counsellor
24. Patient is recommended psychological treatments to aid pain management when indicated	Patient with pain score ≥4 on the NRS or severe pain reported as a priority problem will be offered access to the CBT-based online pain coping skills training course: 'PainTrainer' (www.paintrainer.org)
Drug recommendations:	
25-31. Appropriate and evidence-based medication recommendations	Patients who identify suboptimal effectiveness of pain medications or unacceptable side effects will be referred to GP for medication review
Surgical management:	
32-36. Appropriate and evidence-based surgical interventions	Patients considering arthroplasty will be offered decision support based on the Arthritis Australia's My Joint Pain website information (www.myjointpain.com)

Figure legends

Figure 1. The new implementation strategy: PARTNER model of service delivery. The model includes a focus on core lifestyle interventions (exercise, physical activity, and weight loss, if overweight), incorporating the key features (specialized, evidence-based, sustainable, cost-efficient, flexible, and able to be tailored to individual needs and preferences) and the core principles (biopsychosocial approach, patient-centred care), and compatible within the local context.

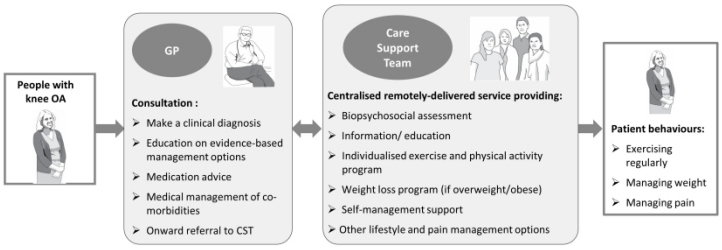
Figure 2. Causal pathway underpinning the PARTNER model. In the pathway, the key 'active ingredients' of the optimal evidence-based intervention for knee OA are patient behaviours including participating in exercise and physical activity, losing weight (if overweight or obese), and effectively self-managing. The 'active ingredients' in the implementation strategy (the PARTNER model), are the roles and behaviours of GPs and the CST.

Additional Files

File name: Additional file 1.
Format: Additional file 1_Egerton.pdf
Title: Key recommendations from five clinical practice guidelines (OARSI, NICE, ACR, EULAR and AAOS) and quality indicators for OA care and chronic disease management.
Description: Text in a table

File name: Additional file 2.
Format: Additional file 2_Egerton.pdf
Title: Main findings from the survey of PARTNER GP Advisory Group. GPs were asked their opinions on the four target behaviours. Survey items were: 1) Do you agree that it is important that GPs do them?, 2) Do you believe that significant change to current practice would be required?, and 3) Do you foresee major barriers to the behaviour taking place in clinical practice?
Description: Text in a table

File name: Additional file 3.
Format: Additional file 3_Egerton.pdf
Title: Content and details of each of the components of the PARTNER GP behaviour change intervention.
Description: Text in a table



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338x190mm (300 x 300 DPI)

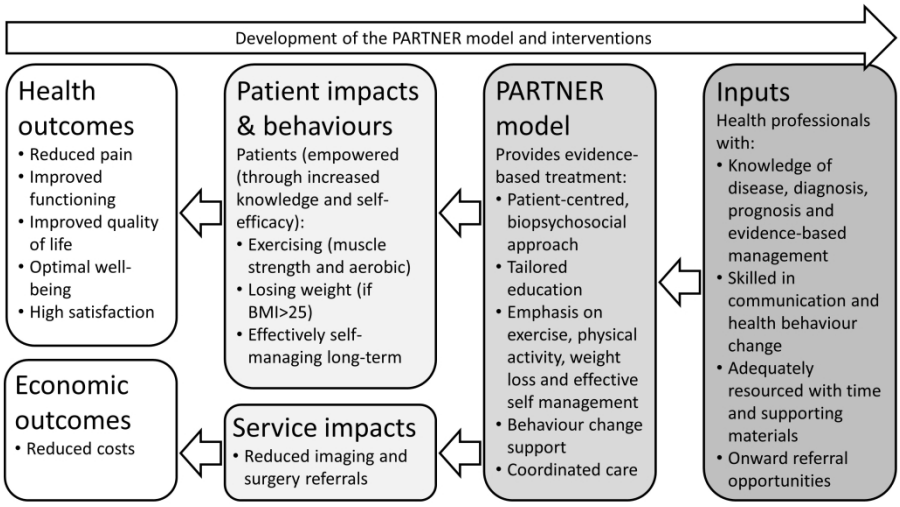

Figure 2. Causal pathway underpinning the PARTNER model. In the pathway, the key 'active ingredients' of the optimal evidence-based intervention for knee OA are patient behaviours including participating in exercise and physical activity, losing weight (if overweight or obese), and effectively self-managing. The 'active ingredients' in the implementation strategy (the PARTNER model), are the roles and behaviours of GPs and the CST.

