■ ARTHROPLASTY

Stakeholder prioritization preferences for individuals awaiting hip and knee arthroplasty

THE PRIORITIZATION OF THOSE AWAITING HIP AND KNEE ARTHROPLASTY (PATHWAY) STUDY

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Aims

Prolonged waits for hip and knee arthroplasty have raised questions about the equity of current approaches to waiting list prioritization for those awaiting surgery. We therefore set out to understand key stakeholder (patient and surgeon) preferences for the prioritization of patients awaiting such surgery, in order to guide future waiting list redesign.

Methods

A combined qualitative/quantitative approach was used. This comprised a Delphi study to first inform which factors patients and surgeons designate as important for prioritization of patients on hip and knee arthroplasty waiting lists, followed by a discrete choice experiment (DCE) to determine how the factors should be weighed against each other. Coefficient values for each included DCE attribute were used to construct a 'priority score' (weighted benefit score) that could be used to rank individual patients waiting for surgery based on their respective characteristics.

Results

In total, 43 people participated in the initial round of the Delphi study (16 patients and 27 surgeons), with a 91% completion rate across all three rounds. Overall, 73 surgeons completed the DCE. Following the final consensus meeting of the Delphi component, the seven final factors designated for inclusion were Pain, Mobility/Function, Activities of Daily Living, Inability to Work/Care, Length of Time Waited, Radiological Severity, and Mental Wellbeing. Output from the adjusted multinomial regression revealed radiological severity to be the most significant factor (coefficient 2.27 (SD 0.31); $p < 0.001$), followed by pain (coefficient 1.08 (SD 0.13); $p < 0.001$) and time waited (coefficient for one month additional wait 0.12 (SD 0.02); $p < 0.001$).

Conclusion

These results present a new robust method for determining comparative priority for those on primary hip and knee hip arthroplasty waiting lists. Evaluation of potential implementation in clinical practice is now required.

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Introduction

Waiting times for primary elective hip and knee arthroplasty in the UK have been increasing over the last decade, with a recent substantial acceleration associated with the cessation of planned care services during the COVID-19 pandemic.[1] The latest estimates suggest that over one million people are waiting for surgery, and that waiting lists will continue to deteriorate due to an ongoing mismatch in supply and demand.[2] Other estimates suggest that without a significant change in the current situation the wait for surgery could reach seven years in some regions.[3] While elective surgery has often been considered 'optional' surgery, there is clear evidence that many patients with end-stage osteoarthritis of the hip and knee

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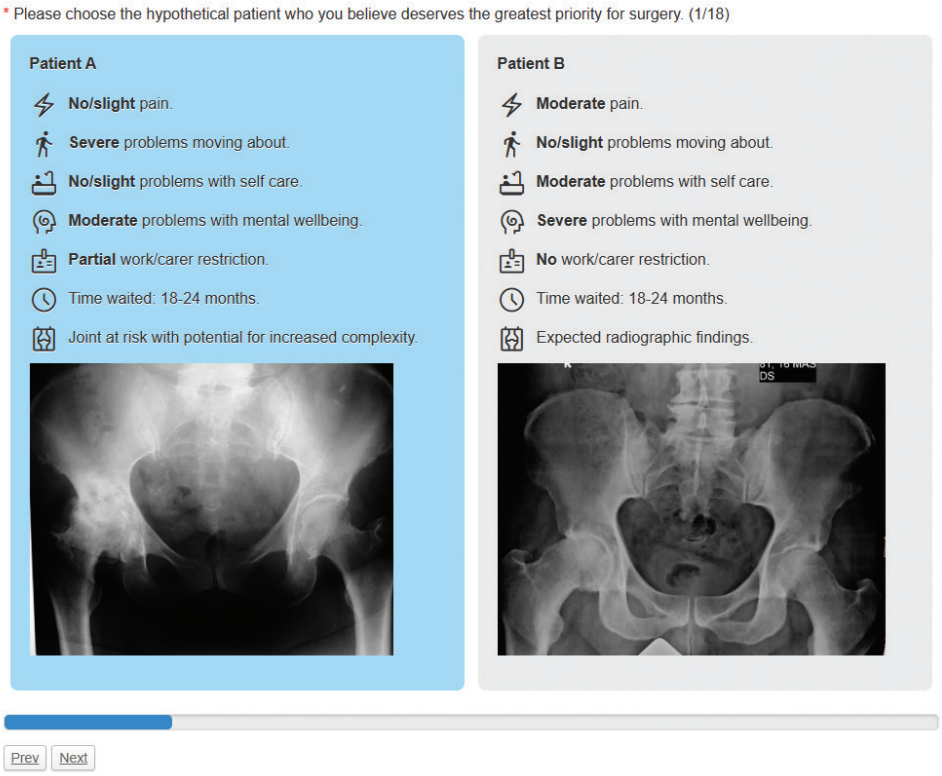

