Cost analysis of the surgical treatment of fractures of the proximal humerus

AN EVALUATION OF THE DETERMINANTS OF COST AND COMPARISON OF THE INSTITUTIONAL COST OF TREATMENT WITH THE NATIONAL TARIFF

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Aims
The aims of this study were to estimate the cost of surgical treatment of fractures of the proximal humerus using a micro-costing methodology, contrast this cost with the national reimbursement tariff and establish the major determinants of cost.

Methods
A detailed inpatient treatment pathway was constructed using semi-structured interviews with 32 members of hospital staff. Its content validity was established through a Delphi panel evaluation. Costs were calculated using time-driven activity-based costing (TDABC) and sensitivity analysis was performed to evaluate the determinants of cost

Results
The mean cost of the different surgical treatments was estimated to be £3282. Although this represented a profit of £1138 against the national tariff, hemiarthroplasty as a treatment choice resulted in a net loss of £952. Choice of implant and theatre staffing were the largest cost drivers. Operating theatre delays of more than one hour resulted in a loss of income

Discussion
Our findings indicate that the national tariff does not accurately represent the cost of treatment for this condition. Effective use of the operating theatre and implant discounting are likely to be more effective cost containment approaches than control of bed-day costs.

Take home message: This cost analysis of fractures of the proximal humerus reinforces the limitations of the national tariff within the English National Health Service, and underlines the importance of effective use of the operating theatre, as well as appropriate implant procurement where controlling costs of treatment is concerned.

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In health economic research, value from the perspective of a service provider is often defined as the health-related outcome achieved per monetary unit spent.[1,2] The importance of value in health care is underlined by on-going fiscal austerity measures, the burden of an ageing population and the increasing cost of emerging technologies, all of which continue to challenge the financial viability of healthcare services. The need to deliver cost effective treatments is well recognised across all medical specialties and has resulted in a surge in health economic research within trauma and orthopaedic surgery.[3,4] In the United Kingdom, where musculoskeletal disease accounts for approximately 10% of all National Health Service (NHS) costs, particular attention has been paid to the analysis of factors that increase cost and how to reduce it in orthopaedic surgery.[5] Furthermore, recent orthopaedic research has considered the financial burden of performing operations with insufficient reimbursement from the government.[6,7]

The methodologies used for investigating cost can be broadly categorised as:

- top-down costing, where average *per diem* departmental or disease specific costs are estimated, based on overall spending and;
- bottom-up micro costing, where each resource required for treatment is analysed and used to generate an estimate of cost.[8]

The latter, although time consuming and often costly, is considered to be a more systematic and transparent approach to establish the actual costs of treatment, and to scrutinise the determinants of cost.[8] Unfortunately, estimates of the costs of treatment often rely on less accurate top-down costing methods, or pre-determined and poorly described hospital charges that lack the detail required in order to understand how value can be added to a particular treatment.[9] Patient-level costing approaches are thought to be superior, and tools such as a Patient Level Information Costing System (PLICS)[10] are emerging. PLICSs are used in the English NHS, but they have yet to be validated, which is a limitation to their application to tariff benchmarking or for use in economic evaluation. Time-driven activity-based costing (TDABC) is a methodology that is commonly used to perform bottom-up micro costing.[11] It involves a systematic analysis of every step in the patient's pathway and estimates the costs of activities based on their unit cost, as well as the time required to perform the service in question. As research continues to highlight how other methodologies fail to provide relevant or accurate information for costing health services, there has been an increase in the use of TDABC.[12]

Although much of the focus on the management of fractures in older patients focuses on fractures of the hip, fractures of the proximal humerus account for approximately 10% of all those in patients aged > 65 years.[13] The recent publication of the Proximal Fracture of the Humerus: Evaluation by Randomisation (ProFHER) trial[14] suggests that surgical treatment may not improve the long-term functional outcomes. However, future research evaluating specific forms of treatment based on the particular configuration of the fracture, and a more homogenous cohort of patients, may offer more clinical applicability.[15] Published research that evaluates the cost of surgical treatment of fractures of the proximal humerus is limited. In the United States, a recent study showed how surgeons who performed more of these procedures incurred less overall cost per case for their hospitals.[16] This analysis used Nationwide inpatient sample costing values, which are derived from United States hospital accounting data. The methodology used to determine these costs is lacking within the medical literature, but it is known to exclude the cost of the clinician.[17] An in-depth micro-costing analysis is required to provide accurate estimates of the costs of treatment, demonstrate what the major determinants of cost are, and allow clinicians and policy makers to review whether further reduction in costs is possible.