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Additional file 1.

Key recommendations from five clinical practice guidelines (OARSI, NICE, ACR, EULAR and AAOS)[1-5] and quality indicators for OA care and chronic disease management [6-8].

Optimal care for management of person with knee OA in primary care setting
Diagnosis, assessment and general management
1. Diagnosis is reached clinically without use of imaging or other investigations unless history or physical examination suggest alternative diagnosis
2. Patient receives information and education about the nature of OA, its causes and consequences including pain and prognosis
3. Pain is assessed
4. Function is assessed
5. Body mass index is assessed
6. Fatigue levels, sleep and mood are assessed using reliable self-reported instruments
7. A comprehensive initial biopsychosocial assessment including participation (work/education, leisure, social roles), health education needs, health beliefs and motivation and self-efficacy to self-manage
8. Physical status (eg joint status, mobility, strength, joint alignment, proprioception, posture) is assessed
9. Patient's health education needs, health beliefs, goals, expectations of treatment, treatment preferences and readiness to self-manage are assessed
10. A written personalized management plan including SMART goals and treatment options is formulated with the patient and a copy is provided to the patient
11. The patient has regular review appointments with a health professional scheduled
Non-drug, conservative management
12. Information/advice is provided to the patient about the importance of muscle strengthening exercise and general physical activity
13. A referral to a physiotherapist is provided when physiotherapy is indicated
14. Strategies to assist the patient to adhere to exercise/physical activity behaviours (e.g. health coaching) are employed
15. Information/advice is provided to patients about the importance of maintaining a healthy weight or weight loss if overweight or obese
16. A formal weight loss program or referral to dietician is provided when patient has a body mass index ≥25
17. Strategies to assist the patient to adhere to dietary modifications or weight loss program are employed
18. Advice about activity pacing is provided
19. A patient-centred approach should be adopted and secondary problems including co-morbidities, mood disorders, sleep disturbance, and fatigue, should be managed, consistent with a biopsychosocial approach to managing chronic pain conditions.
20. Mood disorders (depression/anxiety) are assessed using a valid screening tool and, when indicated, management is provided according to recommended practice.

21. Support and advice is provided to patients to facilitate self-management and on the use of self-treatment strategies such as appropriate footwear, TENS, and thermal agents as appropriate
22. Walking aids and assistive devices to improve activities of daily living are recommended as indicated
23. For those at risk of work disability or who want to start/return to work, vocational rehabilitation is provided
24. Patient is recommended psychological treatments to aid pain management when indicated

Drug recommendations

25. When considering drug therapies, patient is screened for potential risk factors for gastrointestinal, cardiovascular, renal and hepatic toxicity
26. When considering drug therapies, the patient is provided with information about the effects and possible side effects
27. Topical non-steroidal anti-inflammatory drugs (NSAIDs) are offered when patients have joint symptoms (pain/swelling)
28. Paracetamol is offered as the first option for oral pain relief
29. Patients with pain despite more conservative interventions are offered oral NSAIDs, and in patients with gastrointestinal risk factors these are co-prescribed with a PPI or a COX-2 specific inhibitor
30. A short course opioid prescription is offered only if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs and joint replacement surgery is contraindicated or delayed
31. Glucosamine/chondroitin are not recommended

Surgical management

32. Intra-articular corticosteroid injections are offered as an adjunct to non-drug conservative management if the patient has moderate-severe pain that does not respond to, or cannot tolerate, other analgesic medications or NSAIDs
33. Intra-articular hyaluronan injections are not offered
34. Patients are not referred for arthroscopy of the knee to manage OA pain
35. Referral to an orthopaedic surgeon for consideration of joint replacement surgery only occurs if the patient: i) has severe pain or substantially impaired function and quality of life despite course of non-surgical treatment, and ii) it is the patient's preference after they have been provided with detailed information about benefits and risks of surgery, the potential consequences of not having or having surgery and expected recovery and rehabilitation after surgery
36. Referral to an orthopaedic surgeon for consideration of osteotomy only occurs if patient has a mal-aligned knee and uni-compartmental involvement and is too young for a joint replacement

AAOS = American Academy of Orthopaedic Surgeons, ACR = American College of Rheumatology, EULAR = European League against Rheumatism, NICE = National Institute for Health and Care Excellence, OARSI = Osteoarthritis Research Society International.

