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Barriers and facilitators to Orthopaedic Surgeons' uptake of decision aids for Total Knee Arthroplasty: A qualitative study

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Abstract

Objectives: The demand for Total Knee Arthroplasty (TKA) will soon outstrip supply. It is imperative to reserve TKA for those most likely to benefit. Decision aids can help surgeons select appropriate candidates for surgery, but their uptake has been low. The aim of this study was to explore the barriers and facilitators to decision aid uptake among Orthopaedic Surgeons. *Design:* A qualitative study involving face-to-face interviews. Questions were constructed on the Theoretical Domains Framework to systematically explore barriers and facilitators. *Setting:* One tertiary hospital in Australia. *Participants*: Twenty Orthopaedic Surgeons performing TKA. *Outcome measures:* Beliefs underlying similar interview responses were identified and grouped together as themes describing relevant barriers and facilitators to uptake of decision aids. *Results:* While prioritising their clinical acumen, surgeons believed a decision aid could enhance communication and patient informed consent. Barriers identified included the perception that one's patient outcomes were already optimal; a perceived lack of non-operative alternatives for the management of end-stage osteoarthritis; concerns about mandatory cut-offs for patient-centred care, and concerns about the medico-legal implications of using a decision aid. *Conclusions:* Multifaceted implementation interventions are required to ensure that Orthopaedic Surgeons are ready, willing and able to use a TKA decision aid. Audit/feedback to address current decision-making biases such as overconfidence may enhance readiness to uptake. Policy changes and/or incentives may enhance willingness to uptake. Finally, the design/implementation of effective non-operative treatments may enhance ability to uptake by ensuring that surgeons have the resources they need to carry out decisions.

Strengths and limitations of the study

- Very few qualitative studies involving Orthopaedic Surgeons have been published in the literature.
- This study took place in one of the largest arthroplasty clinics in Australia. All twenty surgeons performing TKA in this hospital participated in a one-to-one interview.
- A theoretical framework was used to systematically explore the barriers and facilitators to uptake of a decision aid by Orthopaedic Surgeons.
- Consistent findings are documented between this single site study and international surveys of surgeon' attitudes.
- Beliefs and attitudes are distinct from actual behaviour, and therefore the themes elicited in this study do not provide evidence of the actual influences on uptake of a decision aid.

Background

Up to one quarter of Total Knee Arthroplasties (TKA) are performed on inappropriate candidates according to evidence-based criteria[1] and a similar proportion experience minimal clinical benefit from surgery.[2] To reduce expenditure, optimize the utilization of resources, and avoid unnecessary pain and suffering, it is important to reserve TKA for those who will derive a clinically meaningful improvement in pain and function.

At present, indications for TKA vary widely.[3 4] While the degree osteoarthritis (OA) severity, pain severity and the impact of pain, are key indicators for TKA, surgeons' consideration of other evidence-based indicators such as psychosocial factors remains varied.[5] Observations of orthopaedic consultations suggest that other 'unstated factors' may also influence clinical judgments such as the surgeons' beliefs in their own ability to conduct surgery and their 'instincts' about the patients ability to cope with pain.[6]

In recent years there has been a move towards a model of shared decision-making in Orthopaedics as part of informed consent.[7 8] This model implies that surgeons have a duty to inform patients about the benefits and harms of TKA and the likelihood of their occurrence, supporting them to arrive at an informed, shared decision. Evidence suggests that there is often a lack of time during the clinical encounter for patients to consider or discuss all available treatment options and arrive at a decision congruent with their own preferences.[9]

To help address variations in clinical judgments and promote shared decision-making, decision aids may be useful.[10 11] Decision aids can be designed to estimate important, patient-specific risks of responding to surgery, based on independent prognostic correlates of post-TKA response such as body mass index, degree of OA severity, pre-operative pain, function and mental health.[12] Similar aids have been found to predict outcomes in other areas of medicine with superior accuracy to clinical judgments alone.[13 14] Decision aids have improved patient knowledge and confidence in decisions,[15] and have even been found to reduce the rate of surgical procedures.[16]

Orthopaedic Surgeons recognize the need for an aid to support their decision making for TKA and optimize communication with patients.[5 17] However, the uptake of decision aids amongst surgeons has been low.[8] A number of factors can influence uptake of a decision aid, and the success of implementation efforts depends on the careful assessment of the barriers to, and facilitators of, uptake.[18] The implementation literature advocates the use of theory to ensure the systematic identification of such factors and inform the design of interventions to address them.[19] Using theory not only increases the likelihood of behavior change,[20] but also provides a basis for better understanding the processes underpinning behavior change.[21] To date, studies of decision-making amongst Orthopaedic Surgeons have been few and atheoretical[5 6 22] and the barriers and facilitators of uptake of decision aids for TKA have not been rigorously explored.[8 17]

Methods

Aim and Design:

The aim of this theoretically-informed qualitative study was to explore the barriers and facilitators to uptake of a TKA decision aid through structured one-to-one interviews with Orthopaedic Surgeons.

Participants:

All Orthopaedic Surgeons and Registrars performing TKA at one tertiary teaching hospital in Australia were eligible. Eligible candidates received the study details via email from an institutional administration officer, and were invited to contact the researchers to arrange an interview at a time and place suitable to them.

Data collection:

The Theoretical Domains Framework (TDF)[23] was selected as a comprehensive and validated framework for determining barriers and facilitators related to the implementation of best practice and clinicians' behavior change. The TDF was developed by implementation scientists to synthesise existing behavior change theories into a single framework. A six-stage consensus approach resulted in the identification of 12 theoretical 'domains' describing possible mediators of behavior change.[23] A subsequent validation study[21] revised the original TDF to 14 domains: Knowledge; Skills; Social/professional role and identity; Beliefs about capabilities; Optimism; Beliefs about consequences;

Reinforcement; Intentions; Goals; Memory, attention and decision processes; Environmental context and resources, Social influences; Emotions; and Behavioural regulation. The revised TDF, used in this study, has explained implementation problems and informed the development of theory-informed behavior change interventions.[24-26]

Interview questions were developed for each domain of the TDF with the advice of content experts in the TDF (SF), orthopaedic surgery (MD) and decision-making processes (AS), and in consultation with the literature.[27] In the first part of the interview, questions aimed to elicit current decision-making processes and biases. In the second part, questions aimed to identify beliefs and attitudes towards decision aids and factors that may influence decisions to use one. Table 1 presents the interview schedule.

[Insert Table 1]

The interviewer (SB), a female post-doctoral researcher with methodological expertise in qualitative research, had no previous relationship with the participants and no affiliation with the hospital. Data saturation was considered complete when the beliefs and attitudes of all 20 surgeons working in this setting had been elicited. Face-to-face interviews were conducted with 18 participants in a private office; phone interviews were conducted with two participants. Interviews lasted 20-30 minutes. Nineteen interviews were audio recorded and transcribed verbatim. One participant did not wish the interview to be recorded, therefore hand-written notes were made during the interview. Participant anonymity was ensured at all times. All transcripts were de-identified prior to data

analysis. All participants had the opportunity to review the study findings during a presentation at a scheduled surgical meeting. There was consensus agreement with the researchers' interpretations and no adjustments were made to the study themes.

Analysis:

Adopting an implementation approach,[25] three stages of data analysis were conducted involving deductive and inductive coding. In the first stage (deductive coding), two researchers (SB, EN) independently coded interview transcripts into the 14 TDF domains. Definitions for each domain were derived from the literature[18] and adapted to the study context. Each response or utterance could only be classified into one domain. Pilot coding was performed in which the two researchers independently applied the coding framework to two transcripts. Inter-coder comparisons resulted in refinement of domain definitions (see Additional file 1). This process was conducted three times, until the two researchers were confident that all relevant raw data could be clearly classified into one domain using the refined coding framework.

The two researchers then independently applied the refined coding framework to all 20 transcripts. Inter-coder consistency (i.e. the consistency with which each researcher coded the same statement into the same domain) was calculated using a Kappa statistic. Disagreements were discussed and consensus reached in each instance. Coded raw data was uploaded into a qualitative data sorting software (Codesort[28]) to facilitate further analysis.

In the second stage of analysis (inductive coding), one researcher (SB) generated belief statements based on responses within each domain of the TDF. These belief statements provided detail about the potential influence the domain had on the surgeon's clinical behaviour. The belief statement was worded such that it could describe multiple responses from different participants. Belief statements were reviewed by two further researchers (EN, MD) to check that they remained grounded in the raw data.

In the third stage of analysis, the domains most relevant to surgeon's behaviour were identified through group discussion. Relevancy was determined by: 1. Frequency of beliefs across transcripts and/or 2. The perceived strength of beliefs in influencing behaviour. To illustrate, the belief statement: 'I think that the percentage of my patients who achieve clinically meaningful improvement is higher than that reported in the literature' appeared in 17/20 transcripts and was considered to have a strong influence on surgeon's clinical behaviour, implying that behaviour change was unlikely if surgeons consider that their patients' outcomes are already optimised. 'Knowledge' was therefore identified as a relevant domain. Where the researchers considered that beliefs within and between domains represented similar barriers/facilitators, these were grouped into themes. We calculated frequencies of beliefs to provide the reader with a better understanding of the raw data and to assist us in identifying 'relevant' domains of the TDF. However, readers should be cognisant that the absence of a belief in a transcript is not the same as a lack of endorsement.

Results

Participants:

Aggregate data describing the demographics of the sample is provided to protect individual anonymity. The sample comprised of 15 Consultant surgeons and five Registrars. The surgeons' total experience performing TKA ranged from six months to 30 years (mean ± SD, 12.9 ± 9.3) and the number of TKAs performed each month ranged from less than one to 12 (mean ± SD, 5.9 ± 3.0).

Inter-rater reliability:

Across the 20 interview transcripts, 628 utterances were coded into the 14 domains. There was good inter-coder reliability across all interviews and domains (Kappa = 0.74 Standard error Kappa ± 0.02)

Relevant domains:

Eleven TDF domains were identified as relevant: Knowledge; Behavioural regulation; Memory attention and decision processes; Beliefs about capabilities; Skills; Goals; Social/Professional role and identity; Intention; Beliefs about consequences; Environmental context; and Reinforcement. Table 2 presents the relevant domains, with specific belief statements supported by example quotes.

[Insert Table 2]

Themes identified:

1. Knowledge of one's own patient outcomes

(Relevant TDF domains: Goals; Knowledge; Behavioural regulation; and Beliefs about capabilities)

All participants stated their goal was to optimise outcomes for their patients:

"Ultimately, we will always do our best for the patient" (024)

While almost all participants (n=19) were aware of the literature that up to 20 per cent of patients undergoing TKA have no clinically meaningful improvement from surgery, most believed that this percentage was significantly lower in the patients they operated on:

"I don't count it, but you get an impression. Around 10 per cent of my patients would be saying they are not entirely satisfied by surgery" (016)

All participants based this estimation on patient presentations at post-surgical follow-up appointments. However, participants acknowledged the 'rose-coloured glasses' they saw

their patients through, citing the subtleties of rapport that made patients less likely to report dissatisfaction with surgery:

"To please you, patients often say it is doing better than it really is. So I would think my outcomes are better than 20 per cent, but I am aware of the glasses that I see it through as well as what patients might tell me" (014)

Participants recognised that patients with poor post-surgical outcomes may be less likely to attend follow-up appointments, choosing to seek care elsewhere. Many participants reported that tracking long-term patient outcomes through an existing joint registry could counter-act this, providing a mechanism for them to reflect on any discrepancies between their perceived and actual clinical outcomes:

"If patients choose not to come back, the only way you have got to track them is looking at your results from the registry. But I want to know the answers to the clinical questions – are you happy? Is your pain better than it was pre-op? How you ask the question matters" (028)

Indeed, a key problem identified by many participants was how to define clinically meaningful improvement. Several participants emphasised the importance of 'asking the right question in the right way':

"If you received feedback that the rate of clinically meaningful improvement reported by your patients is not as high as you think it should be, I would want to check who is asking the questions, what they are asking and how they are asking it" (023)

"To me a good result is: they are going to have some intermittent ache in the knee, they're not going to be able to kneel or squat. Others on some assessment scale might consider that a failure. So you have get those parameters right" (010)