The primary objective of this study was to estimate the inpatient cost of the surgical treatment of fractures of the proximal humerus by performing a comprehensive micro-costing analysis using TDABC. The secondary objectives were to determine the institutional financial surplus or loss associated with the treatment options reimbursed by the national tariff, and to establish what the major determinants of cost in the treatment pathway were.

Materials and Methods

This study was performed at a London teaching hospital, and therefore the perspective adopted was that of an English NHS acute hospital. In England, there is a purchaser-provider split, where health services are commissioned by Clinical Commissioning Groups (CCGs). These groups procure services, including trauma care, which is delivered by NHS hospitals whose organisational structure and governance is independent of the CCGs. The reimbursement to a hospital for specific treatments is based on tariffs that have been calculated from national estimates of costs, which are submitted annually by all hospitals in England to the Department of Health. Individual tariffs are known as Healthcare Resource Groups (HRGs). These are often a case mix of similar procedures, rather than one specific procedure.

The steps used were based on the principles outlined by Kaplan for performing TDABC,[11] and incorporate recognised methods for mapping clinical pathways.[18] A summary of the methodology is provided in Figure 1. The patient population and definition of the injury which was used are shown in Table I.

A preliminary meeting of three orthopaedic surgeons (SS, AR, PR) was used to generate an initial patient pathway, or Care Delivery Value Chain (CDVC) as a means of identifying possible major steps within the pathway as well as the stakeholders for each step. For instance, in the case of a patient presenting to the emergency department (ED) with a fracture of the proximal humerus, the stakeholders involved in this single step of the CDVC would be the receptionist, the triage nurse, an ED doctor, an ED nurse and a radiographer. The departmental manager was also defined as a stakeholder because of their role in overseeing the process.

Semi-structured interviews were then conducted with all the stakeholders. Staff members were asked to review the preliminary CDVC and to comment on the overall pathway or individual components and whether these were likely to represent a typical pathway at our institution. Members of staff were asked about their individual role, the time they were likely to spend performing these activities based on a minimum and maximum range, and any consumables or drugs they would use. Time ranges were based on differences in the frailty of the patient and the experience of the member of staff. After reviewing the responses, the CDVC was refined to include the opinions of the stakeholders in the pathway.

Content validity of the CDVC was established using a Delphi-technique. The CDVC was converted into a 65-step questionnaire linked to a five-point Likert-scale.[19] Respondents were asked to rate how much they agreed with each step and to provide comments that rationalised their opinions. The Delphi panel included five orthopaedic consultants, two senior orthopaedic trainees, two anaesthetic consultants, two nurses working in management positions and two upper limb physiotherapists. Our study protocol defined a consensus as being achieved when nine of the 13 panellists (69%) agreed with a step. This was based on existing Delphi-based research defining a consensus as 60% to 67% agreement by respondents,[20,21] as well as an awareness by

Table I. Case scenario used to define the medical condition and patient population. Barthel score fully detailed for staff during interview process. The inpatient length of stay is based on mean length of stay for patients with a fracture of the proximal humerus at our institution

Patient age	70
Injury	Comminuted proximal humerus fracture
Medical comorbidities (ASA grade)	Mild systematic disease (ASA grade 2)
Level of mobility	Independently mobile
Barthel score before admission	20
Social status	Lives in own house with wife
Expected length of hospital stay	3 nights