References

1. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.
2. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthritis and cartilage / OARS, Osteoarthritis Research Society* 2014;22(3):363-88. doi: 10.1016/j.joca.2014.01.003
3. Zhang W, Doherty M, Peat G, et al. EULAR evidence-based recommendations for the diagnosis of knee osteoarthritis. *Annals of the rheumatic diseases* 2010;69(3):483-9. doi: 10.1136/ard.2009.113100
4. Hochberg MC, Altman RD, April KT, et al. American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. *Arthritis Care Res* 2012;64(4):465-74.
5. American Academy of Orthopaedic Surgeons. Treatment of Osteoarthritis of the Knee: Evidence-Based Guideline 2nd Edition. Rosemont, IL, USA, 2013.
6. Runciman WB, Hunt TD, Hannaford NA, et al. CareTrack: Assessing the appropriateness of health care delivery in Australia. *The Medical journal of Australia* 2012;197(2):100-5.
7. Østerås N, Garratt A, Grotle M, et al. Patient-reported quality of care for osteoarthritis: Development and testing of the osteoarthritis quality indicator questionnaire. *Arthritis Care Res* 2013;65(7):1043-51. doi: 10.1002/acr.21976
8. Edwards JJ, Khanna M, Jordan KP, et al. Quality indicators for the primary care of osteoarthritis: A systematic review. *Annals of the rheumatic diseases* 2015;74(3):490-8. doi: 10.1136/annrheumdis-2013-203913

Additional file 2

Main findings from the survey of PARTNER GP Advisory Group. GPs were asked their opinions on the four target behaviours. Survey items were: 1) Do you agree that it is important that GPs do them?, 2) Do you believe that significant change to current practice would be required?, and 3) Do you foresee major barriers to the behaviour taking place in clinical practice?

1. GP makes and gives a diagnosis of osteoarthritis clinically without imaging or other investigations if a person is 45 years or over and has activity related joint pain and has morning stiffness lasting no longer than 30 minutes	"[There is a] Lot of pressure for investigation from patients along with referral to specialist" "I can see a tension though between saving health dollars and reassuring patients (and maybe their GP) that there is nothing more serious in their painful knee."
2. GP provides education/advice to patients about the importance of general physical activity and regular strengthening and/or aerobic exercise during the consultation	"We know that 'telling' will not change behaviour, so it should be about understanding where the patient is at." "Not all GP's would be confident on specific exercise advice"
3. GP provides education/advice to patients either about the importance of maintaining a healthy weight or weight loss	"This step is routine for the majority of GP's - but weight loss is not an easy behavioural change."
4. GP explains PARTNER model and refers patient to the Care Support Team	"This presumes that there is only one pathway within this model of care? I think there should always be options for GPs and practices to navigate decision making pathway about referrals – both if there is a need and where to refer. There may already be mechanisms established in practices for the functions of the CST, so change will be hard to implement." "This assumes this is the only way forward. GPs will have many options they already use such as using their existing networks of therapists with or without an EPC plan." "The issue is whether GPs see value in this, and our job is to convince practices and GPs that CST will add value, rather than impose it" "This follows the diabetic model so is familiar to GP's. Will take some work but should be a concept that can take hold over time." "I think the main issue will be that GPs will need to feel that their existing expertise is being respected while they are also being offered additional assistance to improve their patients' outcomes"
Other comments	"I think pain management – specifically pharmacological advice about pain management should be a focus – as this is often the reason patients present to GPs in their journey with knee OA, and also failure to manage pain is often the trigger for referral to surgeons." "BMI, education and advice about exercise and weight management will universally be said to be already occurring in general practices

	(whether it's by GPs or practice staff, is another issue), so it's more about systematizing these, rather than change practice behaviour." "If approached in the wrong way, GPs' may get offended and not participate." "GPs in general feel they have a special connection to their patients and in their role as gatekeepers to other services. If they feel this role is threatened this may also be a barrier to uptake of the PARTNER model and CST referral." "Key to this is GP's seeing it as an area where they can make a big difference, where they become prepared to devote time towards supervising patient management and feel empowered with the knowledge and self-belief to do it."