The discrepancy between participants' perceptions of clinically meaningful improvement and that of their patients was commonly attributed to mis-matched surgeon-patient pre-surgical expectations of TKA. Participants' reported their expectations of TKA to be a resolution of joint pathology with some corresponding improvement in pain. While disease and pain severity were key considerations in surgical decision-making, all participants acknowledged that patient expectations were important:

"At the end of the day if there is a pathology that can be deleted by surgery and the patient accepts some improvement then that means that the surgery will happen" (025)

"If the patients' expectations are not meeting mine, I won't do the operation because then the patient isn't happy and sometimes they have 2/10 pain and they are not happy" (013)

2. Reliance on 'clinical intuition'

(Relevant TDF domains: Memory, attention and decision processes; and Skills)

For many participants, the accurate assessment of patient expectations presented a challenge. While the physical aspects of the clinical assessment were routine skills that all participants believed they had mastered well, many junior and senior surgeons reported difficulties assessing the psychological aspects of the patients' presentation:

"It is patient factors more than anything else. Because it is very easy to look at xrays and use the Kellgren-Lawrence scale: one to four for disease severity. There is not much of an argument over that. It's about the patient factors, the psychology and behavioural aspects of it which you want reassurance for" (016)

Only a few participants were aware of any validated tools to assess pre-surgical patient predictive factors. Only one participant had prior knowledge of a decision aid but had not used it. Participants relied on their 'clinical intuition' for patients who were less likely to do well, developing a 'gut-feeling' for patients over time:

"You spend all your life looking at patients and assessing them and you start to develop a bit of a gut feeling as to what might be happening. Sometimes you sit in front a patient and think: I know you are telling me this, but I know something else is happening" (015)

3. The role of aids in supporting clinical decision-making

(Relevant TDF domains: Intention; Reinforcement)

Fifteen participants believed an aid would support decision-making, like a 'barometer' or weather app to forecast outcomes, particularly in patients they were unsure about:

"I don't think it would really influence my surgical decision-making, I think it would more affirm my decision to not offer a patient an operation" (029)

"If I think they are OK and they score badly I will relook at it and say why is that? Am I missing something obvious? But at the end of the day if an aid says one thing and my sniff test says there is something not right, I'm still following my nose" (010)

Participants believed an aid would be insensitive to nuances at an individual level and could therefore not replace their clinical acumen:

"Not every tool is perfect and it may not capture every patient… the danger is we may end up refusing to do something because of an aid and therefore patients may not receive the appropriate treatment. Nothing is 100 per cent so you have to expect some patients would fall through the cracks" (019)

All participants expected to be provided with evidence that a decision aid had been rigorously validated and shown to have high specificity and sensitivity before considering

using it. Participants were more likely to trust this evidence if it came from their own institution:

"I think people are mistrustful of things that come out of other institutions but I would trust that a study from [the Department] would be a rigorous design. If the results showed an aid was valid, I guess I would be prepared to try it and see whether I thought it was valid in my hands, in my practice" (026)

Indeed, half of the participants reported that evidence supporting the validity of a decision aid would not be sufficient to convince them to use it. Instead they suggested that they would need to see how an aid correlated with their own clinical decision-making:

"I never trust evidence because you only have to go to Dr x ...even in research there's a lot of doubtful stuff... I know we have got to be evidenced-based but the evidence may apply to a certain situation in a certain individual at a period in time and there is always variations or exceptions around that. So I would try and correlate them in my own mind and if after a while I'm seeing well that person is a bit odd and they are scoring badly on the aid, well ok, this has legs." (010)

4. Implications of a decision aid for patient-surgeon communication and shared decision-making

(Relevant TDF domains: Beliefs about consequences; Memory, attention and decision processes)

Participants perceived that a decision aid would give them an evidence-based approach for saying 'no' to patients, particularly for those participants who reported difficulties declining surgery:

"I think that the main benefit of an aid would be making the patient understand if I am saying no to the surgery it's not because I don't like him or her, it's because there is data written black on white that they are not going to do well...It will not just be my gut feeling. I can give them data and say "sorry it's written here. It's not me it's the computer. So it backs up what I am saying" (013)

Many participants believed an aid could be an important component of informed consent, providing patients with objective data on their likely risk outcomes, enabling them to have the appropriate expectations to weigh up the risk and benefits of surgery for themselves. In this way, some participants saw a decision aid as a valuable support to shared decision-making:

"It comes back down to getting patient consent, as part of that I would incorporate it into my consent form and say preoperatively you have a fifty-fifty chance and that has been discussed with a validated tool. If the patient wishes to go ahead, they can make that informed decision" (021)

Participants were divided in their responses when asked how they would feel about operating if a decision aid predicted a patient had a 50 per cent chance of not responding to TKA. While half agreed with the statement above that decisions to proceed would need to be shared with the patient:

"A patient may be so severely impacted that a one in two shot is worth it…it is totally patient dependent" (023)

The other half reported they would not consider surgery unless there was a greater than 80 per cent chance of responding:

"You have got to be 95 per cent and above. I wouldn't accept anything less than that. I wouldn't offer the operation. It is too big an operation, too big a deal, too big a cost" (024)

5. Ethical and legal concerns about decision aids

(Relevant TDF domain: Beliefs about consequences)

A few participants had serious medico-legal concerns about documenting a specific risk value in patient records, and believed that such information would have to be deliberately withheld from patients in case it fell into the 'wrong' hands:

"You have to think of the medico-legal implications of a patient having a risk value documented in their notes. If they don't have a good result and then lawyers look through and say you had this validated tool and you still went ahead, where would we lie medico-legally?" (024)

While a few participants believed it would be unethical *not* to use a decision aid if it had been shown to improve patient outcomes, others were concerned about the ethical implications of a tool if imposed cut-offs were used to deny patients surgery:

"I guess the ethicists would say you are denying patient-centred care, so that is where there is a potential for a can of worms" (021)

"I don't think it can become compulsory because it takes away patient-centred care" (025)

6. Available resources and organisational culture as barriers to uptake

(Relevant TDF domains: Environmental context and resources; Beliefs about consequences and Social/Professional role and identity)

Almost all participants expressed concerns about making an aid compulsory and imposing mandatory cut-off levels. While many recognised that implementing an aid in

this way would have the potential to improve the use of valuable resources and save costs:

"If you could use the tool to triage patients and push them some where else, it would be more effective for the patient and there would be cost savings for the hospital and the community" (016)

Several participants commented that mandatory cut-offs would only be possible if an effective, non-operative alternative was made available for patients that were denied surgery. A lack of effective surgical alternatives was seen as a key barrier:

"You have to be able to say 'although we don't think you would benefit from surgery, we're going to put you in this intense physiotherapy program with dieticians to improve your knee pain'. They need to be offered something. The problem is these things are available at an individual component level ... but I don't think there is anything formally put in place that patients can be referred from arthroplasty clinics into these programs" (029)

Most participants perceived that the logistics of agreeing on a cut-off value for acceptable risk, and the threat to surgeons' professional identity as a patient-centred practitioner, were insurmountable barriers to imposing mandatory cut-offs:

"A lot of surgeons would say in their hands they will get better results, that is just an inherent bias associated with surgical procedures and surgeons themselves so it would be hard to agree on a level" (019)

"Surgeons wouldn't care if it was compulsory to use an aid, as long as they didn't have to do any work. Making it compulsory to follow it would be dangerous. Because we're all individuals, what you are doing is taking the human experience aspect of the consultation out and then you turn us into proceeduralists that just look at a tick box and operate on someone" (016)

7. Format and content of a decision aid

(Relevant TDF domain: Environmental context and resources)

Finally, participants did not believe it would be difficult to physically integrate an aid into clinical practice. An electronic or online format was seen as the most likely way an aid could be implemented, particularly given the strict time constraints placed on outpatient clinics:

"I can imagine something working on the phone, an app. Simple and intuitive - so you put in a little info - BMI, age, degree of arthritis etc... tick tick tick. And then it gives you the number, bang" (013)

Most believed that an aid would be best used within the patient-surgeon consultation:

"I think it's something that should be done by the surgeon. It is also part of the process where the surgeon gets to know the patient as well - not just their xrays and physical examination but also their psychosocial situation" (019)

While others suggested that an aid could be designed for patients to use on their own or with a support network to save time in the clinical consultation:

"A lot of patients look on my website. You could have a thing on your website saying: 'sometimes patients with certain problems may not be appropriate for a TKA, this test can give you a rough idea of your likely success rate'. You could put it out there before they even come to see you. 'Is this operation for you?' type of thing" (028)

Irrelevant domains:

Three domains were not considered to have a salient influence on the target behaviour. These were: Optimism, Emotion and Social Influences. Optimism was closely connected to the domain Reinforcement i.e. surgeons reported being neither optimistic nor pessimistic about the utility of an aid until they had seen evidence of its effectiveness. The Emotion domain did not appear relevant as described by one surgeon: "I am not worried about the implications of a tool. Knee replacement is wellness surgery, in the worst case scenario they don't get a new knee". The Social Influence of patients did not

appear relevant as surgeons believed patients were accustomed to filling out questionnaires. While surgeons were more likely to trust an aid if it had been developed by their peers, they preferred to test the tool 'in their own hands' and therefore the Social Influences of other surgeons using an aid appeared limited.

Discussion

These findings have implications for the future design and implementation of decision aids into surgical clinical practice. It is possible that current decision-making biases may be key barriers to uptake. Surgical decision-making involves the consideration of the risks versus benefits of surgery.[29] In this study, participants expressed confidence in their ability to successfully remove diseased tissue and correct joint deformity, and the likelihood of some corresponding improvement in pain severity was perceived to be high. At the same time, participants perceived that the risk their patients would not respond to TKA was low. One potential explanation for this is an apparent lack of clarity around the definition of 'clinically meaningful improvement' and 'non-response'. The literature suggests that patients' perceptions of 'clinically meaningful improvement' depend on their satisfaction with improvements in pain and function, closely linked to their expectations of surgery.[30] In contrast, the surgeons in this study believed that a resolution in joint pathology and some corresponding improvement pain could be considered 'meaningful improvement'. This lack of clarity is important, as surgeons who believe that their patient outcomes are already optimised may be less motivated to use a decision aid.

Another explanation may be that surgeons in this sample exhibited an over-confidence bias. Indeed, most participants believed their own patient outcomes were better than that reported in the literature. While it is possible that this belief is accurate and outcomes amongst this sample of surgeons are indeed above average, similar observations were made in a survey study involving 700 Orthopaedic Surgeons in Europe and North America.[31] In that study, 83 per cent of surgeons surveyed considered themselves to be above average diagnosticians; 74 per cent believed they were above average surgeons and 25 per cent believed they were in the top five per cent of surgeons.[31] This over-confidence bias may lead to a confirmation bias in which surgeons only notice things that agree with their point of view and are less attentive to alternative viewpoints due to cognitive dissonance.[32] A confirmation bias can have consequences for the uptake of a decision aid as surgeons may be less likely to consider evidence that contradicts their clinical experience.

Surgical decision-making also involves weighing up of the risks versus benefits of non-operative interventions.[29] The participants highlighted a lack of effective non-operative interventions for end-stage knee OA. A study among Dutch Orthopaedic Surgeons similarly documented a lack of confidence in the efficacy of non-surgical treatments associated with a decreased referral rate.[33] Indeed, there is currently a dearth of evidence-based, non-operative interventions for patients with end-stage knee OA either as an alternative to surgery or as a definitive management when the patient is deemed unsuitable for TKA. In the absence of a treatment alternative, surgery with all its risks and costs is often the default intervention. This is an important barrier to uptake as

evidence suggests surgeons will not use an aid if they do not have the resources to carry out the decisions,[27] or if the aid does not support their own view about effective treatments.[34]

The participants in this study believed a decision aid could promote shared decision-making and enhance informed consent for TKA. Similar attitudes towards decision aids were identified in a previous review[8] and a survey of the wider population of Orthopaedic Surgeons.[17] It may be that surgeons can be motivated to uptake a decision aid because it is the ethical thing to do.[35] However, our study identified concerns about the ethical implications of imposing mandatory cut-offs that would determine eligibility for TKA. These concerns may reflect the participants' desire to defend professional discretion and autonomy. We take the opportunity to emphasise the function of a decision aid is to support, not replace, clinical decision making. However, concerns were also expressed about the legal implications of using a decision aid. This finding contrasts with a study involving US Orthopaedic Surgeons who believed decision aids may reduce litigation and malpractice insurance premiums by enhancing shared decision-making.[36] It may be that these concerns are unique to the medico-legal context of Australia. Certainly, surgeons will be less likely to be uptake a tool if they perceive it makes them vulnerable to medico-legal action.