Fig. 1

Example of a discrete choice experiment choice set.

waiting for joint arthroplasty surgery have worsening quality of life, increasing frailty, and risks of other harms such as opioid dependence.[4-7]

Historically, surgical prioritization has largely been based on the amount of time waited, with evidence of different approaches nationally.[8,9] There has however been an increasing recognition that there is growing inequity among those waiting for surgery when considering potential individual clinical, personal, and economic impacts.[10,11] Previous attempts at prioritization of surgical patients, such as the Federation of Surgical Speciality Associations' (FSSA) Clinical Guide to Surgical Prioritization During the Coronavirus Pandemic and associated Recovery Prioritization Matrix,[12,13] may not be fit for purpose due to their poor interobserver reliability and lack of objectivity.[14] A number of other prioritization methods have also been suggested, but most lack any patient perspective, are based solely on personal opinions of authors, and are too broad to appreciate nuances in the way that prioritization should be approached for different clinical groups.[15-17]

Given this absence of a suitable solution to surgical prioritization for those awaiting hip and knee arthroplasty surgery, this study aimed to establish, through novel methodology, patient and surgeon preferences with regard to prioritization of services, including an assessment of the comparative priority of included factors. This information can then be used to develop a tool that provides a unified, empirical, and objective approach to determining patient priority for surgery in this setting.

Methods

The protocol for this study has previously been published.[18] The study was undertaken in two main stages: first, a Delphi study to determine which attributes should be considered when assessing prioritization of patients awaiting hip/knee arthroplasties, followed by a discrete choice experiment (DCE) to determine the comparative priority of those attributes. A brief overview of the relevant methods for each component is provided below, with full methods available in the study protocol. For both aspects of the study, a secure online platform was used provided by CLINVIVO (UK), with previous evidence for effective use in both the Delphi and DCE settings.[19,20]

This research has been designed in association with a patient partner (DS) and included further input from charitable partner representation (Versus Arthritis) as part of the steering group and Delphi consensus meeting. Patients actively contributed to the priority-setting process through involvement in the Delphi study component of the project.

Delphi study. Participants for the Delphi study included individuals on the waiting list for hip/knee arthroplasty and those who had undergone either operation within the last two years, as well as UK-based consultant orthopaedic surgeons regularly performing hip or knee arthroplasty surgery. Sources of recruitment included charity partners, speciality organizations, and social media, with associated distribution of patient information sheets and implicit consent provided through completion and return of the associated questionnaires.

Table I. Outcomes from the thematic content analysis of the Delphi study Round 1.

Themes	Sub-themes	Number of times identified by participants	Median confidence rating (IQR)
Severity of pain	Requirement for opioid medication Impact on sleep	27	9 (8 to 9)
Mobility/function	Housebound	19	9 (8 to 9)
Ability to perform activities of daily living		13	9 (8 to 9)
Frailty/falls risk	Comorbidity Bilateral disease Arthroplasty needed to facilitate other treatment	11	8 (6 to 8)
Inability to work/financial hardship		20	9 (6 to 9)
Length of time on waiting list		18	9 (6 to 9)
Radiological severity and risk of deterioration*		24	8 (7 to 9)
Mental wellbeing	Impact on relationships	12	7 (5 to 9)
Caring responsibilities		7	9 (8 to 9)
Quality of life		8	9 (6 to 9)
Lifestyle factors	Smoking Obesity	5	8 (7 to 9)
Age (younger)		3	5 (4 to 6)
Social support	Reliance on driving for independence Rural location	3	5 (5 to 8)

*Bone loss/avascular necrosis.