Additional file 3

Content and details of each of the components of the PARTNER GP BCI.

Component	Description	Supporting evidence
Audit/feedback tool	Identify records for five patients with probable knee OA. Self-audit 20 items in six sections: (1) Diagnosis and assessment (2) Education and promotion of active participation in management (3) Non-drug, non-surgical treatment options (4) Medication management (5) Surgical options (6) Ongoing support and review Feedback: Number of items where all patients received recommended management Planning: Reflect on barriers to optimal practice and enablers including learning needs Selection of learning activities and planning for local system changes Implementation of plans Re-audit and feedback Evaluation and conferral of RACGP Continuing Medical Education points.	'Best practice' features to enhance the effectiveness of audit/feedback interventions [1] included: • The target performance is provided • Data are based on recent performance • Data are about the individual's own behaviour • Delivery comes from a trusted and respected source • Recipients are capable and responsible for improvement • Goals for target behaviour are specific, measurable, achievable, relevant, time-bound • Goals set for the target behaviours are aligned with organizational priorities (in this case, the PARTNER model) • A clear action plan in provided when discrepancies are evident Questionnaire items were derived from the literature [2-4]. An expert panel modified the wording and selected the 20 priority items that reflect the aim of the audit activity on best practice diagnosis and management of knee OA with a focus on the target behaviours for GPs in the PARTNER model.
GP professional development	Training module part 1 was developed and delivered in conjunction with Royal Australian College of General Practitioners (RACGP) and confers Continuing Medical Education points: • Evidenced based management of knee OA focussing on diagnosis without imaging and non-drug, non-surgical treatment options • Duration including quiz completion approximately 1 hour	Behaviour change requires effective communication and support from health professionals to facilitate vital self-belief and motivation [5]. In addition, patients need accurate knowledge about consequences and positive beliefs about their prospects and capabilities [6].

	Training module part 2 is a bespoke online training course focussing on: • Communicating with positive language to facilitate effective patient self-management • General skills for improving patient health literacy including 'TeachBack' • Specific communication strategies for conversations about increasing physical activity, losing weight and explaining diagnosis	Widespread explicit and implicit negative weight biases have been shown in large samples of physicians, even in health professionals who specialize in the treatment of obesity (ref Schwartz). Such weight biases impair the quality of healthcare delivery [7]. Thus, methods and resources are needed to reduce weight bias in care delivery. Clinicians should be taught to recognize the complexity of overweight and obesity in terms of behaviour and the influence of mood and mental health disorders [7 8].
Decision support (prompts)	A desktop electronic chronic disease care planning support and medical record software that integrates with the most common GP practice software was customized to be used at the point-of-patient care in a routine clinical consultation. The modified care plan includes prompts to: (1) Include pain, function, sleep, fatigue and mood in assessment (2) Prioritize education of patients on exercise, activity and weight loss as treatment options (3) Refer to the CST (4) Print PARTNER patient education resource and CST brochure	The assessment prompting should facilitate biopsychosocial approach to the problem [9 10]. To be effective, decision support systems need to be [11]: • Automatically provided as part of workflow • Provide recommendations rather than assessments/instructions • Be provided at the point (time and location) of decision making • Be computer based
Facilitated referral process	The desktop electronic care planning tool was also customized to facilitate easy referral to the CST with options for communication with CST from within the patient's record.	Referral processes need to be simple and efficient [12]
Patient education resource	One-sheet printable education resources included: • How a diagnosis is reached • Impacts of knee OA • What causes the pain • What will happen over time • What treatments there are for managing the pain	Evidence for why patients have difficulty up-taking and sustaining the lifestyle behaviours recommended for long term management of their knee OA, and what they perceive they need from their interaction with GPs, informed the content of the resource.