Implications:

The Ready, Willing and Able model posits that these three preconditions must be satisfied before a decision aid will be adopted.[37] 'Ready' refers to the perceived benefit of changing the status quo and adopting an aid to support decision-making. 'Willing' refers to the perceived legitimacy of a decision aid and a willingness to overcome objections and concerns. 'Able' refers to the ability to adopt the decision aid given available resources.[38] Implications for enhancing the readiness, willingness and ability of Australian Orthopaedic Surgeons to uptake a TKA decision aid are described below.

To enhance Readiness to uptake, current decision-making biases may need to be addressed. Information to counter these biases could be provided through audit and feedback. Audit and feedback is defined as a 'summary of the clinical performance of healthcare provider(s) over a specified period of time' (p. 5).[39] It may be particularly effective when clinicians' ability to accurately self-assess is limited.[40] This assumes that clinicians are motivated to improve care but lack intention to change current behaviour because they are unaware of their suboptimal performance. While effect sizes may depend on the format and context in which feedback is provided, findings from a Cochrane review suggest that audit and feedback can yield important improvements in professional practice.[39] Clarity and consensus on the definition of 'clinically meaningful improvement' and 'non-response' to TKA is likely to influence the success of an audit and feedback intervention in this context. Future research is needed to explore how audit and feedback is best delivered in this context including the immediacy and frequency of feedback, and the potential to incorporate other approaches such as the use of surgeon incentives.[41]

To enhance Willingness to uptake, an audit and feedback intervention before and after using a decision aid may be necessary for Orthopaedic Surgeons to gain confidence in its legitimacy. The findings suggest that validating a decision aid in large multi-centre trials may not be sufficient to encourage uptake, as surgeons believed such trials do not account for variations in case load and years of experience. Surgeons perceived themselves as not only scientists, but also 'artists'; believing that surgical success depended, in part, on the 'hands' that performed it. This suggests that Orthopaedic Surgeons may need to be given the opportunity to validate a decision aid 'in their own hands'.

Addressing concerns about the medico-legal implications of a decision aid may also be necessary to enhance Willingness to uptake. This may require the consultation of multiple stakeholders including policy makers, lawyers and institutional administration before the implementation of a decision aid. Legislative changes in the United States have recognised decision aids as a higher standard of informed consent[7] and in the United Kingdom, incentives to use decision aids are being developed.[8] There is evidence that mandating the use of a decision aid as a requirement for gaining informed consent results in significantly improved patient-outcomes including a reduction in the rate of TKA by 38 per cent in a six-month period.[42] Future studies are required to explore if policy changes and/or incentives might influence Willingness to uptake a decisions aid in the Australian context.

To enhance Ability to uptake, it appears important to address the dearth of non-operative alternatives to surgery for end-stage knee OA so that surgeons have the resources to carry out decisions. Future research to design and implement effective, evidence-based, non-operative interventions should be a priority. Targeting Orthopaedic Surgeons' beliefs about the efficacy of such interventions through education strategies will also be important. The study findings suggest that Ability to uptake may be enhanced if a decision aid is packaged in an electronic or online format that is quick and easily accessible. Focus groups involving surgeons and patients to gain feedback on prototypes of a decision aid during the design phase is important to ensure that not only the format, but also content, are accessible to a range of end users.

Conclusions

Using a theoretical framework to systematically explore barriers and facilitators to uptake, this study will inform the design and implementation of future TKA decision aids.[12] The findings suggest that a multifaceted approach will be required to ensure that Orthopaedic Surgeons are ready, willing and able to use a decision aid that can reduce the suffering and economic burden of 'failed' TKA. Research exploring patients' beliefs and attitudes towards a TKR decision aid is required prior to implementation.

Abbreviations

TKA = Total Knee Arthroplasty

OA = Osteoarthritis

TDF = Theoretical Domains Framework

Declarations

Ethics approval: This study was carried out in compliance with the Helsinki Declaration. Approval was given by St Vincent's Hospital Melbourne, Australia (QA 019 /_16).

Availability of data and materials: Requests regarding the datasets used in this study can be directed to the first author. Full interview transcripts will not be shared to protect the anonymity of the study participants.

Competing interests: The authors declare that they have no competing interests

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Authors contributions: SB: led the study design, data collection, data analysis and manuscript preparation. EN contributed to the data analysis. AS, PC and MD contributed to the study design, data analysis and manuscript preparation. SF contributed to the study design and manuscript preparation.

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Table 1. Interview Schedule

TDF domain	Questions
Knowledge	*Evidence from the literature suggests that up to 22% of patients presenting for total knee arthroplasty will not have a clinically meaningful improvement from surgery.* - What do you think about this figure? -How do you interpret the term 'no clinically meaningful improvement'? *For the purposes of this interview, we are interpreting clinically meaningful improvement as no improvement in pain, function or QOL following surgery.* - Are you aware of what percentage of patients that you operate on do not benefit from surgery? How do you know this? Do you track it? Would you like to know? How could feed this information back to you? In what format?
Beliefs about capabilities	- How confident are you in identifying patients who are unlikely to experience an improvement in symptoms from TKR? - How good do you think you are at it compared to others? - Do you feel you are unsure about identifying these patients at times? If so, what would you do?
Behavioural regulation	- Of all the patients referred to you, what is the % of patients that proceed to surgery and how many do you turn away? - What do you do with the ones that don't? Do you refer them somewhere?
Skills	- What skills help you decide if someone is likely to benefit from surgery or not? - Are you aware of any tools currently available to help you assess a patients' risk of not responding? Do you use them? Why/ why not?
Beliefs about consequences	*Based on a set of evidence-based parameters, decision aids can predict the degree of risk that a patient will not achieve a clinically meaningful improvement from TKA* -What do you think the benefits of using a decision aid might be? -What might be the disadvantages of using an aid? - Do you see anything legal or ethical about using a decision aid? -Would the benefits outweigh the potential harms? Why?
Intentions, Goal	-Would using a decision aid influence your surgical decision making? Why/why not?

Reinforcement	-What would motivate you to use a decision aid? -Would you need to be presented with evidence from the literature? How would this evidence be best delivered? Who would it need to be delivered by?
Environmental context and resources	-What would facilitate the use of a decision aid for you? -How would it best be packaged? -When do you think it would be best used? Do you think you are the best person to use it?
Decision process	-If a decision aid predicted that patient had a 50% risk of not benefiting from surgery would you still operate? What about a 70% risk? What would your level of acceptable risk be?
Social/Professional role and identity	-Do you think there would be agreement between surgeons on this cut point?
Social/Emotional influences	-What if something like this tool became compulsory – how would you feel? How do you think other surgeons would feel? -How do you think patients would respond? Would their response influence your use of an aid? -Would you worry about missing potential candidates who might have responded to surgery?
Optimism	-How optimistic are you that a decision aid will reduce the rate of surgery in patients who are at high risk of not benefiting from surgery?

Table 2. Findings summary

Relevant TDF Domains	Specific Belief	Facilitator or barrier	Example quote (participant code)	Frequency out of 20
Knowledge	I am aware of the literature that up to 20% of patients do not have a CMI from TKR	Facilitator	"I think 22% is the high end. But there is a lot of different papers that all suggest 10,15,20%" (012)	19
	I think that this % is lower in my patients	Barrier	"I don't count it, but I think around 10% would be saying they aren't entirely satisfied by surgery" (016)	17
	Any improvement in pain is still an improvement, it depends how you define 'meaningful'	Barrier	"If the surgery is done for the right reason, the pain would decrease, the question is whether the decrease would be 10%, 50% or 100% depending on whether there are other reasons for the pain. But there would be an improvement" (025) "To me a good result is: they are going to have some intermittent ache in the knee, they're not going to be able to kneel or squat. Others on some assessment scale might consider that a failure. So you have get those parameters right" (010)	7
Behavioural regulation	I am aware that the feedback I get from my patients may be biased	Facilitator	"To please you, patients often say it is doing better than it really is. So I would think my outcomes are better than 20%, but I am aware of the glasses that I see it through as well as what patients might tell me" (014)	6
	I would be interested in feedback on the	Facilitator	"There's always a difference between how well you think you are doing and how you *are* doing. Having formal feedback on patient outcomes gives you the	20

	percentage of my patients who achieve a clinically meaningful improvement		opportunity to change things if you are not doing as well as you want to" (023) "What I would like to know is the patient who overall is unhappy with their results and didn't get the result they expected" (010) "I would like feedback on the number of patients who are in each category of satisfaction and I would like to see how my personal results are compared to the group" (016)	
Memory, attention and decision processes	Patient expectations are an important consideration in surgical decision making	Facilitator	"If the patients' expectations are not meeting mine, I won't do the operation because then the patient isn't happy and sometimes they have 2/10 pain and they are not happy. And that is silly. So it is about telling the patient what they can expect and after the operation it is about "you remember what we said" (013)	20
	The lack of effective non-operative alternatives influences my surgical decision making	Barrier	"You have to be able to say 'although we don't think you would benefit from surgery, we're going to put you in this intense physiotherapy program with dieticians to improve your knee pain. They need to be offered something. The problem is these things are available at an individual component level … but I don't think there is anything formally put in place that patients can be referred from arthroplasty clinics into these programs" (029) "Well if you make an alternative plan and say we are not going to do surgery we are going to lose weight, do some physiotherapy, take pain killers, you send them off and they come back and say they have done all of that. It means you don't have another option to offer	12

			them and those patients often just want an option and if there is an option you can give them it is easier to push them away from surgery" (016) "I think there are limitations on what you can improve with non-operative measures" (016)	
	My threshold of acceptable risk for surgery is >80% likelihood of good outcome	Facilitator	"You have got to be 95% and above. I wouldn't accept anything less than that. I wouldn't offer the operation. It is too big an operation, to bigger deal, too bigger cost" (024)	8
	My level of acceptable risk is patient dependent	Facilitator (of shared decision making)	"It is all about risk for reward. When you think about... the person is not unwell, they can safely have an anaesthetic, even risks as high as 50% one in two that the patient will have no benefit, are worth considering…A patient may be so severely impacted that a 1 in 2 shot is worth it…it is totally patient dependent" (023) "I would rather a 10% chance of getting better than sitting in a wheelchair in a lot of pain" (022)	11
Beliefs about capabilities	I find it difficult to assess the patient-related factors that can influence TKR outcome	Facilitator	"It is patient factors more than anything else. Because it is easy to look at xrays and say K-L, 1, 2, 3, 4 for disease severity. There's not much argument over that. It's about the patient factors, the psychology and behavioural aspects of it which you want reassurance for" (016) "Obviously I am not very good because 1 in 5 come back with a problem… so no I didn't know how to identify them pre- operatively. Something is	8

			happening from my assessment to the patients' outcome and I don't know what the link is" (024)	
	I am reasonably good at picking the patients who will do well	Barrier	"I think I am reasonably good… I do have a little bit of a gut feeling about patients" (013)	12
	It can be difficult to say no to patients	Facilitator	"Most of the time if we bring a patient to the case conference it is to get the support of everyone else to say no don't do it. Because if want to do the operation, you just go ahead and do it. If you don't want to do it and you want support that is when you take them along" (016) "It is always easier to consent than decline" (025)	5
Skills	I mostly rely on my experience when it comes to surgical decision making	Barrier	"You spend all your life looking at patients and assessing them and you start to develop a bit of a gut feeling as to what might be happening. Sometimes you sit in front a patient and think: I know you are telling me this, but I know something else is happening" (015) "I don't use any formal tools. I use I guess old fashioned clinical acumen is what I would call it…I have been doing this for a while and you develop a way of assessing people" (028)	10
Social/professional role and identity	Surgery is an art and a science – it is not just about the evidence"	Barrier	"The human body is not a scientific machine. Medicine is an art and science and the art isn't always represented in the research" (028) "I think that medicine is not about numbers, it is about patients. Each patient has their own different pathology and own different personality" (017)	10

