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HIP

A cost-effectiveness assessment of dual-mobility bearings in revision hip arthroplasty

Aims
The rate of dislocation when traditional single bearing implants are used in revision total hip arthroplasty (THA) has been reported to be between 8% and 10%. The use of dual mobility bearings can reduce this risk to between 0.5% and 2%. Dual mobility bearings are more expensive, and it is not clear if the additional clinical benefits constitute value for money for the payers. We aimed to estimate the cost-effectiveness of dual mobility compared with single bearings for patients undergoing revision THA.

Methods
We developed a Markov model to estimate the expected cost and benefits of dual mobility compared with single bearing implants in patients undergoing revision THA. The rates of revision and further revision were calculated from the National Joint Registry of England and Wales, while rates of transition from one health state to another were estimated from the literature, and the data were stratified by sex and age. Implant and healthcare costs were estimated from local procurement prices and national tariffs. Quality-adjusted life-years (QALYs) were calculated using published utility estimates for patients undergoing THA.

Results
At a minimum five-year follow-up, the use of dual mobility was cost-effective with an estimated incremental cost-effectiveness ratio (ICER) of between £3,006 and £18,745/QALY for patients aged < 55 years and between 64 and 75 years, respectively. For those aged > 75 years dual mobility was only cost-effective if the timeline was beyond seven years. The use of dual mobility bearings was cost-saving for patients aged < 75 years and cost-effective for those aged > 75 years if the time horizon was beyond ten years.

Conclusion
The use of dual mobility bearings is cost-effective compared with single bearings in patients undergoing revision THA. The younger the patient is, the more likely it is that a dual mobility bearing can be more cost-effective and even cost-saving. The results are affected by the time horizon and cost of bearings for those aged > 75 years. For patients aged > 75 years, the surgeon must decide whether the use of a dual mobility bearing is a viable economic and clinical option.

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Introduction
Dislocation, after both primary and revision total hip arthroplasty (THA) can be a catastrophic event with a loss of confidence and poor outcome.1 The costs of relocation and revision surgery for persistently dislocating hips can have an implication to healthcare systems.2–4 The rate of dislocation after revision THA varies between 8%5–7 and 10%.8 A similar incidence has been reported from the Swedish Joint Registry.9 When recurrent instability is the indication for revision, the rate of further dislocation may be 35%.10 In 2009, Bozic et al11 reported recurrent dislocation as the main indication for revision THA in 22% of all revisions performed, using a regional registry with more than 50,000 THAs.11 Dual mobility implants have been widely used in parts of Europe for both primary and revision THA with good results, for over two decades.12 The rationale for this is to reduce instability by increasing the jump distance without resorting to larger femoral heads.13 A recent systematic review
of revision THA using modern dual mobility bearings reported a dislocation rate of 2.2% at short-term follow-up, but only 1.2% needed re-revision, with the other 1% being stable after relocation.14

This is in keeping with a report from the Swedish Joint Registry, which recorded that, in revision THA procedures for instability, the incidence of further recurrent dislocation was 2.1% when using dual mobility implants compared with 35.3% when using conventional implants.6 Incidences of between 0% and 1.4% after dual mobility implants were used at revision THA have been reported in smaller series.15–18 Similarly, Darrith et al19 reported an incidence of 0.46% in a recent systematic review.

Some have advocated the use of larger heads rather than dual mobility implants. However, Hartzler et al20 found that dual mobility implants had lower dislocation rates when compared with the use of 40 mm diameter heads in a series of 355 revision THAs in 2018. Although generally dual mobility implants were more likely to be used in patients felt to be at high risk of instability, they found a redislocation rate of 3.1% for dual mobility implants compared with 10% when 40 mm heads were used (hazard ratio 3.2).20

To date, there are no cost-effectiveness models that assess whether the clinical benefits of using dual mobility components compared with conventional bearings in revision THA represent value for money in the UK NHS. While we acknowledge that when deciding on implants and bearings, many factors have to be considered and the final decision will depend on surgeon preferences and individual patient characteristics, we aimed to assess the cost-effectiveness of using a dual mobility rather than a single bearing in patients undergoing revision THA using the National Joint Registry (NJR) of England and Wales21 and an updated meta-analysis.

