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Regional economic burden of revision total knee replacement: A cost-complexity analysis

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ABSTRACT

Background: GIRFT tasked regional networks with addressing case-load, complexity-spread and cost of revision knee replacement (KR), but the regional cost burden is not clear. The tariff for revision KR is currently not dependent on surgical complexity. 2 years of revision KR complexity data using the validated Revision Knee Complexity Classification (RKCC) checklist as a demonstration of complexity spread in the region has previously been published. The aims of this study were to estimate the annual regional cost of revision TKR using existing data, and estimate the cost/saving of complexity-clustering using existing data from 8 revision centres.

Methods: Financial data from the regional high-volume centre for one year (2019) of RKCC data collection was obtained. Mean cost, tariff and balance was calculated for R1, R2 and R3 (RKCC), and applied to data from each revision centre to provide local estimates. Complexity clustering was considered using 3 hypothetical scenarios of high-volume centre absorbing R2s and/or R3s in place of R1s.

Results: Mean net loss was £2,290.08 for R1s, £6,471.42 for R2s and £6,454.26 for R3s. The estimated total annual loss for the region was £1,005,025. Complexity-clustering was associated with greater losses; £162,918 for high-volume centre taking R2s and R3s, £37,477.60 for taking just R3s and £125,440 for taking just R2s.

Conclusion: Revision TKR surgery is expensive and insufficiently remunerated with current measures. Restructuring of regional workload would create additional financial burden on specialist centres with current tariff awards structure. Managing reimbursement at a regional or central level may help to incentivise compliance with GIRFT ideals.

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1. Introduction

The Getting It Right First Time report [1] (GIRFT) tasked revision knee replacement centres with developing clinical networks with a view to reducing rate of surgical complication, re-operation rate and reducing costs. Within these networks complexity and workload could be shared, with provision for lower-volume centres to discuss or refer more complex cases to higher-volume centres. In line with the aims of GIRFT a regional network of revision knee replacement centres was established within the southwest of England. This included 8 trusts with a current revision knee replacement (KR) caseload of varying volumes. One particular revision centre dealt with a particularly higher caseload than all of the other centres, and as such, in line with GIRFT was designated the “regional high-volume centre”. There is no strict threshold for a revision

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centre to be designated as such, however within this network the high-volume centre has been shown to carry out approximately 40% of the regional caseload [2]. In addition the regional high-volume centre facilitates a regular regional MDT where complex cases can be discussed and advice sought if needed, with specialist surgical and microbiological input available. The Revision Knee Complexity Classification checklist (RKCC) has been described by the authors [2,3]. This validated checklist was designed by surgeons in an attempt to stratify revision knee replacement into three groups with the use of patient, indication and operative factors. Issues such as the presence of infection, soft tissue defects, bone loss and patient co-morbidities are used to classify revision knee surgery into R1 (routine revision surgery), R2 (complex) and R3 (salvage or very complex). These factors have been combined into an RKCC proforma for use at a Multi-Disciplinary Team meeting (MDT) to help determine which complexity level is appropriate ahead of the date for surgery. The classification can then form the basis or guide for an MDT discussion between units within a network to plan the revision operation. The authors have previously published two years of regional complexity data following the development of a revision knee replacement network in the South-west [2], and the regional implementation of the RKCC.