Beliefs/attitudes towards a decision aid				
Intention	I would use a decision aid to support, not replace my decision-making	Facilitator	"I don't think it would really influence my surgical decision making, I think it would more affirm my decision to not offer a patient an operation" (029) "If I think they are ok and they score badly I will relook at it and say why is that? Am I missing something obvious? But at the end of the day if an aid says one thing and my sniff test says there is something not right, I'm still following my nose" (010)	16
Beliefs about consequences	I think a decision aid would be a useful objective tool to help me say no to patients	Facilitator	"It would be clinically helpful in the patient cohort who we don't think will do well from surgery, giving us an evidenced based approach for saying this is the reasons why we don't think you will benefit from surgery" (029) "I think that the main benefit of an aid would be making the patient understand if I am saying no to the surgery it's not because I don't like him or her, it is because there is data written black on white that they are not going to do well. ..It will not just be my gut feeling. I can give them data and say "sorry it is written here. It's not me it's the computer. So it backs up what I am saying" (013)	9
	I think an aid would be useful for gaining patient informed consent and shared decision	Facilitator	"I think that is one of the important things about a decision aid and part of the consent process is that they know what to expect and it is still the patients decision to decide if they want to have surgery or not, but they have to be appropriately informed and have the	10

	making		appropriate expectations to weigh up the risk and benefit" (019) "It comes back down to getting patient consent, as part of that I would incorporate it into my consent form and say preoperatively you have a 50:50 chance and that has been discussed with a validated tool" (021)	
	I think a decision aid has the potential to improve the use of resources and save costs	Facilitator	"If you could use a decision aid to triage patients and push them somewhere else, it would be more effective for the patient and there would be cost savings for the hospital and the community" (016)	7
	A disadvantage of a decision aid is that it may not capture the nuances of the individual patient and some patients may miss out on surgery	Barrier	"There are always reasons why people will fall on one side of the line or the other and the data will show that the tool might predict you will do really well but you happen to fall in that small group who are set to do really well but don't, similarly the tool might say you will do really badly we better not operate on you but someone took the punt and you turned out really well so there are always those smaller groups and at times it is possible for the tool to miss certain nuances" (015)	13
	I have concerns about the legal/ethical implications of a decision aid	Barrier	"You have to think of the medico-legal implications of a patient having a risk value documented in their notes. If they don't have a good result and then lawyers look through and say you had this validated tool and you still went ahead, where would we lie medico-legally?" (024) "I guess the ethicists would say you are denying patient-centred care, so that is where there is a potential for a can of worms" (021)	8
Environmental	I would not like to	-*	"I don't think there are things that can become	17

context and resources (how the tool might be implemented)	see a decision aid with mandatory cut-offs implemented		compulsory in terms of a decision aid as I mentioned because it takes away patient-centred care" (025) "No you can't make anything compulsory like that. Not in medicine. Medicine is not black and white, it is grey, you can never make anything compulsory because a surgeon will operate according to their experience" (024) "Surgeons wouldn't care if it was compulsory to use an aid, as long as they didn't have to do any work. Making it compulsory to follow it would be dangerous. Because we're all individuals, what you are doing is taking the human experience aspect of the consultation out and then you turn us into proceeduralists that just look at a tick box and operate on someone" (016)	
	I don't think surgeons could ever agree on a cut-off level on a decision aid	-*	"A lot of surgeons would say in their hands they will get better results, that is just an inherent bias associated with surgical procedures and surgeons themselves so it would be hard to agree on a level" (019) "Unless you can clearly demonstrate a certain cut-off does better, so until there is almost black and white there will be some shades of grey and surgeons will differ in those shades of grey. And even if there is evidence you will still get surgeons that will reject it. That is just my feeling" (021)	17
	I could see an electronic or online tool working well in	Facilitator	"I can imagine something working on the phone, just an app. Simple and intuitive so you put in a little info - BMI, age, degree of arthritis etc.. tick tick tick. And	6

	my practice		then it gives you the number, bang." (013) "A lot of patients look on my website. You could have a thing on your website saying: 'sometimes patients with certain problems may not be appropriate for a TKA, this test can give you a rough idea of your likely success rate'. You could put it out there before they even come to see you. 'Is this operation for you?' type of thing" (028)	
	Time would be a key concern to using a decision aid in my practice	Barrier	"I just couldn't use a tool that is going to take up more time. There is already so much demands on our time and there is not enough time as it is. So the tool may only take 5 minutes but then you add 4, 5, 6 patients and that is half an hour extra of your time that you didn't have" (022) "It is frantic getting patients through and there is always that rush to see all the patients in a really short time and to spend 5-10 minutes to do a questionnaire with a patient… it is hard to justify that. But if there was something validated and it was done as a routine process, the patient came in with a form filled out with a score that would be really nice" (016)	6
Reinforcement	Evidence that tool had been widely validated would not convince me to use it. I would need to correlate it with my own clinical decision making	-*	"I never trust evidence because you only have to go to Dr x …even in research, there is a lot of doubtful stuff. You've got to be careful about basing something totally on results. I know we have got to be evidenced-based but the evidence may apply to a certain situation in a certain individual at a period in time and there is always variations or exceptions around that. So I would try and correlate them in my own mind and if after a while I am seeing well that person is a bit odd	9

			and they are scoring badly on the aid, well ok, this has legs." (010) "I trust [the research] but I want my data no doubt about it because I think I am better… I know lots of faults in techniques or little things that really can comprise outcome. So everyone has a different hand and surgery is very touchy practice…. So I believe what happens around but at the same time I want mine as well because I know what I do differently or I am more careful about" (013)	
	I would be more likely to trust a tool developed and implemented by my peers	Facilitator	"If a decision aid is implemented and I see my colleagues implementing it and it is working in their hands then possibly that would convince me" (024) "I think people are mistrustful of things that come out of other institutions but I would trust that a study from [the Department] would be a rigorous design. Where people are invested in something, they're much more likely to use it. If the results showed an aid was valid, I guess I would be prepared to try it and see whether I thought it was valid in my hands, in my practice" (026)	4
Goals	My goal is to optimise patient outcomes	Facilitator	"Certainly, surgeons want results. If you say you are going to reduce our risk, then why wouldn't we be happy with that" (012)	20

* (-) donates that the belief may be either a facilitator or barrier depending on how an aid is implemented

Additional file 1. Theoretical Domains Framework definitions for coding (adapted from Cane et al. 2012)

TDF Domain	Description
Knowledge	*An awareness of the existence of something* - Awareness of scientific rationale regarding patients at risk of no clinically meaningful improvement from surgery - Awareness of own percentage of patients who don't respond - Awareness of decision aids to assist in identifying surgical candidates
Skills	*An ability or proficiency acquired through practice* - Ability required/acquired through practice/experience to help decide if a patient is likely to benefit from surgery or not - Use of tool to assist in identifying suitable candidates for surgery
Social/ Professional role/identity	*A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting* - Surgeons' expressions about their own professional identity/job/role/professional boundaries when managing a person at high risk of no clinically meaningful improvement
Beliefs about capabilities	*Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use* - The surgeon's confidence that they can identify patients at risk of no clinically meaningful improvement and can employ the skills needed to refuse to operate on the patients
Optimism	*The confidence that things will happen for the best, of that desired goals will be attained* - The confidence expressed that a decision aid will reduce the rate of surgery in patients at high risk of no clinically meaningful improvement
Beliefs about consequences	*Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation* - Perceptions about outcomes, advantages and disadvantages of using a decision aid - Any legal or ethical concerns about using a decision aid
Reinforcement	*Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus* - What incentives would influence the surgeon using a decision aid
Intentions	*A conscious decision to perform a behaviour or a resolve to act in a certain way* - Intentions to use a decision aid
Goals	*Mental representation of outcomes or end states that an individual wants to achieve*
Memory, attention and decision	*The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives* - The processes involved and factors taken into account when the

processes	surgeon makes decisions about whether to operate or not - If the surgeon surgical decision making will be influenced by the decision aid - Surgeon's perceptions of acceptable levels of risk
Environmental context and resources	*Any circumstance of a person's situation or environment that discourage or encourage the development of skills and abilities, independence, social competence and adaptive behaviour* - Availability of, and confidence in, non-operative alternatives - Public versus private differences - How a decision aid might best be packaged/implemented - Attitudes towards mandating use of a decision aid - How surgeons can agree on level of acceptable risk with decision aid
Social influences	*Those interpersonal processes that can cause an individual to change their thoughts, feelings or behaviours* - The influences that other surgeons have on surgeon decision to operate or not - The influences patients have on surgeon decision to operate or not - How the surgeon believes patients might respond to the use of a decision aid
Emotion	*A complex reaction pattern, involving experiential, behavioural and physiological elements, by which the individual attempts to deal with a personally significant matter or event* - The emotional responses of the surgeon to using a decision aid
Behavioural regulation	*Anything aimed at managing or changing objectively observed or measured actions* - Consistency of decisions to operate or not in patients at high risk of not responding - Processes that help regulate behaviour

SUPPLEMENT 1: COREQ 32-ITEM CHECKLIST

Tong A, Sainsbury P, Craig J. (2007) Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Healthcare: 19:349 – 357

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
1. Inter viewer/facilitator	Which author/s conducted the interview?	7
2. Credentials	What were the researcher's credentials?	7
3. Occupation	What was their occupation at the time of the study?	7
4. Gender	Was the researcher male or female?	7
5. Experience and training	What experience or training did the researcher have?	7
6. Relationship with participants established	Was a relationship established prior to study commencement?	7
7. Participant knowledge of the interviewer	What did the participants know about the researcher?	7
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator?	7
Domain 2: study design		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study?	8
10. Sampling	How were participants selected?	6
11. Method of approach	How were participants approached?	6
12. Sample size	How many participants were in the study?	10
13. Non-participation	How many people refused to participate or dropped out? Reasons?	10
14. Setting of data collection	Where was the data collected?	7
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	7
16. Description of sample	What are the important characteristics of the sample?	10
17. Interview guide	Were questions, prompts, guides provided by the authors?	Table 1
18. Repeat interviews	Were repeat interviews carried out?	7
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	7
20. Field notes	Were field notes made during and/or after the inter view?	7
21. Duration	What was the duration of the interviews	7
22. Data saturation	Was data saturation discussed?	7
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	8
Domain 3: analysis and findings		
24. Number of data coders	How many data coders coded the data?	8, 9
25. Description of the coding tree	Did authors provide a description of the coding tree?	Additional file 1
26. Derivation of themes	Were themes identified in advance or derived from the data?	8, 9
27. Software	What software, if applicable, was used to	9

	manage the data?	
28. Participant checking	Did participants provide feedback on the findings?	8
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified?	11-22
30. Data and findings consistent	Was there consistency between the data presented and the findings?	11-22
31. Clarity of major themes	Were major themes clearly presented in the findings?	11-22
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	19, 22, 23

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Barriers and facilitators to Orthopaedic Surgeons' uptake of decision aids for Total Knee Arthroplasty: A qualitative study

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Barriers and facilitators to Orthopaedic Surgeons' uptake of decision aids for Total Knee Arthroplasty: A qualitative study

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Abstract

Objectives: The demand for Total Knee Arthroplasty (TKA) is increasing. Differentiating who will derive a clinically meaningful improvement from TKA from others is a key challenge for Orthopaedic Surgeons. Decision aids can help surgeons select appropriate candidates for surgery, but their uptake has been low. The aim of this study was to explore the barriers and facilitators to decision aid uptake among Orthopaedic Surgeons. *Design:* A qualitative study involving face-to-face interviews. Questions were constructed on the Theoretical Domains Framework to systematically explore barriers and facilitators. *Setting:* One tertiary hospital in Australia. *Participants*: Twenty Orthopaedic Surgeons performing TKA. *Outcome measures:* Beliefs underlying similar interview responses were identified and grouped together as themes describing relevant barriers and facilitators to uptake of decision aids. *Results:* While prioritising their clinical acumen, surgeons believed a decision aid could enhance communication and patient informed consent. Barriers identified included the perception that one's patient outcomes were already optimal; a perceived lack of non-operative alternatives for the management of end-stage osteoarthritis; concerns about mandatory cut-offs for patient-centred care, and concerns about the medico-legal implications of using a decision aid. *Conclusions:* Multifaceted implementation interventions are required to ensure that Orthopaedic Surgeons are ready, willing and able to use a TKA decision aid. Audit/feedback to address current decision-making biases such as overconfidence may enhance readiness to uptake. Policy changes and/or incentives may enhance willingness to uptake. Finally, the design/implementation of effective non-operative treatments may

enhance ability to uptake by ensuring that surgeons have the resources they need to carry out decisions.