Methods
A Markov model with five health states was developed in Microsoft Excel (Microsoft, Redmond, Washington, USA) from the perspective of the NHS.

Markov models22 are ‘repetitive decision trees’ that are used for modelling outcomes.22 These trees indicate the various possibilities or movements between different health states that can occur to a patient at any given time. The health states which were assessed in this study were successful revision, dislocation, re-revision, and death. A patient can only be in one state at any one time. However, they may move from one state to another, and this rate of movement is determined by the effectiveness of the intervention. In this study, the comparison was between the use of dual mobility or single bearings at revision THA. We then assessed the health states over time periods, or cycles. In this model we set the length of a cycle at one year which was considered clinically meaningful, to assess the impact of the intervention23,24 and to be consistent with previous studies.25,26

As more than 95% of patients’ outcomes are captured in the NJR, ‘loss to follow-up’ was not imputed in the model.22 Figure 1 shows a representation of the model, which considers a cohort of 1,000 patients, men and women, aged < 55 years, 55 to 64, 65 to 74, and > 75 years who are deemed eligible for revision surgery. These age groups are in keeping with the way data are categorized in the NJR.27

The model estimates the costs and outcomes of treating patients with either a single bearing (32 or 36 mm head) or a dual mobility bearing. These head sizes are the ones most commonly used for revision THA in the registry. The model does not distinguish the effectiveness of particular implant designs, head composition, or inner diameter of the dual mobility construct because these data are not available from the Registry at present, and this is a known limitation. We also assumed that all other things would be the same between the patient groups such as type of fixation, postoperative weight-bearing and activity levels or restrictions, and the only difference was the use of single or dual bearings.

Following revision surgery with either single or dual bearings, patients can enter the following health states: a) successful revision. Patients in this state may stay successful, or at any point can transition into any of the health states listed below. The rate of movement into another state is called the ‘transition probability’ and is governed by the success of the intervention, in this study being revision THA using single or dual bearings. b) Dislocation: patients that transition into this state can enter a successful post-dislocation state following closed reduction or are at further risk of transition to a re-revision state (state c). c) Patients that had a re-revision are at further risk of another revision, but no further surgical options were considered beyond a second revision. d) Lastly, patients may transition to the death state from any other state at any time. The death state is called the ‘absorbing health state’ as no further transitions can occur.

The model has a 14-year time horizon in line with the NJR data and estimates the number of patients in each health state every year. However, we explored a lifetime horizon in a sensitivity analysis.

**Clinical data on the surface of a single bearing.** Clinical data on revisions for single bearings were derived from the 2018 NJR.28 Thus, the failure rate (revisions) for single bearings reported at five-, ten-, and 14-year follow-ups were used in the
Table I. Risk ratios and model parameters.

| Characteristic | Mean 5-yr revision rates (SE) | Mean 10-yr revision rates (SE) | Mean 14-yr revision rates (SE) | Source |
|----------------|------------------------------|--------------------------------|-------------------------------|--------|
| **Age groups** |                              |                                |                               |        |
| < 55 yrs       | 0.037 (0.001)                 | 0.041 (0.001)                  | 0.078 (0.002)                 | ONS 2018 |
| 55 to 64 yrs   | 0.029 (0.001)                 | 0.027 (0.001)                  | 0.062 (0.001)                 | ONS 2018 |
| 65 to 74 yrs   | 0.022 (0.000)                 | 0.019 (0.000)                  | 0.045 (0.001)                 | ONS 2018 |
| ≥ 75 yrs       | 0.02 (0.000)                  | 0.015 (0.000)                  | 0.035 (0.001)                 | ONS 2018 |

**Re-revision rates for both males and females**

- Re-revision: 0.116 (0.002) N/A 0.177 (0.005) N/A 0.216 (0.012) N/A NJR 2018
- Dislocation: 0.07 (0.003) N/A N/A N/A N/A NJR 2018