References

1. Ivers NM, Sales A, Colquhoun H, et al. No more 'business as usual' with audit and feedback interventions: Towards an agenda for a reinvigorated intervention. *Implementation science : IS* 2014;9(1):14. doi: 10.1186/1748-5908-9-14
2. Porcheret M, Grime J, Main C, et al. Developing a model osteoarthritis consultation: A Delphi consensus exercise. *BMC musculoskeletal disorders* 2013;14:25. doi: 10.1186/1471-2474-14-25
3. Blackburn S, Higginbottom A, Taylor R, et al. Patient-reported quality indicators for osteoarthritis: A patient and public generated self-report measure for primary care. *Research involvement and engagement* 2016;2:5. doi: 10.1186/s40900-016-0019-x
4. Australian Commission on Safety and Quality in Health Care. Osteoarthritis of the knee clinical care standard. Sydney: ACSQHC, 2017.
5. Ng JY, Ntoumanis N, Thogersen-Ntoumani C, et al. Self-determination theory applied to health contexts: A meta-analysis. *Perspectives on psychological science : a journal of the Association for Psychological Science* 2012;7(4):325-40. doi: 10.1177/1745691612447309
6. Dobson F, Bennell KL, French SD, et al. Barriers and facilitators to exercise participation in people with hip and/or knee osteoarthritis: Synthesis of the literature using behavior change theory. *American journal of physical medicine & rehabilitation / Association of Academic Physiatrists* 2016;95(5):372-89. doi: 10.1097/PHM.0000000000000448
7. Massetti GM, Dietz WH, Richardson LC. Excessive weight gain, obesity, and cancer: Opportunities for clinical intervention. *Jama* 2017;318(20):1975-76. doi: 10.1001/jama.2017.15519
8. Dietz WH. Obesity and excessive weight gain in young adults: New targets for prevention. *Jama* 2017;318(3):241-42. doi: 10.1001/jama.2017.6119
9. NICE. Osteoarthritis: Care and management in adults. Clinical Guideline CG177. London: National Institute for Health and Care Excellence, 2014.
10. Fernandes L, Hagen KB, Bijlsma JW, et al. EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. *Annals of the rheumatic diseases* 2013;72(7):1125-35. doi: 10.1136/annrheumdis-2012-202745
11. Kawamoto K, Houlihan CA, Balas EA, et al. Improving clinical practice using clinical decision support systems: A systematic review of trials to identify features critical to success. *Bmj* 2005;330(7494):765. doi: 10.1136/bmj.38398.500764.8F
12. Egerton T, Nelligan R, Setchell J, et al. General practitioners' perspectives on a proposed new model of service delivery for primary care management of knee osteoarthritis: A qualitative study. *BMC family practice* 2017;18(1):85. doi: 10.1186/s12875-017-0656-7

TIDieR Template for Intervention Description and Replication

The TIDieR (Template for Intervention Description and Replication) Checklist*:

Information to include when describing an intervention and the location of the information

Item number	Item	Where located **	
		Primary paper (page or appendix number)	Other † (details)
	BRIEF NAME		
1.	Provide the name or a phrase that describes the intervention.	Title	
	WHY		
2.	Describe any rationale, theory, or goal of the elements essential to the intervention.	Figure 2	
	WHAT		
3.	Materials: Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers. Provide information on where the materials can be accessed (e.g. online appendix, URL).	GP audit p15 GP education p15 (can be accessed online by RACGP members) Patient resources p15 & 17	Also see the protocol[a]
4.	Procedures: Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.	Figure 1 & Table 3 P10 & 16	Also see the protocol[a]
	WHO PROVIDED		
5.	For each category of intervention provider (e.g. psychologist, nursing assistant), describe their expertise, background and any specific training given.	GPs receive training and desktop support (p15) CST described p10 CST receive training (p16)	Also see the protocol[a]
	HOW		
6.	Describe the modes of delivery (e.g. face-to-face or by some other mechanism, such as internet or telephone) of the intervention and whether it was provided individually or in a	Figure 1 & Table 3 P10	Also see the protocol[a]

	group.		
	WHERE		
7.	Describe the type(s) of location(s) where the intervention occurred, including any necessary infrastructure or relevant features.	P17	Also see the protocol[a]
	WHEN and HOW MUCH		
8.	Describe the number of times the intervention was delivered and over what period of time including the number of sessions, their schedule, and their duration, intensity or dose.	P17	Also see the protocol[a]
	TAILORING		
9.	If the intervention was planned to be personalised, titrated or adapted, then describe what, why, when, and how.	Table 3	Also see the protocol[a]
	MODIFICATIONS		
10.‡	If the intervention was modified during the course of the study, describe the changes (what, why, when, and how).	N/A	_____
	HOW WELL		
11.	Planned: If intervention adherence or fidelity was assessed, describe how and by whom, and if any strategies were used to maintain or improve fidelity, describe them.	N/A	_____
12.‡	Actual: If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as planned.	N/A	_____

[a] Protocol published in ANZCTR (ACTRN12617001595303) and Hunter, D. J., Hinman, R. S., Bowden, J. L., Egerton, T., Briggs, A. M., Bunker, S. J., ... & Schofield, D. J. (2018). Effectiveness of a new model of primary care management on knee pain and function in patients with knee osteoarthritis: Protocol for THE PARTNER STUDY. *BMC musculoskeletal disorders*, *19*(1), 132.