Table II. Attributes and levels used in the discrete choice experiment.

Attribute	Levels	Clinical data sources	Type
Severity of pain	4 (no/mild, moderate, severe, extreme)	OHS and OKS ± EQ-5D-5L pain domains	Discrete
Mobility/function	4 (no/mild, moderate, severe, extreme)	OHS and OKS ± EQ-5D-5L mobility domains	Discrete
ADL	4 (no/mild, moderate, severe, extreme)	OHS and OKS ± EQ-5D-5L ADL domains	Discrete
Mental wellbeing	4 (no/mild, moderate, severe, extreme)	OHS and OKS ± EQ-5D-5L anxiety/depression domains	Discrete
Inability to work/care	3 (no restriction, some/partial restriction, full restriction)	Unclear: patient reported vs formal measurements (e.g. Employment and Support Allowance payments)	Discrete
Radiological severity	3 (expected radiological osteoarthritis, joint at risk with potential for increased operative complexity, joint at risk with likelihood for increased operative complexity)	Radiological assessment by surgeon	Discrete
Length of time waited	0 to 36 months	Date from addition to surgical waiting list to present	Continuous

ADL, activities of daily living; EQ-5D-5L, EuroQol five-dimension five-level questionnaire; OHS, Oxford Hip Score; OKS, Oxford Knee Score.

The initial stage of the Delphi study was an 'ideas generation round' where participants could put forward any potential suggestions for priority ideas that could be included in the prioritization process, with an associated confidence rating. Results were then collated using direct content analysis to inform assimilation of similar attributes and direct the next stage of the Delphi. For the second and third stages, individuals anonymously rated the importance of the included priorities using a nine-point Likert scale using their own preferences and associated anonymized feedback. Consensus was established based on the following established criteria:[21] consensus in (≥ 70% scoring 7 to 9, and < 15% scoring 1 to 3); consensus out (≥ 70% scoring 1 to 3, and < 15% scoring 7 to 9); and no consensus (any other score combinations).

Following the third round, a final online consensus meeting was undertaken to determine the definitive priorities to be included. This included members of the project steering committee, a patient partner, and specialist society/musculoskeletal charity representation.

For the Delphi study, a target sample size of 60 was set, with a minimum sample of 20 to 30 participants having been previously identified as required for sufficient online discussion.[22]

Discrete choice experiment. Alongside definition of the attributes to be included in the DCE during the final consensus meeting, consideration was also given to the levels of each attribute. To generate a D-efficient design (one which maximizes the contained information while minimizing the respondent burden) for the DCE, a coordinated exchange algorithm (CEA) was used via the R statistics (R Foundation for Statistical Computing, Austria) package 'idefix', with 18 choice sets. Priors related to the potential weighting of each included attribute and their associated levels were set according to the clinical experience of the primary author (LF).

Following discussion among the project steering committee, it was decided that recruitment for the DCE was to be among orthopaedic surgeons only, due to their regular involvement and familiarity with the prioritization process, in particular regarding radiological parameters.

An initial pilot was performed using 14 trauma and orthopaedic speciality registrars to check the content of the DCE and ensure an avoidance of cognitive overload due to the high numbers of choice sets. Further adjustments were made due to a low frequency of choice set differences in the 'time waited'

Table III. Updated multinomial regression analysis (collapsed model). Due to the use of dummy coding the lowest (reference) level is not contained within the multinomial regression output for dichotomous variables.