ASA, American Society of Anesthesiologists

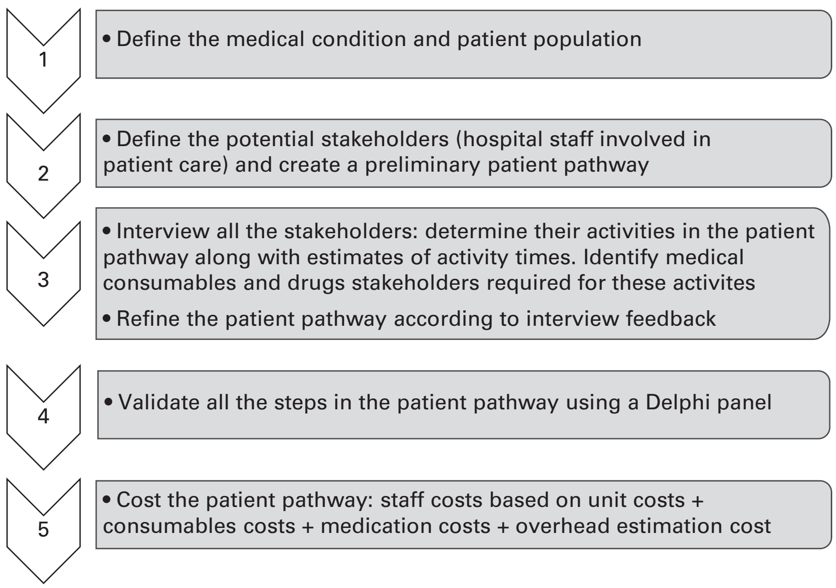

Fig. 1

Outline of processes involved in performing a time-driven activity-based costing analysis in this study.

the authors that certain members of the panel may be neutral regarding aspects of the pathway in which they are not involved. When consensus was not achieved for a particular step, it was modified according to the reviewers' comments, and in the next round of the Delphi-panel assessments the questionnaire would describe how these revisions had been made. The Delphi-process was ended after a consensus had been reached for all 65 steps.

Staff costs were calculated using wage information acquired from the NHS pay scale[22] (2014 costs). For all staff in the pathway, a minimum, a mean and a maximum salary were estimated based on intensity banding, seniority banding, point level on the pay scale and clinical excellence points achievable in the case of consultants. Further adjustment was made based on national insurance, pensionable income and London weighting.

All medical consumables, including prostheses and medications were assigned unit costs at the discounted prices charged to the institution by suppliers (2014 prices). The costs of laboratory investigations were calculated at predefined institutional estimates based on the staff costs, as well as the equipment and reagent costs of each test. The costs of imaging, including the cost of radiographers and radiologists, were estimated based on the time spent performing or reporting each procedure. Estimates of overhead costs were generated from the accounts of the estates and facilities department that oversees the non-clinical costs within the hospital. These costs were compared with the hospital's general ledger. At our institution, these account for approximately 26% of the overall financial expenditure, and this proportion represents 35% of the direct costs of care. Therefore, after the TDABC estimates of the cost of treatment were obtained, these values were increased by 35% to account for overhead expenditure within the inpatient treatment pathway.

The ranges of expected activity times, as well as the different costs for individuals within the pathway resulted in a minimum, mean and maximum possible estimate of the