** **Authors** - use N/A if an item is not applicable for the intervention being described. **Reviewers** – use '?' if information about the element is not reported/not sufficiently reported.

† If the information is not provided in the primary paper, give details of where this information is available. This may include locations such as a published protocol or other published papers (provide citation details) or a website (provide the URL).

‡ If completing the TIDieR checklist for a protocol, these items are not relevant to the protocol and cannot be described until the study is complete.

* We strongly recommend using this checklist in conjunction with the TIDieR guide (see *BMJ* 2014;348:g1687) which contains an explanation and elaboration for each item.

* The focus of TIDieR is on reporting details of the intervention elements (and where relevant, comparison elements) of a study. Other elements and methodological features of studies are covered by other reporting statements and checklists and have not been duplicated as part of the TIDieR checklist. When a **randomised trial** is being reported, the TIDieR checklist should be used in conjunction with the CONSORT statement (see www.consort-statement.org) as an extension of **Item 5 of the CONSORT 2010 Statement.** When a **clinical trial protocol** is being reported, the TIDieR checklist should be used in conjunction with the SPIRIT statement as an extension of **Item 11 of the SPIRIT 2013 Statement** (see www.spirit-statement.org). For alternate study designs, TIDieR can be used in conjunction with the appropriate checklist for that study design (see www.equator-network.org).

Standards for Reporting Implementation Studies: the StaRI checklist for completion

The StaRI standard should be referenced as: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths CJ, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor SJC for the StaRI Group. Standards for Reporting Implementation Studies (StaRI) statement. *BMJ* 2017;356:i6795

The detailed Explanation and Elaboration document, which provides the rationale and exemplar text for all these items is: Pinnock H, Barwick M, Carpenter C, Eldridge S, Grandes G, Griffiths C, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor S, for the StaRI group. Standards for Reporting Implementation Studies (StaRI). Explanation and Elaboration document. *BMJ Open* 2017 2017;7:e013318

Notes: A key concept of the StaRI standards is the dual strands of describing, on the one hand, the implementation strategy and, on the other, the clinical, healthcare, or public health intervention that is being implemented. These strands are represented as two columns in the checklist.

The primary focus of implementation science is the implementation strategy (column 1) and the expectation is that this will always be completed.	The evidence about the impact of the intervention on the targeted population should always be considered (column 2) and either health outcomes reported or robust evidence cited to support a known beneficial effect of the intervention on the health of individuals or populations.

The StaRI standard refers to the broad range of study designs employed in implementation science. Authors should refer to other reporting standards for advice on reporting specific methodological features. Conversely, whilst all items are worthy of consideration, not all items will be applicable to, or feasible within every study.

Checklist item		Reported on page #	Implementation Strategy	Reported on page #	Intervention
			"Implementation strategy" refers to how the intervention was implemented		"Intervention" refers to the healthcare or public health intervention that is being implemented.
Title and abstract					
Title	**1**	p1	Identification as an implementation study, and description of the methodology in the title and/or keywords		
Abstract	**2**	p1	Identification as an implementation study, including a description of the implementation strategy to be tested, the evidence-based intervention being implemented, and defining the key implementation and health outcomes.		
Introduction					
Introduction	**3**	p4 p11	Description of the problem, challenge or deficiency in healthcare or public health that the intervention being implemented aims to address.		
Rationale	**4**	p4 p10	The scientific background and rationale for the implementation strategy (including any underpinning	P4 Figure 2	The scientific background and rationale for the intervention being implemented (including evidence