The association between surgical complexity and cost is not well described. Complexity is likely to be the biggest contributor to care episode cost for a patient undergoing revision total knee replacement. A more complex procedure is likely to be associated with increased theatre time, increased blood loss, increased risk of patient morbidity [4–6], longer length of stay in hospital, less predictable clinical outcomes [7] and higher implant costs which may need to be loaned from industry (commonly referred to as loan kit) rather than using “off-the-shelf” implants. In addition, current remuneration for revision knee replacement services is not based on such a robust assessment of complexity, but rather is determined by a set of HRG (Healthcare Resource Group) codes. These do pertain to revision knee replacement in isolation but are allocated based on patient factors, or “co-morbidity and complication score” (CC-score), ICD-10 diagnoses, and Operative Procedure Codes (OPC) rather than the surgical complexity directly. Petrie *et al.* (2021) have demonstrated that the current tariff and remuneration scheme for revision knee replacement service is inadequate, results in units recording losses for almost all procedures carried out, and places an increased financial burden on units carrying out higher volumes of complex work [8]. Case-load volume has been demonstrated to be associated with outcomes [9]; Yapp *et al.* (2021) reported increased rates of re-revision in centres where lower numbers of cases were carried out. Addressing this has been one of the aims of the recent GIRFT revision knee network care pathway. If the aims of this are met, then we can expect to see a redistribution of revision knee activity, with movement away from very low volume centres and a potential movement based on complexity with the most complex R3 cases being done at the Major Revision Centres. If this occurs then a complexity-based tariff system may need to be considered to avoid what would amount to a financial penalty on high-volume or tertiary referral centres. There is currently no data on this subject.

2. Aims

1. Calculate the annual regional cost of revision KR using existing data
2. Estimate the regional financial deficit across 8 revision centres associated with the current tariff arrangements
3. Estimate the regional and local cost/saving of complexity clustering using 3 hypothetical scenarios of high-volume centre absorbing R2s and/or R3s in place of R1s in equal volume

3. Methods

The RKCC checklist was introduced to the region in 2018, and has been part of an ongoing regional audit into revision complexity and caseload across 8 revision KR centres [2]. Regional RKCC data from 1st January 2019 to 31st December 2019 was used for this study. Financial data was made available by the accounts department at the high-volume revision KR centre hospital for this same period of RKCC data collection. Financial data for a care episode was included only if it was complete. Cost was established as the total sum ascribed to the inpatient episode covering bed-days, medication, consumables, theatre use and implants. Tariff represented the total sum of remuneration to the trust from NHS England associated with the particular care episode, with the balance defined as the difference between the two.

Being the regional high-volume centre, with a broad spread of caseload and complexity, it was felt that financial data was likely to approximate well to the rest of the region. The mean cost, tariff and balance was calculated for R1 (lower complexity), R2 and R3 (highest complexity). The calculated means were then applied to data from each revision centre within the region to provide local estimates of mean cost, mean tariff and mean balance. The complexity-clustering effect was considered using 3 hypothetical scenarios of work load adjustment with the high-volume centre absorbing R2s and/or R3s in place of R1s, whilst keeping the total annual caseload the same.

The primary outcome measures for the study were mean cost, mean tariff and mean balance for each of R1, R2 and R3 within the high-volume centre. Secondary outcome measures were estimated total regional deficit for revision KR spend, and estimated total regional deficits for the hypothetical scenarios of complexity clustering described.

A number of assumptions underpinned this study: a. that inpatient stay costs are similar between hospitals; b. that the market forces factor is similar between hospitals within the same geographical region; c. that similar tariffs would be generated in a similar fashion for low-complexity procedures, and that length of stay and patient co-morbidities between

hospitals is similar within the region; d. lastly that the RKCC checklist data was a true representation of regional revision KR practice; and that loan kit costs are comparable between revision centres.

4. Results

Within the calendar year 1st January 2019 to 31st December 2019, 122 revision total knee replacements were carried out in the regional high-volume centre (58 R1, 46 R2, 18 R3). Complete financial data from 93 revision KRs was available; 49 R1s, 30 R2s and 14 R3s. This data was used to calculate the mean cost, tariff and balance for each complexity category (R1, R2 and R3) as determined by the RKCC (Table 1). This mean data was then used to estimate total tariff costs and balance in the regional high-volume centre (Table 2), and the region as a whole, incorporating an additional 7 revision units (Table 3). Within the region as a whole in 2019 252 revision KRs were performed (R1 148, R2: 77, R3:27) [2].