**Postoperative mortality**

- < 55 yrs: 0.022 (0.001) 0.025 (0.001) 0.050 (0.001) 0.050 (0.001) 0.080 (0.003) 0.075 (0.003) NJR 2018
- 55 to 64 yrs: 0.048 (0.001) 0.038 (0.001) 0.123 (0.002) 0.094 (0.002) 0.209 (0.006) 0.161 (0.004) NJR 2018
- 65 to 74 yrs: 0.106 (0.001) 0.072 (0.001) 0.292 (0.003) 0.215 (0.002) 0.507 (0.007) 0.400 (0.005) NJR 2018
- ≥ 75 yrs: 0.271 (0.003) 0.186 (0.002) 0.666 (0.005) 0.535 (0.003) 0.878 (0.009) 0.793 (0.006) NJR 2018

**All-cause mortality**

- < 55 yrs: 0.001 0.001 N/A N/A N/A N/A ONS 2018
- 55 to 64 yrs: 0.005 0.006 N/A N/A N/A N/A ONS 2018
- 65 to 74 yrs: 0.012 0.015 N/A N/A N/A N/A ONS 2018
- ≥ 75 yrs: 0.133 0.145 N/A N/A N/A N/A ONS 2018

N/A, not applicable; NJR, National Joint Registry; SE, standard error.

Table II. Risk ratios and model parameters

| Clinical-effectiveness of dual mobility | Mean value (range; SE) | Source |
|----------------------------------------|------------------------|--------|
| All revision                           | 0.45 (0.28 to 0.74; 0.117) | Meta-analysis |
| Dislocation                            | 0.32 (0.17 to 0.61; 0.112) | Meta-analysis |
| Revision due to dislocation            | 0.35 (0.15 to 0.74; 0.148) | Meta-analysis |

N/A, not applicable; ONS, Office of National Statistics; SE, standard error.

Table III. Risk ratios and model parameters

| Health state cost data | Mean (SE) | Source |
|------------------------|-----------|--------|
| **Health state utility** |           |        |
| Well post-revision THA, £ | 489 (62.37) | NHS reference costs |
| Dislocation, £           | 2,500 (318.88) | NHS reference costs |
| Revision costs, £        | 10,390 (1,325.26) | NHS reference costs |
| Re-revision, £           | 10,390 (1,325.26) | NHS reference costs |
| **Intervention cost data** |         |        |
| Single bearing, £        | 900 (115) | NHS supply chain |
| Dual mobility, £          | 2,000 (255) | NHS supply chain |

| **Health utility data by age** | Mean (SE) | Source |
|-------------------------------|-----------|--------|
| < 55 yrs                      | 0.736 (0.018) | Fawsitt et al³⁰ (2019) |
| 55 to 64 yrs                  | 0.767 (0.007) | Fawsitt et al³⁰ (2019) |
| 65 to 74 yrs                  | 0.762 (0.004) | Fawsitt et al³⁰ (2019) |
| ≥ 75 yrs                      | 0.79 (0.003) | Fawsitt et al³⁰ (2019) |

N/A, not applicable; SE, standard error; THA, total hip arthroplasty.

model (Tables I–III). Because they are reported as rates, we converted them to probabilities needed for the modelling using the following formula

\[ p = 1 - e^{-rt} \]

where \( p \) is the probability, \( r \) is the rate and \( t \) is the unit of time.

Re-revision was defined as a subsequent operation to deal with a failed revision, due, for instance, to dislocation. To have a more accurate level of rates of dislocation, we updated three recent meta-analyses that compared single and dual bearings in revision THA¹²⁻¹⁴ since the NJR does not accurately report this information.

**Clinical data on dual mobility.** As previously stated, the NJR data enabled us to report how many patients lie in one particular health state without intervention, thus providing baseline data without dual mobility. In order to compare the effectiveness of the intervention (single or dual bearing) we had to also perform a meta-analysis. This gives us an overall estimate of effectiveness of the intervention, thus how much using dual mobility bearings mitigates dislocation or any cause re-revision. A meta-analysis combines many studies which ask and answer the same question with outcomes to give an overall estimate of effect.