Attribute	Coefficient (SE)	p-value
Moderate pain	2.86 (1.37)	0.036
Severe/extreme pain	3.23 (0.68)	< 0.001
Moderate mobility impairment	1.71 (0.65)	0.009
Severe/extreme mobility impairment	1.83 (0.57)	0.001
Moderate impairment in ADLs	0.30 (0.24)	0.224
Severe/extreme impairment in ADLs	0.67 (0.22)	0.002
Moderate impact on mental wellbeing	0.31 (0.61)	0.606
Severe/extreme impact on mental wellbeing	0.06 (0.50)	0.907
Work/carer status impairment	0.50 (0.66)	0.447
Potential risk of harm with operative delay based on radiological severity	1.77 (0.27)	< 0.001
Likelihood of harm with operative delay based on radiology severity	3.36 (0.42)	< 0.001
Length of time waited	0.10 (0.03)	0.002
Alternative specific constant	0.30 (0.45)	0.511

ADLs, activities of daily living; SE, standard error.

Table IV. Willingness to wait (WTW) values for a change in level of significant dichotomous variables compared to the length of time waited. WTW denotes the amount of time (months) that individuals taking part in the discrete choice experiment would trade-off for a change in one level of each attribute.

Level change	WTW, mths
No/mild pain to moderate pain	29.6
No/mild pain to severe/extreme pain	33.5
Moderate pain to severe/extreme pain	3.8
No/mild mobility impairment to moderate impairment	17.8
No/mild mobility impairment to severe/extreme impairment	19.0
Moderate impairment to severe/extreme impairment	1.2
No/mild impairment in ADLs to severe/extreme impairment	7.0
Expected radiological osteoarthritis to potential risk of harm with operative delay based on radiological severity	18.4
Potential risk of harm to likelihood of harm with operative delay based on radiological severity	16.5

ADLs, activities of daily living; WTW, willingness to wait.

attribute, with recruitment to the DCE then undertaken through the same channels as previously described. An example choice set is displayed in Figure 1. Information sheets were provided and consent implicit through completion of the DCE process.

For the DCE a target sample of 100 was set, with a minimum sample of 56 suggested from the framework outlined by Orme[23] where $c = 4$, $t = 18$, and $a = 2$ (c is the largest number of levels for any included attribute, t is the number of choice tasks, and a is the number of alternatives per task). Results were analyzed using a multinomial regression model as outlined in the study protocol. Given the inclusion of waiting time as a continuous parameter, surgeon preferences regarding the willingness to wait (WTW) of patients were calculated for each of the included attribute levels. In the analysis $p < 0.05$ denoted statistical significance and prompted inclusion in the final model algorithm.

Prioritization tool. Following conclusion of the DCE, the generated coefficients for each included attribute and level were used to generate a proof-of-concept prioritization tool using the R 'Shiny' package. The developed tool allows for automatic generation of a 'priority score' (utility score) for patients included on the waiting list for primary hip and knee arthroplasty based on their personal attributes, with ranking according to priority score.

Results

Delphi study. The three Delphi rounds ran from June to November 2022, with the consensus meeting undertaken on 1 December 2023. A total of 43 people participated in the initial round of the Delphi study, with a 91% completion rate for all three rounds. This included 16 patients and 27 surgeons. Of the patients, seven (44%) were currently awaiting surgery and nine (56%) had undergone hip or knee arthroplasty within the last two years. The most frequent age range for participants was 60 to 69 years (8/16; 50%), versus 40 to 49 years and 50 to 59 years for the surgeon group (11/25; 44% each). The majority of participants were male (30/43; 70%). The 13 priorities identified from the first round are included in Table I, along with the sub-priorities, frequency, and median confidence rating.

Following dissemination of the priorities and round 2, 'consensus in' (as defined previously) was achieved across 11/13 (85%) items. The only items where 'no consensus' was achieved were Age (younger) and Social Support. Following round 3, there were no changes to the consensus decision of the participants with regard to inclusion of items. Severity of Pain was the most strongly rated priority at completion of the final round (median importance rating 8 (IQR 8 to 9)).