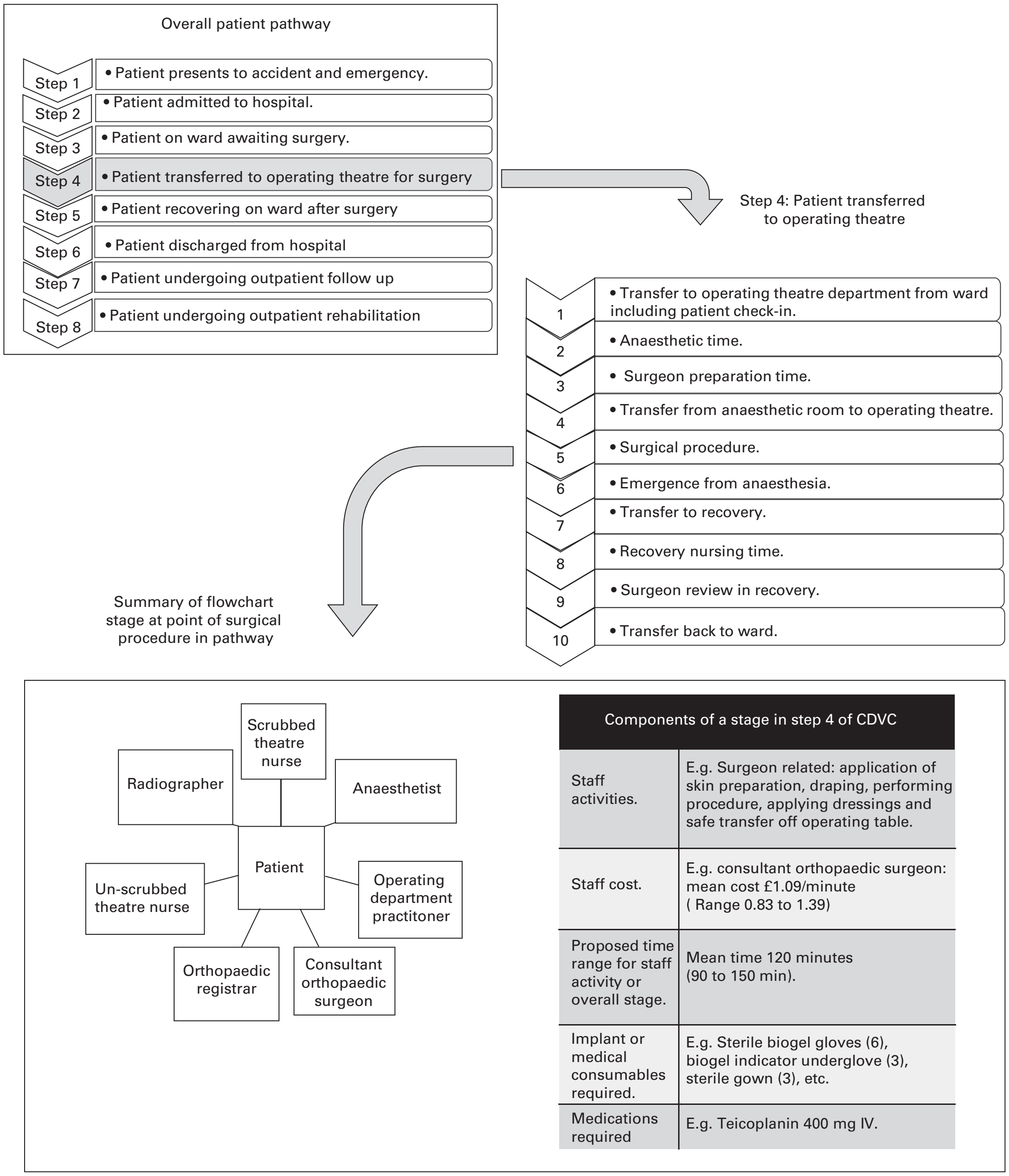

Fig. 2

Diagram showing how costing was performed for each of the different steps that made up the entire Care Delivery Value Chain.

cost of treatment. The individual costs of the prostheses for the different procedures performed were then applied to the costing methodology to produce a range for the estimate of costs for the different operations. An overall estimate of costs was calculated as the mean value of these procedures and compared with the overall reimbursement tariff.

Statistical analysis. The major determinants of cost within the pathway were presented using descriptive analysis. One-way sensitivity analysis using a 20% change for each parameter was used in order to scrutinise the determinants of cost further. Threshold analysis was performed using the overall reimbursement tariff to evaluate how delays in the operating theatre would affect surplus. Descriptive statistical analysis was performed using SPSS v21 (IBM Corp., Armonk, New York).

Results

The initial CDVC consisted of ten major steps and 26 stakeholders. After the interviews of the members of staff, this was refined to eight major steps and 32 stakeholders.

Table II. Examples of how activity cost was estimated within the care delivery value chain. Also included within the analysis were a minimum and maximum capacity cost for staff based on possible variations in earnings, a minimum and maximum activity range based on expected variations in activity times and a minimum and maximum overall activity cost

Staff member	Mean capacity-cost rate (£/min)	Activity	Mean time required to perform activity (mins)	Mean cost of activity (£)
Consultant orthopaedic surgeon	1.09	Performing surgical procedure including skin preparation, draping, surgery and safe transfer to bed	120	130.8
Consultant anaesthetist	1.09	Preparation and performing anaesthetic procedure	30	32.7
Orthopaedic SHO	0.34	Completing electronic discharge summary	12.5	4.25
Ward nurse	0.28	Nursing ward round patient review	7.5	2.1
Casualty department radiographer	0.31	Positioning patient, performing and uploading x-ray	15	5.38
Porter	0.16	Transfer of patient from casualty to ward	15	2.4