We conducted a systematic literature review to identify studies which compared single and dual bearings in PubMed (MeSH: with heading of instability, dual mobility; total hip arthroplasty; total hip replacement, revision hip arthroplasty) and identified three systematic reviews that were published in 2018.¹²⁻¹⁴ There were five studies that compared single and dual bearings in these reviews. However, none of the three reviews captured all the five studies in their analysis. All revision hip arthroplasties were considered with exclusion of those under the age of 18 and in those who had revision done for cancer.

Consequently, we performed a meta-analysis of the five studies using RevMan v. 5.3 (The Nordic Cochrane Centre, Copenhagen, Denmark). All studies reported the following outcomes, which were included in the meta-analysis: 1) all cause revisions, 2) dislocation, 3) re-revision due to dislocation. We reported risk ratios as the summary statistic since all the outcomes were dichotomous, and \( p \)-values ≤ 0.05 were considered statistically significant. All potential studies were reviewed by staff orthopaedic surgeons (AA and AK) for accuracy and inclusion. If a dispute was encountered, it was reviewed by a third orthopaedic surgeon (SEW).
The follow-ups ranged from six months to three years. In the base model, the effect of dual mobility on the rates of dislocation and revision was limited to three years after surgery in line with the maximum follow-up in the studies. After three years, the risks of dislocation and revision were assumed to be equivalent for single and dual bearings. This assumption was made due to the lack of longer-term follow-up data suggesting otherwise. The risk ratios applied in the model are shown in Table I.

**Mortality rates.** As also previously reported, the all-cause sex- and age-specific mortality was obtained from UK Life Tables 2015/17, which reports mortality rates by age and sex (Table I). Postoperative mortality was obtained from the NJR. Both all-cause and postoperative mortality were assumed to be the same in patients treated with both single and dual bearings as currently there is no evidence suggesting otherwise.

**Health-related quality of life (HRQOL) and utility data used in the model.** Quality of life data or health utilities were obtained from a previously published economic evaluation from the UK. The authors of this study estimated the health state utilities from the Patient-Reported Outcome Measures (PROMs) dataset for 32,577 patients aged > 40 years who had a THA in 2010/2011. We assumed the same utilities for the first and subsequent revisions. Different implants were also assumed to have similar utility on patients as there is no evidence to suggest otherwise. The data on utilities were combined with survival to estimate quality-adjusted life-years (QALYs).

**Healthcare resource costs.** The model adopted the health and social care payer perspectives, considering only those costs and benefits that are incurred by the single payer health service (NHS). The costs of revision surgery, closed reduction and follow-up care were obtained from the NHS reference costs and were estimated as a weighted average based on the relevant HGRs (Healthcare Group Resources) codes. Costs of implants were obtained from NHS Supply chain. In line with current standard practice in the UK including the National Institute for Health and Care Excellence (NICE) guidelines for economic analysis, a 3.5% annual discount rate was applied for both cost and outcomes. Discounting is an economic term that indicates the rate at which society is willing to trade off present costs against future benefits and is commonly used in cost-effectiveness studies. All costs are reported in 2018/19 British pounds.

**Cost-effectiveness analysis and SA.** The base-case analysis compared the cost-effectiveness of single and dual bearing THAs for all patients aged > 18 years undergoing revision THA in the UK. In order to summarize the cost-effectiveness of an intervention, an incremental cost-effectiveness ratio (ICER) is calculated. This is the difference in costs between the two interventions, divided by the difference in their effects. In this study, this is the overall costs of using dual mobility bearings minus the overall costs of using single bearings divided by the overall clinical benefits of using dual mobility bearings minus the overall clinical benefits of using single bearings.

\[
\text{ICER} = \frac{\Delta \text{COSTS}}{\Delta \text{QALYs}}
\]

In order to determine if the intervention is cost-effective, the ICER is compared with the maximum amount that the healthcare payer is willing to pay for an additional unit of health benefit. In this context, NICE has a threshold figure of between £20,000 and £30,000/QALY. When the difference in costs (AC) is a negative value and the difference in benefits is positive (AQALYs) we conclude that the intervention (dual mobility) is a dominant strategy which represents a cost-saving to the system. If the ICER is below the threshold, we conclude that the intervention is cost-effective; if it is above the threshold, we conclude that it is not cost-effective according to the guidance issued by NICE.