For all revision levels R1, R2 and R3 a negative balance was recorded. Within the high-volume centre mean loss was £2,290 for R1, £6,471 for R2 and £6,454 for R3. This was calculated as the mean of the differences between cost per case and tariff per case. Based on a year total of 122 cases; 58 R1s, 46 Rs and 18 R3s estimated total loss was £546,687 (Table 2). Applied to the region as a whole, based on a yearly total of 252 cases (R1 148, R2: 77, R3:27) the total estimated loss for the year was £1,058,238 (Table 3).

3 hypothetical scenarios of carrying out a larger volume of complex cases in the regional high-volume centre were considered, keeping the total yearly case volume fixed at 122. In the first scenario we considered all of the regional R2s and R3s being carried out at the high-volume centre in place of a corresponding number of R1s (Table 4). In this scenario the

Table 1

Table 1 shows the calculated mean cost, mean tariff and mean balance for the raw financial data within a single year, based on 93 cases where financial data was complete.

High volume centre means based on 49 R1s, 30 R2s and 14 R3s:			
	Cost	Tariff	Balance
R1	£9,937	£7,647	-£2,290
R2	£15,333	£8,862	-£6,471
R3	£17,857	£11,403	-£6,454

Table 2

Table 2 shows the estimated regional total cost, tariff and balance for each complexity level R1, R2 and R3 based on an annual caseload of 122 operations.

Estimated high-volume total spend:				
	Number	Cost	Tariff	Balance
R1	58	£443,497	£576,322	-£132,824
R2	46	£407,651	£705,336	-£297,685
R3	18	£205,253	£321,430	-£116,177
Total	122			-£546,687

Table 3

Table 3 shows the estimated regional total cost, tariff and balance for each complexity level R1, R2 and R3 based on an annual caseload of 252 operations.

Estimated regional totals (based on 252 total, R1: 148, R2: 77, R3:27):			
	Cost	Tariff	Balance
R1	£963,460	£1,252,010	-£288,551
R2	£841,888	£1,456,673	-£614,785
R3	£273,671	£428,574	-£154,902
Total			-£1,058,238

Table 4

The estimated cost, tariff and balance in the scenario where all regional R2s and R3s are done at the high volume centre, based on a total of 122 operations.

Hypothetical 1: Taking all regional R2s and R3s, local R1s - fixed caseload. Estimated cost, tariff and balance				
	Number	Cost	Tariff	Balance
R1	19	£145,283	£188,795	-£43,512
R2	76	£673,510	£1,165,338	-£491,828
R3	27	£307,880	£482,145	-£174,265
Total	122			-£709,604

Table 5

The estimated cost, tariff and balance in the scenario where all regional R3s are done at the high-volume centre, based on a total of 122 operations.

Hypothetic 2: Taking all regional R3s, local R1s and R2s only – fixed caseload. Estimated cost, tariff and balance				
	Number	Cost	Tariff	Balance
R1	49	£374,679	£486,893	-£112,214
R2	46	£407,651	£705,336	-£297,685
R3	27	£307,880	£482,145	-£174,265
Total	122			-£584,164

Table 6

The estimated cost, tariff and balance in the scenario where all regional R2s are done at the high volume centre, based on a total of 122 operations.

Hypothetical 3: Taking all regional R2s, local R1s and R3s only –fixed caseload. Estimated cost, tariff and balance				
	Number	Cost	Tariff	Balance
R1	28	£214,102	£278,224	-£64,122
R2	76	£673,510	£1,165,338	-£491,828
R3	18	£205,254	£321,430	-£116,177
Total	122			-£672,127

estimated loss for the year was -£709,604; this represented an additional loss of £162,917. In the second scenario we considered all of the regional R3s being carried out at the high-volume centre in place of a corresponding number of R1s, keeping local R2s and R1s (Table 5). This scenario was associated with an estimated loss of £584,164; and a further loss of £41,477. In the third scenario we considered all regional R2s being carried out at the high-volume centre in place of a corresponding number of R1, keeping local R1s and R3s (Table 6). This scenario was associated with an estimated total loss of £672,127; again, representing a further loss of £125,440.