At the final consensus meeting, all potential included attributes were reviewed. Details of discussion and decision-making

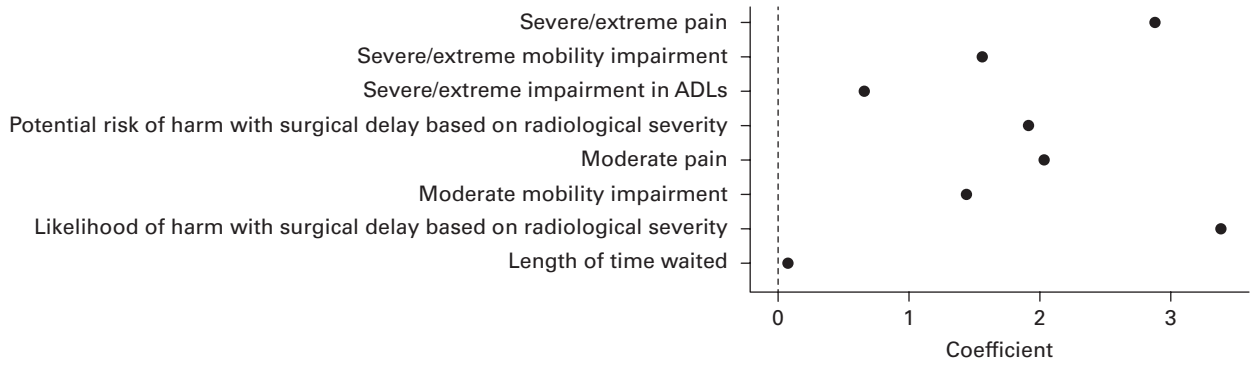

Fig. 2

Coefficient plot for statistically significant results from the multinomial regression analysis of the discrete choice experiment output. ADLs, activities of daily living.

rationale from the consensus meeting to decide the final attributes are documented in the meeting notes (Supplementary Material). The seven final attributes designated for inclusion were Pain, Mobility/Function, Activities of Daily Living (ADLs), Inability to Work/Care, Length of Time Waited, Radiological Severity, and Mental Wellbeing (Supplementary Table i).

Discrete choice experiment. The included attributes, as well as their respective levels, potential clinical data source, and variable type, are detailed in Table II.

A total of 73 individuals completed the DCE, which ran from August to November 2023. The most frequent age range of participants was 39 to 49 years (28/73; 38%), with 66/73 (90%) male. Regarding surgeon experience levels, these were broadly split evenly across 0 to ten years (18/51; 35%), ten to 20 years (16/51; 31%), and > 20 years (17/51; 34%) where responses were available. The median time taken to complete the DCE was 8 minutes 27 seconds (IQR 4 mins 30 seconds to 12 mins 24 seconds).

For the main multinomial regression analysis, given the smaller than planned sample size and the complexity of included attributes and levels (associated with subsequent level imbalance), the initial data analysis revealed non-significant results (Supplementary Table ii). A decision was therefore made to collapse upper threshold values ('severe and extreme' states) of some variables to accommodate the smaller sample. This was felt to have face validity due to adjustment of most variables from levels consistent with the EuroQol five-dimension five-level questionnaire (EQ-5D-5L)[24] to the EQ-5D-3L version (covering Pain, Mobility/Function, ADLs, and Mental Wellbeing).[25] The coefficients produced from this output are contained within Table III, with significant results detailed in Figure 2. Of note, despite both Mental Wellbeing and Inability to Work/Care being ranked as important in the Delphi process, they were not significantly associated with the priority decision-making process conducted by individuals taking part in the DCE.

Length of time waited was used for calculation of the WTW for a change of level of variables that were significant within the collapsed multinomial regression model. The results are shown in Table IV.