**Sensitivity analysis.** A one-way sensitivity analysis and a probabilistic sensitivity analysis were also conducted and the results presented in a table for one-way sensitivity analysis and cost-effectiveness acceptability curves for the probabilistic sensitivity analysis. A sensitivity analysis is done in order to address the impact of possible uncertainty in the best information available on clinical benefits and treatment costs by alternately assigning low and high values and then recording the results. For the one-way sensitivity analysis, baseline values were varied SD 20% if ranges were not reported in the literature in accordance with other economic studies.

A probabilistic sensitivity analysis was also performed. This entails specifying a distribution for each parameter in the model to represent the uncertainty about the point estimate. This means that the uncertainty about multiple input assumptions can be tested simultaneously (in this case the costs of implants and utility values). This is distinct from one-way sensitivity analysis, which allows uncertainty about single inputs to be tested individually.

The lognormal distribution was implemented to capture the uncertainty surrounding the treatment effect; gamma and beta distributions were used to capture the uncertainty in cost and utility values respectively.

**Results**

Dual mobility bearings had fewer dislocations and re-revisions and therefore resulted in increased QALYs over five-, ten-, and 14-year follow-up periods compared with single bearings for both sexes in all age groups.

**Follow-up of up to five years.** For all age groups at a shorter follow-up period of five years, the use of dual mobility resulted in an increase in mean cost per patient (Table IV) as well as increased QALYs. The estimated ICERs fell below £30,000/QALY for both sexes for age groups < 75 years and would be deemed cost-effective in accordance with NICE guidance. For those aged > 75 years, the ICERs were £45,032/QALY for males and £50,625 for females and would not be deemed to be cost-effective.

**Follow-up of up of between ten and 14 years.** For follow-up periods between ten years and 14 years, the use of dual mobility was cost-saving for all ages ≤ 75 years resulting in better clinical outcomes and less cost overall. For those aged > 75 years dual mobility would only be deemed to be cost-effective at a willingness to pay threshold of between £20,000 and 30,000/QALY. Overall, the cost-effectiveness results are more favourable for younger patients compared with older patients. Table II and Table III summarize the results for both males and females by age group.

**Sensitivity analysis.** At five-year follow-up, the results for those aged < 55 years are robust for all follow-up periods and remain cost-effective. For those aged between 55 to 64 years,
the cost of dual mobility affects the results. If the price of dual mobility bearings falls to £1,500, it becomes cost-saving compared with single bearing. If the price of dual mobility increases to £2,500 the ICER increases to > £30,000/QALY for both males and females and is thus no longer cost-effective.

In those aged > 75 years, the cost-effectiveness remains uncertain emphasizing that dual mobility is not cost-effective using the base-case assumptions in this age group. However, if its cost is reduced to £1,500 then it may become cost-effective. A threshold analysis, an assessment to see at what follow-up time dual mobility would become cost-effective with base case assumptions, showed that it was cost-effective in those aged > 75 years after seven years.

At a ten-year follow-up. Beyond ten years, the level of uncertainty decreases in all groups aged < 75 years, and dual mobility is a dominant strategy; it results in less costs overall and has improved clinical outcomes, and is thus a cost-saving compared with single bearing. In those aged > 75 years, dual mobility is cost-effective, but not cost-saving compared with single bearing. The results of one-way sensitivity analysis are summarized in Table V.

We also conducted a probabilistic sensitivity analysis and presented the results using cost-effectiveness acceptability curves. This confirmed the findings of the one-way sensitivity analysis, suggesting that our base case conclusions are unlikely to be a chance finding. The cost-effectiveness acceptability curves show the probability that an intervention is cost-effective at a given willingness to pay threshold by the payers. These are available in the supplementary material.

Discussion
Dual mobility bearings were developed in an attempt to reduce the risk of dislocation in primary THA. However, the higher rates of dislocation associated with revision THA can make them an option for revision procedures.

With much higher costs of these implants, a balance between the clinical value of limiting the risk of dislocation and potential further revision has to be struck with the economic benefits. We therefore designed this study to assess the cost-effectiveness of dual mobility compared with traditional single bearing implants over a five-, ten-, and 14-year follow-up period for both sexes and for differing age groups.