5. Discussion

This study has demonstrated that revision surgery is expensive, and that as it stands with current tariff payment arrangements revision KR centres are likely to run at significant loss. This cost is likely to be intimately related to the complexity of the procedures being carried out with higher complexity cases yielding greater financial deficits. It was observed in this study that it is the regional volume of R2s that contributes the most to the total financial deficit. This will be due in part to the volume itself but also due to the cost of delivering a R2 revision procedure. Many of these procedures will be for infection; the treatment of which can be prolonged and costly. These procedures can also involve the use of stemmed or linked components which are generally highly modular and as such, highly expensive.

An aim of GIRFT has been to create networks within which complex caseload could be shared while keeping costs and complication rates low. Through the estimation of local high-volume centre cost within three hypothetical scenarios, it has been demonstrated that any increase in complex caseload is associated with an additional cost burden. Corresponding savings are likely to be made throughout the region, but without greater financial provision to high-volume centres, delivering a greater volume of complex service may not be sustainable. If the aims of GIRFT are to be met, it is likely that a top-up payment for regional high-volume centres from NHS England will be required. A top-up payment for regional high-volume centres has been suggested. At the point where revision units generate HRG codes related to care episodes where revision KR takes place, an additional payment could be delivered to high-volume centres. The extent of this top-up payment could be complexity dependent with the revision level (R1, R2 or R3) from the RKCC as the proposed metric.

An additional aim of GIRFT was to reduce reliance on loan kit due to the increased industry costs associated with using components that are not routinely available, as opposed to “off the shelf” implants and systems that have been through tight procurement and contracting arrangements. Unfortunately it was not possible to look in detail at the regional loan kit financial particulars in this study. Specific arrangements between certain revision centres and industry for the provision of loan-kit meant that the assumption that loan kit costs between centres was equivalent was untenable. As such, loan kit cases were not considered separately. The authors have previously reported however that in our region, over a two year period, a greater proportion of loan kit use took place at lower volume revision KR centres (Figure 1) [2]. It is likely therefore that applying mean data from the high-volume centre may have underestimated the regional deficit due to the greater reliance on loan kit elsewhere in the region.

An acknowledged limitation of this study is the generalisability of the data from the regional high-volume centre to the region as a whole. It is likely that aside from loan-kit use the operational costs of revision KR service delivery are comparable across the region. Regional case-load was derived from the collation of RKCC checklists from local and regional MDTs. It is an assumption that this is well representative of the true regional case-load and it has been demonstrated previously that this data is faithful to that of the National Joint Registry [2]. While limitations remain, it is important to point out that this study

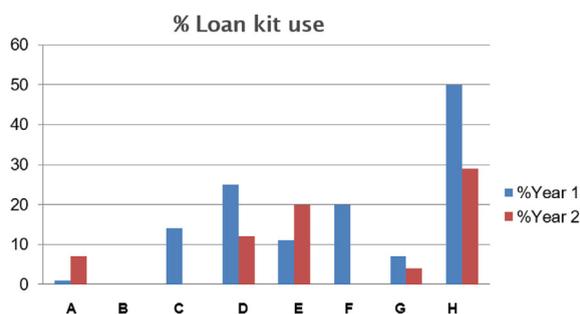


Figure 1. % loan kit use as a proportion of total yearly caseload in 8 regional revision KR centres (A-H). The high-volume regional centre is designated centre A [2].

was an exercise in estimating the regional deficit or providing a revision KR service, and also giving consideration to what might happen financially was the regional high-volume centre to increase caseload or case-mix.

If the aims of GIRFT are to be pursued and a potential NHS wide cost saving on revision KR procedures is to be achieved, then it is appropriate that based on the results of this study that a complexity related top-up payment should be provided to revision KR centres. It is difficult to see how the reported estimated financial deficit could be overcome by improved operational efficiency alone and any desire to move more complex work to single centres must be met by an appropriate financial arrangement so that these centres do not absorb the full increased financial burden. It may be the case that financial incentivisation will need to be in place to encourage ongoing service delivery within a network. This would allow the aims of the GIRFT project to be met while reducing the current significant financial deficit associated with delivering revision KR services.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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