Table III. Mean costs for all three procedures based on variations in staff capacity-cost rates and proposed activity times

Cost group	Minimum (£)	Maximum (£)	Mean (£)
Accident and emergency staff cost	39.49	91.88	62.35
Accident and emergency consumables	48.37	48.37	48.37
Accident and emergency medications	0.20	0.20	0.20
Wards and radiology staff cost	119.21	338.87	230.32
Wards and radiology consumables	34.63	34.63	34.63
Wards and radiology drugs	21.70	21.70	21.70
Theatre staff cost	371.01	1026.12	649.69
Theatre consumables and implant	1350.74	1350.74	1350.74
Theatre drugs	33.72	33.72	33.72
Overall direct cost	2019.07	2946.23	2,431.72
Corporate overheads (35 % of direct costs)	706.67	1031.18	851.10
Total cost of treatment	2725.74	3977.41	3282.82

The updated CDVC was then evaluated by a Delphi-panel and there was a 100% rate of response for both rounds of the process. In the first round, there was a consensus on 45 (69.2%) steps of the summarised pathway. Amendments were made in accordance with opinions provided by responders and after a second round, a consensus was achieved on all the steps of the pathway.

A total of 130 activities were included in the final CDVC (Fig. 2) which was adapted to the three main types of surgery performed for comminuted fractures of the proximal humerus: open reduction and plate fixation, hemiarthroplasty and soft-tissue reconstruction with a tubular plate. The mean number of consumables was 109 (100 to 118), the number of drugs required was 159 and cost per unit of time was determined for 25 different types of staff (Table II).

The overall inpatient cost of surgical treatment based on the mean values of the different forms of treatment was £3282.82 (Table III). Implant and theatre consumables together formed the largest determinant of cost at £1350.74, which was 41.15% of the overall cost (Table III). Staffing theatres also represented a large determinant of cost, estimated at £649.69, representing 19.79% of the overall cost. The cost of ward and radiology department staff (doctors, nurses, allied health professionals and wider healthcare staff), ward consumables and drugs was £286.65, which was only 8.73% of the overall cost of treatment. Overheads were estimated to be £851.10 based on a pre-determined estimate of overhead costing valued at 35% of the overall costs of treatment. A mean bed-day during the inpatient period was valued at £128.40. This estimate was derived from the total healthcare staffing costs for ward-level activities within our CDVC, and all medication and consumable costs incurred on the ward were included. We then added an overhead estimate to this cost using our defined method for calculating the overhead costs, which would account for non-clinical ward costs such as electricity, water and capital costs. The mean operating theatre cost was £2746.10 based on theatre staffing, prostheses, consumables, medications and an estimate of overhead costs. There was a large variation in the costs of the different procedures (Table IV), and this resulted in subgroup costs based on the type of procedure ranging from £2055.50 for a soft-tissue reconstruction, to £4679.31 for a hemiarthroplasty (Fig. 3).

With reference to the 2013 to 2014 payment by results tariffs,[23] the overall reimbursement for the inpatient care of those with a fracture of the proximal humerus was £4421.70 (Table V). This represented a mean surplus for inpatient care of £1138.88. The most profitable margin was £2923.27 for a minimum TDABC estimate when

Table IV. Procurement costs specific to implants required for three different procedures. Implant trays are owned by the hospital and represent a capital investment. Sterilisation costs were included for each tray in the overall theatre consumable cost calculations (£80 per instrument tray)

	Cost	Units	Total cost
Plating procedure			
Plate	£532.08	1	£532.08
3.5 mm locking screw	£43.42	6	£260.52
3.5 mm cortical screw	£11.91	4	£47.64
Overall cost			£840.24
Soft-tissue reconstruction			
Third tubular plate	£25.00	1	£25.00
3.5 mm cortical screw	£11.91	2	£23.82
5.0 Ethibond	£3.26	2	£6.52
18 G blunt needle	£1.10	1	£1.10
Overall cost			£56.44
Hemiarthroplasty			
Implant head	£450.00	1	£450.00
Implant stem	£1375.00	1	£1375.00
Cement	£50.00	1	£50.00
Cement mixer	£45.00	1	£45.00
Overall cost			£1920.00