		Figure 1	theory/framework/model, how it is expected to achieve its effects and any pilot work).	Table 3	about its effectiveness and how it is expected to achieve its effects).
Aims and objectives	**5**	p4	The aims of the study, differentiating between implementation objectives and any intervention objectives.		
Methods: description					
Design	**6**	n/a	The design and key features of the evaluation, (cross referencing to any appropriate methodology reporting standards) and any changes to study protocol, with reasons		
Context	**7**	p9	The context in which the intervention was implemented. (Consider social, economic, policy, healthcare, organisational barriers and facilitators that might influence implementation elsewhere).		
Targeted 'sites'	**8**	p10 Figure 1	The characteristics of the targeted 'site(s)' (e.g locations/personnel/resources etc.) for implementation and any eligibility criteria.	P4	The population targeted by the intervention and any eligibility criteria.
Description	**9**	p10 p16 Figure 1	A description of the implementation strategy	p10 p12-13 Figure 1	A description of the intervention
Sub-groups	**10**	n/a	Any sub-groups recruited for additional research tasks, and/or nested studies are described		
Methods: evaluation					
Outcomes	**11**	n/a	Defined pre-specified primary and other outcome(s) of the implementation strategy, and how they were assessed. Document any pre-determined targets	n/a	Defined pre-specified primary and other outcome(s) of the intervention (if assessed), and how they were assessed. Document any pre-determined targets
Process evaluation	**12**	n/a	Process evaluation objectives and outcomes related to the mechanism by which the strategy is expected to work		
Economic evaluation	**13**	n/a	Methods for resource use, costs, economic outcomes and analysis for the implementation strategy	n/a	Methods for resource use, costs, economic outcomes and analysis for the intervention
Sample size	**14**	n/a	Rationale for sample sizes (including sample size calculations, budgetary constraints, practical considerations, data saturation, as appropriate)		
Analysis	**15**	n/a	Methods of analysis (with reasons for that choice)		

Sub-group analyses	**16**	n/a	Any a priori sub-group analyses (e.g. between different sites in a multicentre study, different clinical or demographic populations), and sub-groups recruited to specific nested research tasks		
Results					
Characteristics	**17**	n/a	Proportion recruited and characteristics of the recipient population for the implementation strategy	n/a	Proportion recruited and characteristics (if appropriate) of the recipient population for the intervention
Outcomes	**18**	n/a	Primary and other outcome(s) of the implementation strategy	n/a	Primary and other outcome(s) of the Intervention (if assessed)
Process outcomes	**19**	n/a	Process data related to the implementation strategy mapped to the mechanism by which the strategy is expected to work		
Economic evaluation	**20**	n/a	Resource use, costs, economic outcomes and analysis for the implementation strategy	n/a	Resource use, costs, economic outcomes and analysis for the intervention
Sub-group analyses	**21**	n/a	Representativeness and outcomes of subgroups including those recruited to specific research tasks		
Fidelity/ adaptation	**22**	n/a	Fidelity to implementation strategy as planned and adaptation to suit context and preferences	n/a	Fidelity to delivering the core components of intervention (where measured)
Contextual changes	**23**	n/a	Contextual changes (if any) which may have affected outcomes		
Harms	**24**	n/a	All important harms or unintended effects in each group		
Discussion					
Structured discussion	**25**	n/a	Summary of findings, strengths and limitations, comparisons with other studies, conclusions and implications		
Implications	**26**	n/a	Discussion of policy, practice and/or research implications of the implementation strategy (specifically including scalability)	n/a	Discussion of policy, practice and/or research implications of the intervention (specifically including sustainability)
General					
Statements	**27**	n/a[a]	Include statement(s) on regulatory approvals (including, as appropriate, ethical approval, confidential use of routine data, governance approval), trial/study registration (availability of protocol), funding and conflicts of interest		

[a] The study to evaluate the effectiveness of the designed implementation strategy has been described in:

1) The clinical trials registry – ANZCTR ACTRN12617001595303
2) Cluster randomised controlled trial protocol paper: Hunter, D. J., Hinman, R. S., Bowden, J. L., Egerton, T., Briggs, A. M., Bunker, S. J., ... & Schofield, D. J. (2018). *Effectiveness of a new model of primary care management on knee pain and function in patients with knee osteoarthritis: Protocol for THE PARTNER STUDY*. BMC musculoskeletal disorders, 19(1), 132.
3) Process evaluation protocol paper: Bowden, J. L., Egerton, T., Hinman, R. S., Bennell, K. L., Briggs, A. M., Bunker, S. J., ... & Zwar, N. A. (2020). *Protocol for the process and feasibility evaluations of a new model of primary care service delivery for managing pain and function in patients with knee osteoarthritis (PARTNER) using a mixed methods approach.* BMJ open, 10(2).