We found that over the time frame assessed for all groups, considering a cohort of 1,000 patients, the use of dual mobility can decrease the risk of dislocation and further revision, resulting in higher QALYs. The economic analyses showed that over a five-year follow-up period, the use of dual mobility can be cost-effective for all patients aged < 75 years. The results are more favourable for younger patients and over a longer period of follow-up. For those aged > 75 years, dual mobility is not cost-effective over a five-year period and becomes effective beyond seven years. Sensitivity analysis showed that the results in those aged > 75 years remain uncertain until after ten years.

Over a ten-year period, the use of dual mobility is cost-saving in those aged < 75 years and cost-effective in those aged > 75 years. As mentioned earlier, the model favours younger patients and those with longer follow-up. The estimated savings increase with increased follow-up and there are also more savings in the younger age groups. For instance, for females

| Characteristic | Results for 5-yr follow-up | Results for 10-yr follow-up | Results for 14-yr follow-up |
|----------------|----------------------------|-----------------------------|-----------------------------|
| **Men**        |                            |                             |                             |
| < 55 yrs       | Costs, £ | QALYs | ICER, £ | Costs, £ | QALYs | ICER, £ | Costs, £ | QALYs | ICER, £ |
| Single bearing | 4,741    | 4.04  | 6,756   | 10,254 | 6.66  | 14,830 | 8.36   |
| Dual mobility  | 4,921    | 4.07  | 12,642  | 9,346  | 6.72  | 13,361 | 8.43   |
| 55 to 64 yrs   |          |       |         | Dominant |       |         | Dominant |       |       |
| Single bearing | 4,436    | 3.96  | 9,055   | 6.36   |       | 12,870 | 7.78   |
| Dual mobility  | 4,744    | 3.98  | 8,484   | 6.41   |       | 11,796 | 7.84   |
| 65 to 74 yrs   |          |       |         | Dominant |       |         | Dominant |       |       |
| Single bearing | 4,067    | 3.80  | 7,536   | 5.81   |       | 10,083 | 6.85   |
| Dual mobility  | 4,510    | 3.82  | 7,353   | 5.85   |       | 9,569  | 6.90   |
| ≥ 75 yrs       |          |       |         | Dominant |       |         | 23,216 | 17,422 |
| Single bearing | 2,969    | 2.74  | 3,984   | 3.37   |       | 4,545  | 3.65   |
| Dual mobility  | 3,633    | 2.76  | 4,475   | 3.39   |       | 4,958  | 3.68   |
| **Women**      |                            |                             |                             |
| < 55 yrs       | Costs, £ | QALYs | ICER, £ | Costs, £ | QALYs | ICER, £ | Costs, £ | QALYs | ICER, £ |
| Single bearing | 4,853    | 4.03  | 11,008  | 6.64   |       | 16,478 | 8.33   |
| Dual mobility  | 4,974    | 4.06  | 9,847   | 6.70   |       | 14,571 | 8.41   |
| 55 to 64 yrs   |          |       |         | Dominant |       |         | Dominant |       |       |
| Single bearing | 4,395    | 3.97  | 9,165   | 6.40   |       | 13,194 | 7.86   |
| Dual mobility  | 4,726    | 3.99  | 8,567   | 6.45   |       | 12,050 | 7.92   |
| 65 to 74 yrs   |          |       |         | Dominant |       |         | 9,725  | 6.94   |
| Single bearing | 4,023    | 3.83  | 7,411   | 5.89   |       | 9,334  | 6.99   |
| Dual mobility  | 4,499    | 3.85  | 7,292   | 5.93   |       | 9,334  | 6.99   |
| ≥ 75 yrs       |          |       |         | Dominant |       |         | 29,009 | 24,923 |
| Single bearing | 2,886    | 2.76  | 50,625  | 3.33   |       | 4,117  | 3.53   |