Table V. Calculation of institutional reimbursement based on 2013/2014 payment by result tariffs. Market force factors are valued at 1.2417

Reimbursement type	HRG code	HRG name	Tariff adjusted for institutional market force factors (£)
Accident and emergency episode	VB08Z	Category 2 treatment and category 1 investigation	136.59
Orthopaedic admission and surgical treatment	HA61C	Major shoulder and upper limb for trauma without complication or comorbidity	4285.11
Overall reimbursement for admission and treatment			4421.70

HRG, Healthcare Resource Group

performing a soft-tissue reconstruction procedure. In the case of a maximum TDABC estimate applied to performing a hemiarthroplasty, there was a net loss of £952.20.

Overall sensitivity analysis revealed that implants and theatre consumables represented the determinant of cost with the biggest effect on estimates of the overall cost (Fig. 4). Sensitivity analysis applied to staff costing revealed that variations in consultant time were the most sensitive determinant of staffing costs within the CDVC (Fig. 5). Threshold analysis of the effects of delays to the operating theatre on overall cost revealed that after a 60-minute delay, the hospital would start to incur a net loss on treatment based on mean estimates taken across the three types of surgical procedure performed (Fig. 6). This analysis was based on the assumption that a delay had occurred that prevented the anaesthetic from commencing, and all members of the operating department team were redundant during that time. After the capacity cost of all the redundant staff members and the overhead estimates were calculated, an additional opportunity cost of £15/min was included, based on existing NHS health economic research on theatre efficiency.[24]

Discussion

To the best of our knowledge, this is the first study to use TDABC methodology for the analysis of cost in orthopaedic trauma. The overall inpatient cost for surgical treatment of a fracture of the proximal humerus in an elderly patient was £3282.82. When compared with the reimbursement from the national tariff, this represents a net profit of £1138.88. However, hemiarthroplasty is likely to result in an institutional loss of up to £952.20 because of substantially higher costs of the implant. The largest determinants of cost in the pathway were the cost of the implant and the theatre consumables. Theatre staff were the second largest cost and their overall cost was almost three-times the cumulative costs of staffing the rest of the inpatient pathway. Furthermore, operating theatre inefficiency, as defined as redundancy of the theatre team for over one hour, would result in a net loss to the institution. These findings may be of particular importance to NHS trusts that report financial deficits and need to find ways to achieve efficiency savings.[25]

Establishing the cost and clinical outcomes of a form of treatment are important so that clinicians, healthcare managers and policy makers can understand its value.[26] With

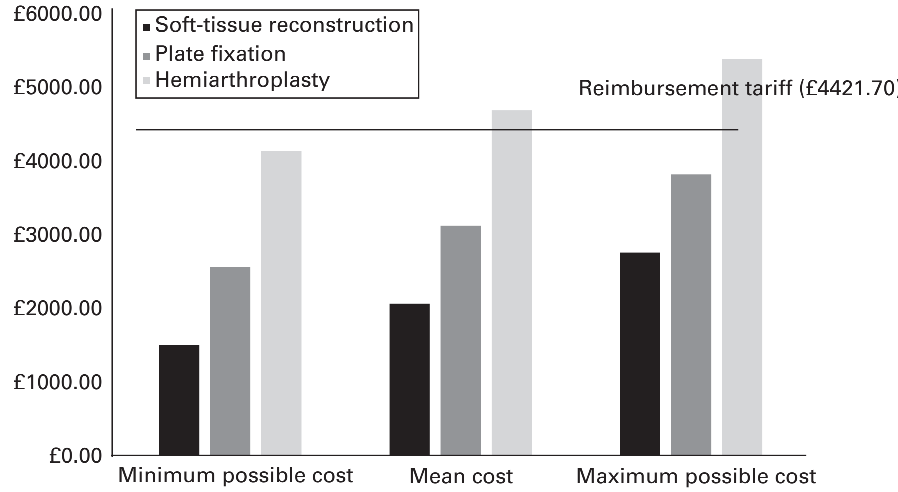

Fig. 3

Chart showing the differences in overall estimates of cost between surgical procedures based on estimates of time within the pathway.