Strengths and limitations of the study

- Very few qualitative studies involving Orthopaedic Surgeons have been published in the literature.
- This study took place in one of the largest arthroplasty clinics in Australia. All twenty surgeons performing TKA in this hospital participated in a one-to-one interview.
- A theoretical framework was used to systematically explore the barriers and facilitators to uptake of a decision aid by Orthopaedic Surgeons.
- Consistent findings are documented between this single site study and international surveys of surgeon' attitudes.
- Beliefs and attitudes are distinct from actual behaviour, and therefore the themes elicited in this study do not provide evidence of the actual influences on uptake of a decision aid.

Background

Up to one quarter of Total Knee Arthroplasties (TKA) are performed on inappropriate candidates according to evidence-based criteria[1] and a similar proportion experience minimal clinical benefit from surgery.[2] The rates of TKA are increasing[3]; differentiating who will derive a clinically meaningful improvement from TKA from others is a key challenge for Orthopaedic Surgeons. While the degree osteoarthritis (OA) severity, pain severity and the impact of pain, are key indicators for TKA, surgeons' consideration of other evidence-based indicators such as psychosocial factors remains varied[4-6] Observations of orthopaedic consultations suggest that other 'unstated factors' may also influence clinical judgments such as the surgeons' beliefs in their own ability to conduct surgery and their 'instincts' about the patients ability to cope with pain.[7]

In recent years there has been a move towards a model of shared decision-making in Orthopaedics as part of informed consent.[8 9] This model implies that surgeons have a duty to inform patients about the benefits and harms of TKA and the likelihood of their occurrence, supporting them to arrive at an informed, shared decision. Evidence suggests that there is often a lack of time during the clinical encounter for patients to consider or discuss all available treatment options and arrive at a decision congruent with their own preferences.[10]

To help address variations in clinical judgments and promote shared decision-making, decision aids may be useful.[11 12] Decision aids can be designed to estimate important, patient-specific risks of responding to surgery, based on independent prognostic

correlates of post-TKA response such as body mass index, degree of OA severity, pre-operative pain, function and mental health.[13] Similar aids have been found to predict outcomes in other areas of medicine with superior accuracy to clinical judgments alone.[14] [15] Decision aids have improved patient knowledge and confidence in decisions,[16] and have even been found to reduce the rate of surgical procedures.[17]

Orthopaedic Surgeons recognize the need for an aid to support their decision making for TKA and optimize communication with patients.[6 18] However, the uptake of decision aids amongst surgeons has been low.[9] A number of factors can influence uptake of a decision aid, and the success of implementation efforts depends on the careful assessment of the barriers to, and facilitators of, uptake.[19] The implementation literature advocates the use of theory to ensure the systematic identification of such factors and inform the design of interventions to address them.[20] Using theory not only assists in designing studies that are better able to facilitate behavior change,[21] but also provides a basis for better understanding the processes underpinning behavior change.[22] To date, studies of decision-making amongst Orthopaedic Surgeons have been few and atheoretical[6 7 23] and the barriers and facilitators of uptake of decision aids for TKA have not been rigorously explored.[9 18]

Methods

Aim and Design:

This theoretically-informed qualitative study is the first phase of a wider project seeking to design and implement a decision aid into an Australian Orthopaedic clinic setting. The aim of this study was to explore the barriers and facilitators to uptake of a TKA decision aid through structured one-to-one interviews with Orthopaedic Surgeons.

Participants:

All Orthopaedic Surgeons and Registrars performing TKA at one tertiary teaching hospital in Australia were eligible. Eligible candidates received the study details via email from an institutional administration officer, and were invited to contact the researchers to arrange an interview at a time and place suitable to them.

Data collection:

The Theoretical Domains Framework (TDF)[24] was selected as a comprehensive and validated framework for determining barriers and facilitators related to the implementation of best practice and clinicians' behavior change. The TDF was developed by implementation scientists to synthesise existing behavior change theories into a single framework. A six-stage consensus approach resulted in the identification of 12 theoretical 'domains' describing possible mediators of behavior change.[24] A subsequent validation study[22] revised the original TDF to 14 domains: Knowledge; Skills; Social/professional role and identity; Beliefs about capabilities; Optimism; Beliefs about consequences; Reinforcement; Intentions; Goals; Memory, attention and decision processes;

Environmental context and resources, Social influences; Emotions; and Behavioural regulation. The revised TDF, used in this study, has explained implementation problems and informed the development of theory-informed behavior change interventions.[25-27]

Interview questions were developed for each domain of the TDF with the advice of content experts in the TDF (SF), orthopaedic surgery (MD) and decision-making processes (AS), and in consultation with the literature.[28] Interviews were prefaced by stating that the researchers planned to develop a decision aid, thus the discussion was centered around a hypothetical decision aid rather than a defined one. In the first part of the interview, questions aimed to elicit current decision-making processes and biases. In the second part, questions aimed to identify beliefs and attitudes towards decision aids and factors that may influence decisions to use one. Table 1 presents the interview schedule.

[Insert Table 1]

The interviewer (SB), a female post-doctoral researcher with methodological expertise in qualitative research, had no previous relationship with the participants and no affiliation with the hospital. Data saturation was considered complete when the beliefs and attitudes of all 20 surgeons working in this setting had been elicited. Face-to-face interviews were conducted with 18 participants in a private office; phone interviews were conducted with two participants. Interviews lasted 20-30 minutes. Nineteen interviews were audio recorded and transcribed verbatim. One participant did not wish the interview to be

recorded, therefore hand-written notes were made during the interview. Participant anonymity was ensured at all times. All transcripts were de-identified prior to data analysis. All participants had the opportunity to review the study findings during a presentation at a scheduled surgical meeting. There was consensus agreement with the researchers' interpretations and no adjustments were made to the study themes.

Analysis:

Adopting an implementation approach,[26] three stages of data analysis were conducted. In the first stage, two researchers (SB, EN) independently coded interview transcripts by classifying each interview response or utterance into one of the 14 TDF domains. For example, the response "I think 22 per cent is the high end. But there are a lot of different papers that all suggest 10, 15, 20 per cent", was classified into the 'Knowledge' domain of the TDF. Definitions for each domain were derived from the literature[19] and adapted to the study context. Pilot coding was performed in which the two researchers independently coded two transcripts. Inter-coder comparisons resulted in refinement of domain definitions (see Additional file 1). This process was conducted three times, until the two researchers were confident that all relevant interview responses could be clearly coded into one domain. The two researchers then independently coded all 20 transcripts. Disagreements were discussed and consensus reached in each instance. Coded responses were uploaded into a qualitative data sorting software (Codesort[29]) to facilitate further analysis.

In the second stage of analysis, one researcher (SB) generated 'belief statements' based on the coded interview responses. For example, from the response: "I think 22 per cent is the high end. But there are a lot of different papers that all suggest 10, 15, 20 per cent" classified in the 'Knowledge' domain, we generated the belief statement: 'I am aware of the literature that up to 20 per cent of patients do not have a clinically meaningful improvement from TKA'. Belief statements were worded such that they could describe similar responses from different participants. Belief statements were reviewed by two further researchers (EN, MD), before being interpreted as a likely 'facilitator' or 'barrier' to surgeon's uptake of a decision aid. Continuing the example above, the belief statement: 'I am aware of the literature that up to 20 per cent of patients do not have a clinically meaningful improvement from TKA' was interpreted as a facilitator to uptake, in that we considered surgeons would be more likely to use a decision aid if they were aware that a substantial proportion of TKA's resulted in suboptimal outcomes.

In the third stage of analysis, we identified the domains most likely to influence surgeon's behaviour (i.e. using a decision aid or not). This was determined by: 1. Frequency of beliefs across transcripts and 2. The perceived strength of beliefs in influencing behaviour. To illustrate, the belief statement: 'I think that the percentage of my patients who achieve clinically meaningful improvement is higher than that reported in the literature' appeared in 17/20 transcripts and was considered to have a strong influence on whether a surgeon would use a decision aid or not, implying that behaviour change (i.e. using a decision aid) was unlikely if surgeons considered that their patients' outcomes were already optimised. 'Knowledge' was therefore identified as a relevant

domain. Where the researchers considered that beliefs within and between domains represented similar barriers/facilitators, these were grouped into themes. We present frequencies of beliefs (see Table 2) to provide the reader with a better understanding of the range of interview responses and to assist us in identifying 'relevant' domains of the TDF. However, readers should be cognisant that the absence of a belief in a transcript is not the same as a lack of endorsement.

Results

Participants:

Aggregate data describing the demographics of the sample is provided to protect individual anonymity. The sample comprised of 15 Consultant surgeons and five Registrars. The surgeons' total experience performing TKA ranged from six months to 30 years (mean ± SD, 12.9 ± 9.3) and the number of TKAs performed each month ranged from less than one to 12 (mean ± SD, 5.9 ± 3.0).

Relevant domains

Across the 20 interview transcripts, 628 utterances were coded into the 14 domains. Eleven domains of the TDF were identified as relevant: Knowledge; Behavioural regulation; Memory attention and decision processes; Beliefs about capabilities; Skills; Goals; Social/Professional role and identity; Intention; Beliefs about consequences;

Environmental context; and Reinforcement. Table 2 presents the relevant domains, with specific belief statements supported by example quotes.

[Insert Table 2]

The seven themes are described below, illustrated by interview extracts found in Table 3 and denoted in the text as 'Quote' numbers e.g. Q1

[Insert Table 3]

Themes identified:

1. Knowledge of one's own patient outcomes

(Relevant TDF domains: Goals; Knowledge; Behavioural regulation; and Beliefs about capabilities)

The goal of all participations was to optimise outcomes for their patients (Q1). While almost all participants (n=19) were aware of the literature that up to 20 per cent of patients undergoing TKA have no clinically meaningful improvement from surgery, most believed that this percentage was significantly lower in the patients they operated on (Q2). All participants based this estimation on patient presentations at post-surgical follow-up appointments. However participants acknowledged the 'rose-coloured glasses' they saw their patients through, citing the subtleties of rapport that made patients less likely to report dissatisfaction with surgery (Q3).

It was also recognised that patients with poor post-surgical outcomes may be less likely to attend follow-up appointments, choosing to seek care elsewhere. Participants believed that tracking long-term patient outcomes through an existing joint registry could counter-act this (Q4, Q5).

However, a key problem identified by many participants was how to define clinically meaningful improvement. Seven surgeons emphasised the importance of 'asking the right question in the right way' (Q6, Q7). The discrepancy between surgeons' perception of clinically meaningful improvement and that of their patients was commonly attributed to mis-matched surgeon-patient pre-surgical expectations of TKA. Surgeons reported their expectations of TKA to be a resolution of joint pathology with some corresponding improvement in pain. While disease and pain severity were key considerations in surgical decision-making, all participants acknowledged that patient expectations were important (Q8, Q9).

2. Reliance on 'clinical intuition'

(Relevant TDF domains: Memory, attention and decision processes; and Skills)

The accurate assessment of patient expectations presented a challenge for many surgeons. While the physical aspects of the clinical assessment were routine skills that all participants believed they had mastered well, many junior and senior surgeons reported difficulties assessing the psychological aspects of the patients' presentation (Q10).

Only a few participants were aware of any validated tools to assess pre-surgical patient predictive factors. One participant had prior knowledge of a decision aid but had not used it. None of the other participants were aware of any decision aid for TKA. Participants relied on their 'clinical intuition' for patients who were less likely to do well. A 'gut-feeling' for patients was developed with experience, over time (Q11).

3. The role of aids in supporting clinical decision-making

(Relevant TDF domains: Intention; Reinforcement)

Fifteen of the participants believed an aid would support decision-making, like a 'barometer' or weather app to forecast outcomes, particularly in patients they were unsure about (Q12, Q13). However, most participants (n=13) believed an aid would be insensitive to nuances at an individual level and could therefore not replace their clinical acumen (Q14).

All participants expected to be provided with evidence that a decision aid had been rigorously validated and shown to have high specificity and sensitivity before considering using it. Participants were more likely to trust this evidence if it came from their own institution (Q15). However, half of the participants reported that evidence supporting the validity of a decision aid would not be sufficient to convince them to use it. Instead they would need to see how the tool correlated with their own clinical decision-making (Q16).