Prioritization tool. Following completion of the DCE, the proof-of-concept prioritization tool was developed to automatically generate the priority score and record other relevant perioperative variables (Figure 3).[26] Such a system allows for determination of relative priority for every patient on an individual surgeon's (or department's) waiting list to assist in the decision-making processes around when individual patients are listed for surgery. The tool could also potentially be used at the stage of general practitioner referral to help triage the priority of referrals to secondary care where there are prolonged waits to outpatient review. The prototype is freely available online.[26]

Discussion

This study presents a prioritization strategy for those waiting for primary hip and knee arthroplasty as defined by patients and healthcare professionals. This includes both a determination of the attributes that should be included in the prioritization process, and how different levels of these attributes can be ranked against each other to determine comparative priority based on patient characteristics. From this work, we present a proof-of-concept prioritization tool which shows how this information could be further formally developed to allow for clinical practice implementation within elective orthopaedic services following appropriate testing and feasibility assessment. Furthermore, the unique methodology (use of weighted benefit scores to determine comparative priority across individuals) used within this study provides a clear roadmap for development of similar systematic approaches to patient prioritization in other clinical areas of need.

To date, other previous work has demonstrated an ad hoc and largely inadequately evidenced approach to surgical prioritization. For example, the FSSA guidance (one of the key cornerstones of national surgical priority setting during the COVID-19 pandemic) was developed based only on the clinical opinion of selected individuals, with no justification or explanation of how this process was undertaken.[12,13] Evaluation in the setting of elective primary hip arthroplasty identified only fair to moderate agreement concerning interobserver reliability of this tool, highlighting the issues with use in this clinical population.[14] Other attempts at developing widely applicable clinical

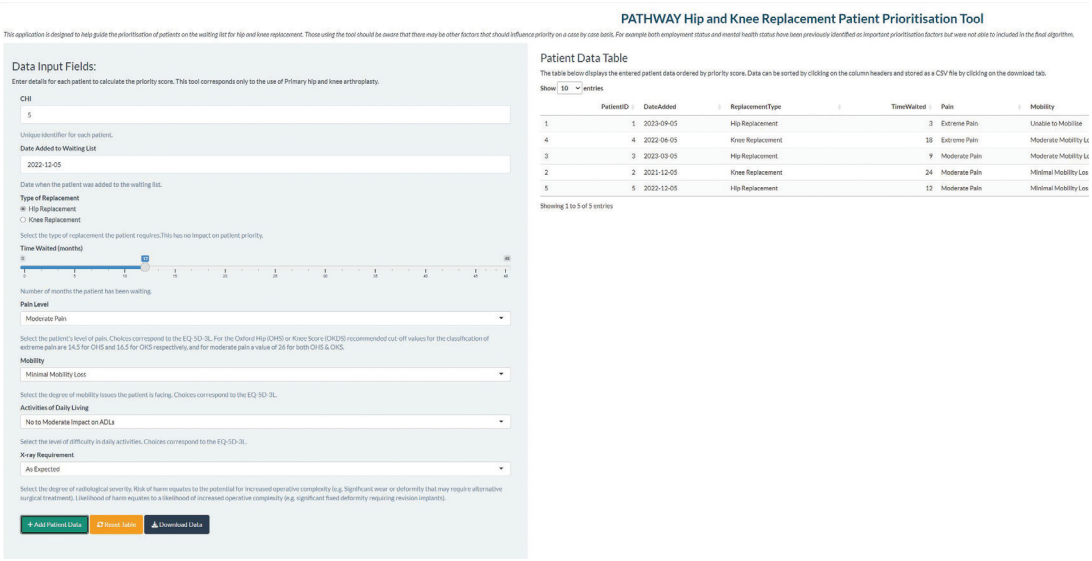

Fig. 3

Proof-of-concept example using the study output within a tool to allow for determination of comparative patient priority.

prioritization tools have largely been done without any clear justification for attribute selection or weighting.[17,27]

To our knowledge, only one other patient prioritization project used patients as participants in the research process.[16] It used a series of virtual workshops involving a range of participants from various rural areas within Coventry and Warwickshire. This did not, however, focus on hip and knee arthroplasty patients, who have specific domain knowledge and for whom priorities are likely to differ compared to the general population.