ICER, incremental cost-effectiveness ratio; QALY, quality-adjusted life-years.
aged < 55 years, there are mean savings of £1,161 at ten years compared with £1,907 at 14 years. This compares with mean savings of £119 and £391, respectively, for those aged between 65 and 74 years. These results are further confirmed by both the one way and probabilistic sensitivity analyses. For instance, compared with £1,907 at 14 years. This compares with mean savings of £119 and £391, respectively, for those aged between 65 and 74 years. These results are further confirmed by both the one way and probabilistic sensitivity analyses. For instance, older patients have a shorter life expectancy and the cost difference may make it difficult to justify the extra cost, especially in patients with comorbidities. However, as has been previously reported, the chronological age of a patient can ‘not be a perfect proxy for years of remaining active life, but it is a known factor for all patients’.[38] Additionally, the average life expectancy in the UK is approximately 82 years and is continuing to rise,[39] which may justify the additional costs of dual mobility, but this is to be at the discretion of the treating surgeon, the indication for revision, the resources available to the healthcare institution and the overall health of the patient. To the best of our knowledge, this is the first study that has assessed the cost-effectiveness of single and dual bearings in the NHS in the UK. A strength of the study is the use of NJR data which are relevant and correctly characterize the UK population. Furthermore, robust sensitivity analysis was performed, a one-way and a probabilistic sensitivity analysis, to ensure confidence in the results. The limitations of this study include the fact that it is primarily applicable to the UK healthcare system, as the baseline data and cost-assumptions were from the perspective of the NHS. However, we believe that the results may be extrapolated to other healthcare systems, especially those with a universal single payer platform. We suspect that the NJR reflects similar outcomes as many other healthcare systems, and implant cost-ratios would not be too different. We acknowledge that the data also use an older generation of polyethylene for survivorship and this may have an effect on the cost-effectiveness conclusions and we urge caution on the interpretation of the results.

Dual mobility bearings may be associated with high wear rates in the long term as there are two metal/polyethylene interfaces and a much larger surface area of contact on the outer bearing. There is also a risk of adverse local tissue reaction and corrosion of the liner/cup interface.[39] An in vivo study with ultra-high molecular polyethylene dual mobility bearings showed that rates of wear of more than a threshold of 0.1 mm/year may risk the development of osteolysis.[40] More recently, a radioisometric analysis of highly cross-linked polyethylene showed no higher rates of wear than with traditional single bearings.[41] However, comparison of wear is beyond the scope of this study. Additionally, there have never been reported case reports of osteolysis being associated with particles of debris.

However, a small study involving matched cohorts of patients aged < 55 years showed no difference in functional scores.[42] With the lack of long-term wear rates and associated survivorship, dual mobility implants should be used with caution,[28] especially in patients with risk factors for recurrent dislocation. We acknowledge that cost should not be the only reason for the choice of implant.

Surgeons, patients, and manufacturers will attempt to improve the survivorship of revision THAs and minimize the risk of dislocation using one of these strategies. This analysis...
suggests that dual mobility may be a cost-effective option for revision THA especially in patients aged < 75 years for the five-year postoperative period, and it becomes cost-saving beyond ten years in all age groups. For those aged > 75 years, cost-effectiveness is uncertain at five years but dual mobility is predicted to become cost-effective beyond seven years postoperatively.

This study was not intended to dictate the choice of bearings to be used in revision surgery. We solely aimed to advise surgeons in their decision-making process as to the cost-effectiveness of dual mobility bearings in revision hip surgery, with the costs in different age groups and the potential sequelae.

The findings do not suggest that dual mobility is a panacea for all revision cases and clinical judgement cannot be superseded by economic analysis. This analysis does, however, provide some justification for the use of these more expensive implants when the surgeon feels that they may be clinically indicated, particularly in revision THAs in younger patients in whom instability is the indication for surgery.

Take home message
- Dual mobility bearings may be cost-effective in all patients aged < 75 years undergoing revision total hip arthroplasty. This is especially true of those with instability as the indication for revision surgery.
- In those aged > 75 years, dual mobility bearings become cost-saving after seven years.

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A COST-EFFECTIVENESS ASSESSMENT OF DUAL-MOBILITY BEARINGS IN REVISION HIP ARTHROPLASTY

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