4. Implications of a decision aid for patient-surgeon communication and shared decision-making

(Relevant TDF domains: Beliefs about consequences; Memory, attention and decision processes)

Nine participants perceived that a decision aid would give them an evidence-based approach for saying 'no' to patient, particularly for those participants who reported difficulty declining for surgery (Q17). Many participants (n=10) believed an aid could be an important component of patient informed consent, providing patients with objective data on their likely risk outcomes, enabling them to have the appropriate expectations to weigh up the risk and benefits of surgery for themselves. In this way, a decision aid was seen as a valuable support to shared decision-making (Q18).

When asked how they would feel about operating if a decision aid predicted a patient had a 50 per cent chance of not responding to TKA, surgeons were divided in their responses. While eleven believed that decisions to proceed would need to be shared with the patient (Q19), eight reported they would not consider surgery unless there was a greater than 80 per cent chance the patient would respond (Q20).

5. Ethical and legal concerns about decision aids

(Relevant TDF domain: Beliefs about consequences)

Eight participants had medico-legal concerns about documenting a specific risk value in patient records, with a few believing that such information would have to be deliberately withheld from patients in the case it fell into the 'wrong' hands (Q21). While some participants believed it would be unethical *not* to use a decision aid if it had been shown to improve patient outcomes, others were concerned about the ethical implications of a tool if imposed cut-offs were used to deny patients surgery (Q22, Q23).

6. Available resources and organisational culture as barriers to uptake

(Relevant TDF domains: Environmental context and resources; Beliefs about consequences and Social/Professional role and identity)

Almost all participants expressed concerns about making an aid compulsory and imposing mandatory cut-off levels. While many recognised that implementing the tool in this way would have the potential to improve the use of valuable health resources and save costs (Q24), several participants commented that mandatory cut-offs would only be possible if an effective, non-operative alternative was made available for patients that were denied surgery. The existing lack of effective alternative to surgery was seen as a key barrier (Q25).

There was widespread agreement amongst surgeons (n=17) that the logistics of agreeing on a cut-off value for acceptable risk, and the threat to surgeons' professional identity as

a patient-centred practitioner, were insurmountable barriers to imposing mandatory cut-offs (Q26, Q27).

7. Format and content of a decision aid

(Relevant TDF domain: Environmental context and resources)

Finally, physically integrating an aid into clinical practice was not seen as a key barrier to implementation. An electronic or online format was seen as the most likely way an aid could be implemented, particularly given the strict time constraints placed on outpatient clinics (Q28).

Most believed that an aid would be best used within the patient-surgeon consultation (Q29, Q30), while a couple suggested that an aid could be designed for patients to use on their own or with a support network to save time in the clinical consultation (Q31, Q32).

Irrelevant domains:

Three domains did not appear to have a salient influence on the target behaviour. These were: Optimism, Emotion and Social Influences. Optimism was closely connected to the domain Reinforcement i.e. surgeons reported being neither optimistic nor pessimistic about the utility of an aid until they had seen evidence of its effectiveness. The Emotion domain did not appear relevant as described by one surgeon: "I am not worried about the implications of a tool. TKA is wellness surgery, in the worst case scenario they don't get

a new knee". The Social Influence of patients did not appear relevant as surgeons believed patients were accustomed to filling out questionnaires. While surgeons were more likely to trust an aid if it had been developed by their peers, they preferred to test the tool 'in their own hands' and therefore the Social Influences of other surgeons using an aid appeared limited.

Discussion

These findings have implications for the future design and implementation of decision aids into surgical clinical practice. It is possible that current decision-making biases may be key barriers to uptake. Surgical decision-making involves the consideration of the risks versus benefits of surgery.[30] In this study, participants expressed confidence in their ability to successfully remove diseased tissue and correct joint deformity, and the likelihood of some corresponding improvement in pain severity was perceived to be high. At the same time, participants perceived that the risk their patients would not respond to TKA was low. One potential explanation for this is an apparent lack of clarity around the definition of 'clinically meaningful improvement' and 'non-response'. The literature suggests that patients' perceptions of 'clinically meaningful improvement' depend on their satisfaction with improvements in pain and function, closely linked to their expectations of surgery.[31] In contrast, the surgeons in this study believed that a resolution in joint pathology and some corresponding improvement pain could be considered 'meaningful improvement'. This lack of clarity is important, as surgeons who believe that their patient outcomes are already optimised may be less motivated to use a decision aid.

Another explanation may be that surgeons in this sample exhibited an over-confidence bias. Indeed, most participants believed their own patient outcomes were better than that reported in the literature. While it is possible that this belief is accurate and outcomes amongst this sample of surgeons are indeed above average, similar observations were made in a survey study involving 700 Orthopaedic Surgeons in Europe and North America.[32] In that study, 83 per cent of surgeons surveyed considered themselves to be above average diagnosticians; 74 per cent believed they were above average surgeons and 25 per cent believed they were in the top five per cent of surgeons.[32] This over-confidence bias may lead to a confirmation bias in which surgeons only notice things that agree with their point of view and are less attentive to alternative viewpoints due to cognitive dissonance.[33] A confirmation bias can have consequences for the uptake of a decision aid as surgeons may be less likely to consider evidence that contradicts their clinical experience.

Surgical decision-making also involves weighing up of the risks versus benefits of non-operative interventions.[30] The participants highlighted a lack of effective non-operative interventions for end-stage knee OA. A study among Dutch Orthopaedic Surgeons similarly documented a lack of confidence in the efficacy of non-surgical treatments associated with a decreased referral rate.[34] Indeed, there is currently a dearth of evidence-based, non-operative interventions for patients with end-stage knee OA either as an alternative to surgery or as a definitive management when the patient is deemed unsuitable for TKA. In the absence of a treatment alternative, surgery with all its risks

and costs is often the default intervention. This is an important barrier to uptake as evidence suggests surgeons will not use an aid if they do not have the resources to carry out the decisions,[28] or if the aid does not support their own view about effective treatments.[35]

The participants in this study believed a decision aid could promote shared decision-making and enhance informed consent for TKA. Similar attitudes towards decision aids were identified in a previous review[9] and a survey of the wider population of Orthopaedic Surgeons.[18] It may be that surgeons can be motivated to uptake a decision aid because it is the ethical thing to do.[36] However, our study identified concerns about the ethical implications of imposing mandatory cut-offs that would determine eligibility for TKA. These concerns may reflect the participants' desire to defend professional discretion and autonomy. We take the opportunity to emphasise the function of a decision aid is to support, not replace, clinical decision making. However, concerns were also expressed about the legal implications of using a decision aid. This finding contrasts with a study involving US Orthopaedic Surgeons who believed decision aids may reduce litigation and malpractice insurance premiums by enhancing shared decision-making.[37] It may be that these concerns are unique to the medico-legal context of Australia. Certainly, surgeons will be less likely to be uptake a tool if they perceive it makes them vulnerable to medico-legal action.

Implications:

The Ready, Willing and Able model posits that these three preconditions must be satisfied before a decision aid will be adopted.[38] 'Ready' refers to the perceived benefit of changing the status quo and adopting an aid to support decision-making. 'Willing' refers to the perceived legitimacy of a decision aid and a willingness to overcome objections and concerns. 'Able' refers to the ability to adopt the decision aid given available resources.[39] Implications for enhancing the readiness, willingness and ability of Australian Orthopaedic Surgeons to uptake a TKA decision aid are described below.

To enhance Readiness to uptake, current decision-making biases may need to be addressed. Information to counter these biases could be provided through audit and feedback. Audit and feedback is defined as a 'summary of the clinical performance of healthcare provider(s) over a specified period of time' (p. 5).[40] It may be particularly effective when clinicians' ability to accurately self-assess is limited.[41] This assumes that clinicians are motivated to improve care but lack intention to change current behaviour because they are unaware of their suboptimal performance. While effect sizes may depend on the format and context in which feedback is provided, findings from a Cochrane review suggest that audit and feedback can yield important improvements in professional practice.[40] Clarity and consensus on the definition of 'clinically meaningful improvement' and 'non-response' to TKA is likely to influence the success of an audit and feedback intervention in this context. Future research is needed to explore how audit and feedback is best delivered in this context including the immediacy and frequency of feedback, and the potential to incorporate other approaches such as the use of surgeon incentives.[42]

To enhance Willingness to uptake, an audit and feedback intervention before and after using a decision aid may be necessary for Orthopaedic Surgeons to gain confidence in its legitimacy. The findings suggest that validating a decision aid in large multi-centre trials may not be sufficient to encourage uptake, as surgeons believed such trials do not account for variations in case load and years of experience. Surgeons perceived themselves as not only scientists, but also 'artists'; believing that surgical success depended, in part, on the 'hands' that performed it. This suggests that Orthopaedic Surgeons may need to be given the opportunity to validate a decision aid 'in their own hands'.

Addressing concerns about the medico-legal implications of a decision aid may also be necessary to enhance Willingness to uptake. This may require the consultation of multiple stakeholders including policy makers, lawyers and institutional administration before the implementation of a decision aid. Legislative changes in the United States have recognised decision aids as a higher standard of informed consent[8] and in the United Kingdom, incentives to use decision aids are being developed.[9] There is evidence that mandating the use of a decision aid as a requirement for gaining informed consent results in significantly improved patient-outcomes including a reduction in the rate of TKA by 38 per cent in a six-month period.[43] Future studies are required to explore if policy changes and/or incentives might influence Willingness to uptake a decisions aid in the Australian context.

To enhance Ability to uptake, it appears important to address the dearth of non-operative alternatives to surgery for end-stage knee OA so that surgeons have the resources to carry out decisions. Future research to design and implement effective, evidence-based, non-operative interventions should be a priority. Targeting Orthopaedic Surgeons' beliefs about the efficacy of such interventions through education strategies will also be important. The study findings suggest that Ability to uptake may be enhanced if a decision aid is packaged in an electronic or online format that is quick and easily accessible. Focus groups involving surgeons and patients to gain feedback on prototypes of a decision aid during the design phase is important to ensure that not only the format, but also content, are accessible to a range of end users.

Limitations

Qualitative studies involving Orthopaedic Surgeons are rare. The strength of this study is the 100% participation rate by Orthopaedic Surgeons in one tertiary hospital setting. While the sampling strategy means the generalizability of these findings to other contexts may be limited, we have documented significant similarities with international studies. We acknowledge that while beliefs, attitudes and intentions can predict behaviors with a degree of accuracy, they are distinct from actual behavior[44]. Thus the themes elicited in this study do not provide evidence of the actual influences on uptake of a decision aid.

Conclusions

Using a theoretical framework to systematically explore barriers and facilitators to uptake, this study will inform the design and implementation of future TKA decision aids.[13] The findings suggest that a multifaceted approach will be required to ensure that Orthopaedic Surgeons are ready, willing and able to use a decision aid that can reduce the suffering and economic burden of 'failed' TKA. Research exploring patients' beliefs and attitudes towards a TKA decision aid is required prior to implementation.

Abbreviations

TKA = Total Knee Arthroplasty

OA = Osteoarthritis

TDF = Theoretical Domains Framework

Declarations

Ethics approval: This study was carried out in compliance with the Helsinki Declaration. Approval was given by St Vincent's Hospital Melbourne, Australia (QA 019 /_16).

Availability of data and materials: Requests regarding the datasets used in this study can be directed to the first author. Full interview transcripts will not be shared to protect the anonymity of the study participants.

Competing interests: The authors declare that they have no competing interests

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Authors contributions: SB: led the study design, data collection, data analysis and manuscript preparation. EN contributed to the data analysis. AS, PC and MD contributed to the study design, data analysis and manuscript preparation. SF contributed to the study design and manuscript preparation.