Regarding patient prioritization specifically in the hip and knee arthroplasty setting, the only major development had previously been from the Western Canada Waiting List Project team, who used regression analyses based on the New Zealand major joint arthroplasty criteria.[28] There was, however, no patient involvement and it included feedback from only 13 individuals during the score development process. Nonetheless, their included attributes were broadly similar to those identified during our study, with the exception of mental wellbeing, which was not included in their criteria. Abnormal examination findings were explicitly stated in their criteria, but were not identified as significant in our project, likely because these would be strongly associated with other attributes, for example pain, function, or radiological severity.

The primary limitation to our study included the sample size for both the Delphi and DCE components, which was smaller than targeted in both situations (though above minimum thresholds)[22,23] due to a difficulty in recruitment. This particularly impacted the DCE, where limited inferences could be drawn due to the smaller sample and the complexity of the DCE in terms of the attributes, levels, and number of choice sets. Future studies could attempt to improve on this with larger samples, which would also allow for inclusion of two-way interaction terms (for example, an association between pain and function) in the multinomial regression and comparison of patient and surgeon opinions in the Delphi study. However, given the difficulty in recruitment, this would likely have to involve greater incentivization for participation with significant associated cost and concerns over how this may influence the study process. The complexity of the DCE also limited the ability to include other relevant individuals in the research process such as patients, service managers, and commissioners. Other limitations include the use of a UK national population, meaning that findings may be less applicable in other countries where beliefs around prioritization may differ. The study findings are also specific to hip and knee arthroplasty patients and therefore are unlikely to be directly relevant to other clinical pathology, even within the setting of trauma and orthopaedics.

The strengths of the study include the novel use of the DCE methodology to elicit the weighted benefit scores (‘priority score’) in the setting of patient prioritization, where it has only been previously used to determine priority at the wider hospital or health board clinical service provision level. The combination of both the Delphi and DCE components provides a robust system for providing a clear evidence base for priority decision-making that can be applied objectively at a national level to reduce inequalities and provide more equitable access to care while long waits for surgery persist. The developed proof-of-concept prioritization tool demonstrates a clear pathway to impact for this work and the potential for clinical implementation at scale. Concerns over any potential manipulation of the tool by patients and surgeons will hopefully be allayed by the inclusion of both subjective and objective parameters, with input from both the patient and the surgeon, which should minimize the potential for this to occur.

Due to the individualized nature of patient prioritization and the need to balance other considerations such as theatre availability, staffing, and surgical implant availability, it is anticipated that such a tool would be used as a guide only for surgeons

making the final prioritization decision. Though both work/carer status and mental wellbeing were both non-significant in the DCE (possibility due to differences in prioritization importance between surgeons and patients), these factors were still clearly identified throughout the Delphi process as important, and consideration will therefore be given to optimizing integration into the final priority tool. Deprivation is another factor that has previously been identified as an important concern when addressing social inequity, which was not fully considered by this work, however given the strong links between deprivation and domains of the EQ-5D (which form a significant part of the developed priority score) it is likely that this would be indirectly captured and considered in the current scoring system.[29]

It is also important to note that before any potential clinical use, the tool will require rigorous testing and validation in clinical practice, including quantitative and qualitative assessment of the ethical considerations, potential benefits, and barriers to deployment, from both a surgeon and patient perspective, with potential refinement as necessary.[30] We plan to use the Idea, Development, Exploration, Assessment, Long term study (IDEAL)-D framework,[31] a proposal for the safe and comprehensive evaluation of medical devices, as a roadmap for future evidence development. Dynamic updates are also likely to be necessary to ensure that the clinical picture remains accurate in the face of changing patient parameters over time.

This is the the first stakeholder-led, rigorously developed prioritization system that can be used to objectively determine comparative priority for patients on waiting lists for primary hip and knee arthroplasty. Further testing is now warranted to assess real-world clinical applicability and progress towards potential wide-scale implementation. The methodological framework used in this study may also be applied beneficially to other clinical areas where robust methods of patient prioritization are lacking.

Take home message

- This study provides an innovative stakeholder-led method for determining comparative priority for those awaiting primary elective hip and knee arthroplasty.

Social media

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Supplementary material

Supplementary material contains the original multinomial regression analysis ("full model").

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