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Table 1. Interview Schedule

TDF domain	Questions
Knowledge	*Evidence from the literature suggests that up to 22 per cent of patients presenting for total knee arthroplasty will not have a clinically meaningful improvement from surgery.* - What do you think about this figure? -How do you interpret the term 'no clinically meaningful improvement'? *For the purposes of this interview, we are interpreting clinically meaningful improvement as no improvement in pain, function or QOL following surgery.* - Are you aware of what percentage of patients that you operate on do not benefit from surgery? How do you know this? Do you track it? Would you like to know? How could feed this information back to you? In what format?
Beliefs about capabilities	- How confident are you in identifying patients who are unlikely to experience an improvement in symptoms from TKA? - How good do you think you are at it compared to others? - Do you feel you are unsure about identifying these patients at times? If so, what would you do?
Behavioural regulation	- Of all the patients referred to you, what is the % of patients that proceed to surgery and how many do you turn away? - What do you do with the ones that don't? Do you refer them somewhere?
Skills	- What skills help you decide if someone is likely to benefit from surgery or not? - Are you aware of any tools currently available to help you assess a patients' risk of not responding? Do you use them? Why/ why not?
Beliefs about consequences	*Based on a set of evidence-based parameters, decision aids can predict the degree of risk that a patient will not achieve a clinically meaningful improvement from TKA* -What do you think the benefits of using a decision aid might be? -What might be the disadvantages of using an aid? - Do you see anything legal or ethical about using a decision aid? -Would the benefits outweigh the potential harms? Why?
Intentions, Goal	-Would using a decision aid influence your surgical decision making? Why/why not?

Reinforcement	-What would motivate you to use a decision aid? -Would you need to be presented with evidence from the literature? How would this evidence be best delivered? Who would it need to be delivered by?
Environmental context and resources	-What would facilitate the use of a decision aid for you? -How would it best be packaged? -When do you think it would be best used? Do you think you are the best person to use it?
Decision process	-If a decision aid predicted that patient had a 50 per cent risk of not benefiting from surgery would you still operate? What about a 70 per cent risk? What would your level of acceptable risk be?
Social/Professional role and identity	-Do you think there would be agreement between surgeons on this cut point?
Social/Emotional influences	-What if something like this tool became compulsory – how would you feel? How do you think other surgeons would feel? -How do you think patients would respond? Would their response influence your use of an aid? -Would you worry about missing potential candidates who might have responded to surgery?
Optimism	-How optimistic are you that a decision aid will reduce the rate of surgery in patients who are at high risk of not benefiting from surgery?

Table 2. Findings summary

Relevant TDF Domains	Specific Belief	Facilitator or barrier	Example quote (participant code)	Frequency out of 20
Knowledge	I am aware of the literature that up to 20 per cent of patients do not have a CMI from TKA	Facilitator	"I think 22 per cent is the high end. But there are a lot of different papers that all suggest 10,15,20 per cent" (012)	19
	I think that this % is lower in my patients	Barrier	"I don't count it, but I think around 10 per cent would be saying they aren't entirely satisfied by surgery" (016)	17
	Any improvement in pain is still an improvement, it depends how you define 'meaningful'	Barrier	"If the surgery is done for the right reason, the pain would decrease, the question is whether the decrease would be 10, 50 or 100 per cent depending on whether there are other reasons for the pain. But there would be an improvement" (025) "To me a good result is: they are going to have some intermittent ache in the knee, they're not going to be able to kneel or squat. Others on some assessment scale might consider that a failure. So you have get those parameters right" (010)	7
Behavioural regulation	I am aware that the feedback I get from my patients may be biased	Facilitator	"To please you, patients often say it is doing better than it really is. So I would think my outcomes are better than 20 per cent, but I am aware of the glasses that I see it through as well as what patients might tell me" (014)	6
	I would be interested in	Facilitator	"There's always a difference between how well you think you are doing and how you *are* doing. Having	20

	feedback on the percentage of my patients who achieve a clinically meaningful improvement		formal feedback on patient outcomes gives you the opportunity to change things if you are not doing as well as you want to" (023) "What I would like to know is the patient who overall is unhappy with their results and didn't get the result they expected" (010) "I would like feedback on the number of patients who are in each category of satisfaction and I would like to see how my personal results are compared to the group" (016)	
Memory, attention and decision processes	Patient expectations are an important consideration in surgical decision making	Facilitator	"If the patients' expectations are not meeting mine, I won't do the operation because then the patient isn't happy and sometimes they have 2/10 pain and they are not happy. And that is silly. So it is about telling the patient what they can expect and after the operation it is about "you remember what we said" (013)	20
	The lack of effective non-operative alternatives influences my surgical decision making	Barrier	"You have to be able to say 'although we don't think you would benefit from surgery, we're going to put you in this intense physiotherapy program with dieticians to improve your knee pain. They need to be offered something. The problem is these things are available at an individual component level … but I don't think there is anything formally put in place that patients can be referred from arthroplasty clinics into these programs" (029) "Well if you make an alternative plan and say we are not going to do surgery we are going to lose weight, do some physiotherapy, take pain killers, you send them off and they come back and say they have done all of	12

			that. It means you don't have another option to offer them and those patients often just want an option and if there is an option you can give them it is easier to push them away from surgery" (016) "I think there are limitations on what you can improve with non-operative measures" (016)	
	My threshold of acceptable risk for surgery is >80% likelihood of good outcome	Facilitator	"You have got to be 95 per cent and above. I wouldn't accept anything less than that. I wouldn't offer the operation. It is too big an operation, to bigger deal, too bigger cost" (024)	8
	My level of acceptable risk is patient dependent	Facilitator (of shared decision making)	"It is all about risk for reward. When you think about... the person is not unwell, they can safely have an anaesthetic, even risks as high as 50 per cent one in two that the patient will have no benefit, are worth considering…A patient may be so severely impacted that a 1 in 2 shot is worth it…it is totally patient dependent" (023) "I would rather a 10 per cent chance of getting better than sitting in a wheelchair in a lot of pain" (022)	11
Beliefs about capabilities	I find it difficult to assess the patient-related factors that can influence TKA outcome	Facilitator	"It is patient factors more than anything else. Because it is easy to look at xrays and say K-L, 1, 2, 3, 4 for disease severity. There's not much argument over that. It's about the patient factors, the psychology and behavioural aspects of it which you want reassurance for" (016) "Obviously I am not very good because 1 in 5 come back with a problem… so no I didn't know how to	8

			identify them pre- operatively. Something is happening from my assessment to the patients' outcome and I don't know what the link is" (024)	
	I am reasonably good at picking the patients who will do well	Barrier	"I think I am reasonably good… I do have a little bit of a gut feeling about patients" (013)	12
	It can be difficult to say no to patients	Facilitator	"Most of the time if we bring a patient to the case conference it is to get the support of everyone else to say no don't do it. Because if want to do the operation, you just go ahead and do it. If you don't want to do it and you want support that is when you take them along" (016) "It is always easier to consent than decline" (025)	5
Skills	I mostly rely on my experience when it comes to surgical decision making	Barrier	"You spend all your life looking at patients and assessing them and you start to develop a bit of a gut feeling as to what might be happening. Sometimes you sit in front a patient and think: I know you are telling me this, but I know something else is happening" (015) "I don't use any formal tools. I use I guess old fashioned clinical acumen is what I would call it…I have been doing this for a while and you develop a way of assessing people" (028)	10
Social/professional role and identity	Surgery is an art and a science – it is not just about the evidence"	Barrier	"The human body is not a scientific machine. Medicine is an art and science and the art isn't always represented in the research" (028) "I think that medicine is not about numbers, it is about patients. Each patient has their own different	10

			pathology and own different personality" (017)	
Beliefs/attitudes towards a decision aid				
Intention	I would use a decision aid to support, not replace my decision-making	Facilitator	"I don't think it would really influence my surgical decision making, I think it would more affirm my decision to not offer a patient an operation" (029) "If I think they are ok and they score badly I will relook at it and say why is that? Am I missing something obvious? But at the end of the day if an aid says one thing and my sniff test says there is something not right, I'm still following my nose" (010)	16
Beliefs about consequences	I think a decision aid would be a useful objective tool to help me say no to patients	Facilitator	"It would be clinically helpful in the patient cohort who we don't think will do well from surgery, giving us an evidenced based approach for saying this is the reasons why we don't think you will benefit from surgery" (029) "I think that the main benefit of an aid would be making the patient understand if I am saying no to the surgery it's not because I don't like him or her, it is because there is data written black on white that they are not going to do well. ..It will not just be my gut feeling. I can give them data and say "sorry it is written here. It's not me it's the computer. So it backs up what I am saying" (013)	9
	I think an aid would be useful for gaining patient informed consent	Facilitator	"I think that is one of the important things about a decision aid and part of the consent process is that they know what to expect and it is still the patients decision to decide if they want to have surgery or not, but they	10

	and shared decision making		have to be appropriately informed and have the appropriate expectations to weigh up the risk and benefit" (019) "It comes back down to getting patient consent, as part of that I would incorporate it into my consent form and say preoperatively you have a 50:50 chance and that has been discussed with a validated tool" (021)	
	I think a decision aid has the potential to improve the use of resources and save costs	Facilitator	"If you could use a decision aid to triage patients and push them somewhere else, it would be more effective for the patient and there would be cost savings for the hospital and the community" (016)	7
	A disadvantage of a decision aid is that it may not capture the nuances of the individual patient and some patients may miss out on surgery	Barrier	"There are always reasons why people will fall on one side of the line or the other and the data will show that the tool might predict you will do really well but you happen to fall in that small group who are set to do really well but don't, similarly the tool might say you will do really badly we better not operate on you but someone took the punt and you turned out really well so there are always those smaller groups and at times it is possible for the tool to miss certain nuances" (015)	13
	I have concerns about the legal/ethical implications of a decision aid	Barrier	"You have to think of the medico-legal implications of a patient having a risk value documented in their notes. If they don't have a good result and then lawyers look through and say you had this validated tool and you still went ahead, where would we lie medico-legally?" (024) "I guess the ethicists would say you are denying patient-centred care, so that is where there is a potential for a can of worms" (021)	8

Environmental context and resources (how the tool might be implemented)	I would not like to see a decision aid with mandatory cut-offs implemented	-*	"I don't think there are things that can become compulsory in terms of a decision aid as I mentioned because it takes away patient-centred care" (025) "No you can't make anything compulsory like that. Not in medicine. Medicine is not black and white, it is grey, you can never make anything compulsory because a surgeon will operate according to their experience" (024) "Surgeons wouldn't care if it was compulsory to use an aid, as long as they didn't have to do any work. Making it compulsory to follow it would be dangerous. Because we're all individuals, what you are doing is taking the human experience aspect of the consultation out and then you turn us into proceeduralists that just look at a tick box and operate on someone" (016)	17
	I don't think surgeons could ever agree on a cut-off level on a decision aid	-*	"A lot of surgeons would say in their hands they will get better results, that is just an inherent bias associated with surgical procedures and surgeons themselves so it would be hard to agree on a level" (019) "Unless you can clearly demonstrate a certain cut-off does better, so until there is almost black and white there will be some shades of grey and surgeons will differ in those shades of grey. And even if there is evidence you will still get surgeons that will reject it. That is just my feeling" (021)	17
	I could see an electronic or online	Facilitator	"I can imagine something working on the phone, just an app. Simple and intuitive so you put in a little info -	6

	tool working well in my practice		BMI, age, degree of arthritis etc.. tick tick tick. And then it gives you the number, bang." (013) "A lot of patients look on my website. You could have a thing on your website saying: 'sometimes patients with certain problems may not be appropriate for a TKA, this test can give you a rough idea of your likely success rate'. You could put it out there before they even come to see you. 'Is this operation for you?' type of thing" (028)	
	Time would be a key concern to using a decision aid in my practice	Barrier	"I just couldn't use a tool that is going to take up more time. There is already so much demands on our time and there is not enough time as it is. So the tool may only take 5 minutes but then you add 4, 5, 6 patients and that is half an hour extra of your time that you didn't have" (022) "It is frantic getting patients through and there is always that rush to see all the patients in a really short time and to spend 5-10 minutes to do a questionnaire with a patient… it is hard to justify that. But if there was something validated and it was done as a routine process, the patient came in with a form filled out with a score that would be really nice" (016)	6
Reinforcement	Evidence that tool had been widely validated would not convince me to use it. I would need to correlate it with my own clinical decision making	-*	"I never trust evidence because you only have to go to Dr x …even in research, there is a lot of doubtful stuff. You've got to be careful about basing something totally on results. I know we have got to be evidenced-based but the evidence may apply to a certain situation in a certain individual at a period in time and there is always variations or exceptions around that. So I would try and correlate them in my own mind and if	9

			after a while I am seeing well that person is a bit odd and they are scoring badly on the aid, well ok, this has legs." (010) "I trust [the research] but I want my data no doubt about it because I think I am better… I know lots of faults in techniques or little things that really can comprise outcome. So everyone has a different hand and surgery is very touchy practice…. So I believe what happens around but at the same time I want mine as well because I know what I do differently or I am more careful about" (013)	
	I would be more likely to trust a tool developed and implemented by my peers	Facilitator	"If a decision aid is implemented and I see my colleagues implementing it and it is working in their hands then possibly that would convince me" (024) "I think people are mistrustful of things that come out of other institutions but I would trust that a study from [the Department] would be a rigorous design. Where people are invested in something, they're much more likely to use it. If the results showed an aid was valid, I guess I would be prepared to try it and see whether I thought it was valid in my hands, in my practice" (026)	4
Goals	My goal is to optimise patient outcomes	Facilitator	"Certainly, surgeons want results. If you say you are going to reduce our risk, then why wouldn't we be happy with that" (012)	20

* (-) donates that the belief may be either a facilitator or barrier depending on how an aid is implemented

Table 3. Supporting extracts

Quote number	Quote (Participant code)
Q1	"Ultimately, we will always do our best for the patient" (024)
Q2	"I don't count it, but you get an impression. Around 10 per cent of my patients would be saying they are not entirely satisfied by surgery" (016)
Q3	"Often, to please you, patients say that it is doing better than it really is. So I would think my outcomes are better than 20 per cent, but I am aware of the glasses that I see it through as well as what patients might tell me" (014)
Q4	"There's always a difference between how well you are doing and how well you think you are doing. Having formal feedback on patient outcomes gives you the opportunity to change things if you are not doing as well as you want to" (023)
Q5	"If patients choose not to come back, the only way you have got to track them is looking at your results from the registry. But I want to know the answers to the clinical questions – are you happy? Is your pain better than it was pre-op? How you ask the question matters" (028)
Q6	"If you received feedback that the rate of clinically meaningful improvement reported by your patients is not as high as you think it should be, you have to look at whether you are not picking the right patients, or you are operating on patients that are not going to do well. I think it would be more likely to be the way the question is asked. I would want to check who is asking the questions, what they are asking and how they are asking it" (023)
Q7	"To me a good result is: they are going to have some intermittent ache in the knee, they are not going to be able to kneel or squat, they are going to be aware that it is there. That to me is a good result. Now others on some assessment scale they might say well that is in our system considered a failure thing, so you have get those parameters right" (010)
Q8	"At the end of the day if there is a pathology that can be deleted by surgery and the patient accepts some improvement then that means that the surgery will happen" (025)
Q9	"If the patients' expectations are not meeting mine, I won't do the operation because then the patient isn't happy and sometimes they have 2/10 pain and they are not happy" (013)
Q10	"It is patient factors more than anything else. Because it is very easy for me to look at xrays and use the Kellgren-Lawrence scale: 1, 2, 3, 4 for disease severity. There is not much of an argument over that. It is about the patient factors, the psychology and behavioural aspects of it which is more what you want reassurance for" (016)
Q11	"You spend all your life looking at patients and assessing them and you start to develop a bit of a gut feeling as to what might be happening when you sit in front of a patient and you might be saying you know you are telling me this but actually I know something else is happening" (015)
Q12	"I don't think it would really influence my surgical decision making, I think it would more affirm my decision to not offer

	a patient an operation" (029)
Q13	"If I think they are OK and they score badly I will relook at it and say why is that? Am I missing something obvious? But at the end of the day if the tool says one thing and my sniff test says there is something not right, I am still following my nose" (010)
Q14	"Not every tool is perfect and it may not capture every patient... the danger is we may end up refusing to do something because of this tool and therefore the patient may not receive the appropriate treatment based on a decision aid and nothing is 100% so you have to expect some patients would fall through the cracks" (019)
Q15	"I think people are mistrustful of things that come out of other institutions but I would trust that a study from [the Department] would be a rigorous design. Where people are invested in something, they are much more likely to use it. If the results showed the tool was valid, I guess I would be prepared to try it and see whether I thought it was valid in my hands, in my practice" (026)
Q16	"I never trust evidence because you only have to go to Dr x …even in research, there is a lot of doubtful stuff and you have got to be careful about basing something totally on results. I know we have got to be evidenced based but the evidence may apply to a certain situation in a certain individual at a period in time and there is always variations or exceptions around that. So I would try and correlate them in my own mind and if after a while I am seeing well that person is a bit odd and they are scoring badly on that, well ok, this has legs." (010)
Q17	"I think that the main benefit of a tool would be making the patient understand if I am saying no to the surgery it is not because I don't like him or her, it is because there is data written black on white that they are not going to do well…It will not just be my gut feeling. I can give them data and say "sorry it is written here. It is not me it is the computer. So it backs up what I am saying" (013)
Q18	"It comes back down to getting patient consent, as part of that I would incorporate it into my consent form and say preoperatively you have a 50:50 chance and that has been discussed with a validated tool. If the patient wishes to go ahead, they can make that informed decision" (021)
Q19	"A patient may be so severely impacted that a 1 in 2 shot is worth it…it is totally patient dependent" (023)
Q20	"You have got to be 95% and above. I wouldn't accept anything less than that. I wouldn't offer the operation. It is too big an operation, too big a deal, too big a cost" (024)
Q21	"You have to think the medico-legal implications of a patient having a risk value documented in their notes. If they don't have a good result and then some have the lawyers look through and say you had this tool that was validated and you still went ahead where would we lie medico-legally?" (024)
Q22	"I guess the ethicists would say you are denying patient-centred care, so that is where there is a potential for a can of worms" (021)
Q23	"I don't think it can become compulsory because it takes away patient-centred care" (025)

Q24	"If you could use the tool to triage patients and push them some where else, it would be more effective for the patient and there would be cost savings for the hospital and the community" (016)
Q25	"You have to be able to say: 'although we don't think you would benefit from surgery, we are going to put you in this intense physiotherapy program with dieticians and this is how we are going to improve your knee pain'. They need to be offered something. The problem is these things are available at an individual component level - we have got dieticians and physiotherapists and exercise groups, but I don't think there is anything formally put in place that patients can be referred from arthroplasty clinics into these programs" (029)
Q26	"A lot of surgeons would say in their hands they will get better results, that is just an inherent bias associated with surgical procedures and surgeons themselves so it would be hard to agree on a level" (019)
Q27	"Well compulsory to have it? Ok. That would be easy to do and surgeons wouldn't care as long as they didn't have to do any work. Making it compulsory to follow it would be dangerous. Because we are all individuals, what you are doing is taking the human experience aspect of the consultation out and then you turn us into proceeduralists that just look at a tick box and operate on someone" (016)
Q28	"I can imagine something working on the phone, an app. It needs to be simple and intuitive - so you put in a little info - BMI, age, degree of arthritis etc,.. tick tick tick. And then it gives you the number, bang" (013)
Q29	"I think it is something that should be done by the surgeon. It is also part of the process where the surgeon gets to know the patient as well - not just their xrays and physical examination but also their psychosocial situation" (019)
Q30	"I would want the tool to be applied within the consultation. Because I would never believe a value until I have seen the person. Because we might just have one of those weird situations that fall out of the 'normal' range." (010)
Q31	"When you have got 10 minutes for a consultation you don't have time to spend another 10 minutes going through the tool. So it would have to be either the patient themselves or secretarial person prior to the consultation" (012)
Q32	"I have a lot of patients look me up on my website. You could have a thing on your website saying: 'sometimes patients with certain problems may not be appropriate for a TKA, this test can give you a rough idea of your success rate'. You could put it out there before they even come to see you. 'Is this operation for you?' type of thing" (028)

Appendix 1. Theoretical Domains Framework definitions for coding

TDF Domain	Description
Knowledge	*An awareness of the existence of something* - Awareness of scientific rationale regarding patients at risk of no clinically meaningful improvement from surgery - Awareness of own percentage of patients who don't respond - Awareness of decision aids to assist in identifying surgical candidates
Skills	*An ability or proficiency acquired through practice* - Ability required/acquired through practice/experience to help decide if a patient is likely to benefit from surgery or not - Use of tool to assist in identifying suitable candidates for surgery
Social/ Professional role/identity	*A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting* - Surgeons' expressions about their own professional identity/job/role/professional boundaries when managing a person at high risk of no clinically meaningful improvement
Beliefs about capabilities	*Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use* - The surgeon's confidence that they can identify patients at risk of no clinically meaningful improvement and can employ the skills needed to refuse to operate on the patients
Optimism	*The confidence that things will happen for the best, of that desired goals will be attained* - The confidence expressed that a decision aid will reduce the rate of surgery in patients at high risk of no clinically meaningful improvement
Beliefs about consequences	*Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation* - Perceptions about outcomes, advantages and disadvantages of using a decision aid - Any legal or ethical concerns about using a decision aid
Reinforcement	*Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus* - What incentives would influence the surgeon using a decision aid
Intentions	*A conscious decision to perform a behaviour or a resolve to act in a certain way* - Intentions to use a decision aid
Goals	*Mental representation of outcomes or end states that an individual wants to achieve*
Memory, attention and decision processes	*The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives* - The processes involved and factors taken into account when the surgeon makes decisions about whether to operate or not - If the surgeon surgical decision making will be influenced by the decision aid - Surgeon's perceptions of acceptable levels of risk
Environmental context and resources	*Any circumstance of a person's situation or environment that discourage or encourage the development of skills and abilities, independence, social competence and adaptive behaviour* - Availability of, and confidence in, non-operative alternatives

	- Public versus private differences - How a decision aid might best be packaged/implemented - Attitudes towards mandating use of a decision aid - How surgeons can agree on level of acceptable risk with decision aid
Social influences	*Those interpersonal processes that can cause an individual to change their thoughts, feelings or behaviours* - The influences that other surgeons have on surgeon decision to operate or not - The influences patients have on surgeon decision to operate or not - How the surgeon believes patients might respond to the use of a decision aid
Emotion	*A complex reaction pattern, involving experiential, behavioural and physiological elements, by which the individual attempts to deal with a personally significant matter or event* - The emotional responses of the surgeon to using a decision aid
Behavioural regulation	*Anything aimed at managing or changing objectively observed or measured actions* - Consistency of decisions to operate or not in patients at high risk of not responding - Processes that help regulate behaviour

SUPPLEMENT 1: COREQ 32-ITEM CHECKLIST

Tong A, Sainsbury P, Craig J. (2007) Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Healthcare: 19:349 – 357

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
1. Inter viewer/facilitator	Which author/s conducted the interview?	7
2. Credentials	What were the researcher's credentials?	7
3. Occupation	What was their occupation at the time of the study?	7
4. Gender	Was the researcher male or female?	7
5. Experience and training	What experience or training did the researcher have?	7
6. Relationship with participants established	Was a relationship established prior to study commencement?	7
7. Participant knowledge of the interviewer	What did the participants know about the researcher?	7
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator?	7
Domain 2: study design		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study?	8
10. Sampling	How were participants selected?	6
11. Method of approach	How were participants approached?	6
12. Sample size	How many participants were in the study?	10
13. Non-participation	How many people refused to participate or dropped out? Reasons?	10
14. Setting of data collection	Where was the data collected?	7
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	7
16. Description of sample	What are the important characteristics of the sample?	10
17. Interview guide	Were questions, prompts, guides provided by the authors?	Table 1
18. Repeat interviews	Were repeat interviews carried out?	7
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	7
20. Field notes	Were field notes made during and/or after the inter view?	7
21. Duration	What was the duration of the interviews	7
22. Data saturation	Was data saturation discussed?	7
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	8
Domain 3: analysis and findings		
24. Number of data coders	How many data coders coded the data?	8, 9
25. Description of the coding tree	Did authors provide a description of the coding tree?	Additional file 1
26. Derivation of themes	Were themes identified in advance or derived from the data?	8, 9
27. Software	What software, if applicable, was used to	8

	manage the data?	
28. Participant checking	Did participants provide feedback on the findings?	8
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified?	Table 3
30. Data and findings consistent	Was there consistency between the data presented and the findings?	11-22 and Table 3
31. Clarity of major themes	Were major themes clearly presented in the findings?	11-22 and Table 3
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	19, 22, 23 and Table 3