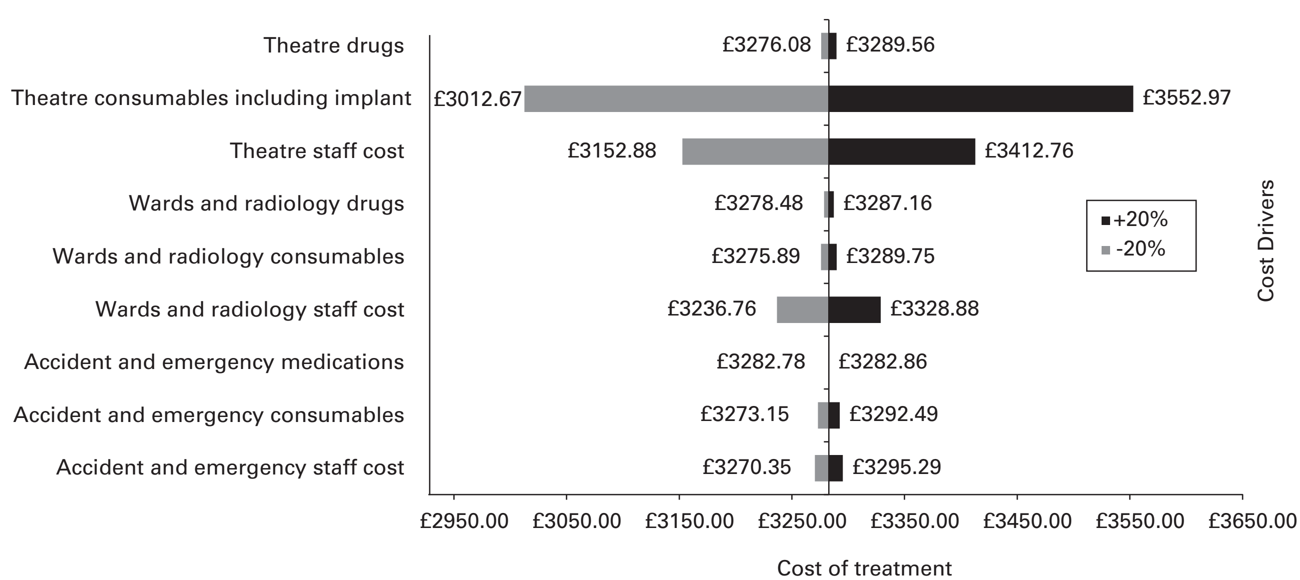

Fig. 4

One-way sensitivity analysis evaluating the effect of different cost drivers on the overall cost of treatment using a 20% change for each parameter.

much of the focus of clinical research centred on evaluating patient-reported outcomes, the standards for measuring these have become well established.[27] Unfortunately, while the cost of a treatment contributes equally to understanding its value, methods for determining these costs, particularly in health economic research within orthopaedic surgery, continue to rely on top-down estimates, or the use of national tariffs.[28,29] Top-down costing is often discouraged because it lacks the transparency or detail in order to produce accurate estimates which can be studied and used to deliver efficiency savings.[8] In the case of the national tariffs, national guidelines for performing health economic evaluations advocate their use,[30] despite research consistently showing that these surrogate estimates are inaccurate.[6,7,31] Detailed analysis of a form of treatment using TDABC not only provides a more accurate estimate of overall cost, but also an in-depth analysis of the determinants of cost along the patient pathway, and as a result, the ability to improve efficiency and enhance the use of resources.[26] Our findings show how, for this treatment pathway, redundancy within the operating theatre has important implications on the cost of treatment. Although there is a strong emphasis on control of bed-day costs to improve efficiency in the NHS,[32] within our treatment pathway, delays in the operating theatre of an hour resulted in an additional £1108.80 in costs incurred to the hospital. While a comparison with bed-day costs has some limitations, the calculated value of an additional bed day was £128.40. The difference between these two values underlines the importance of improving theatre use.

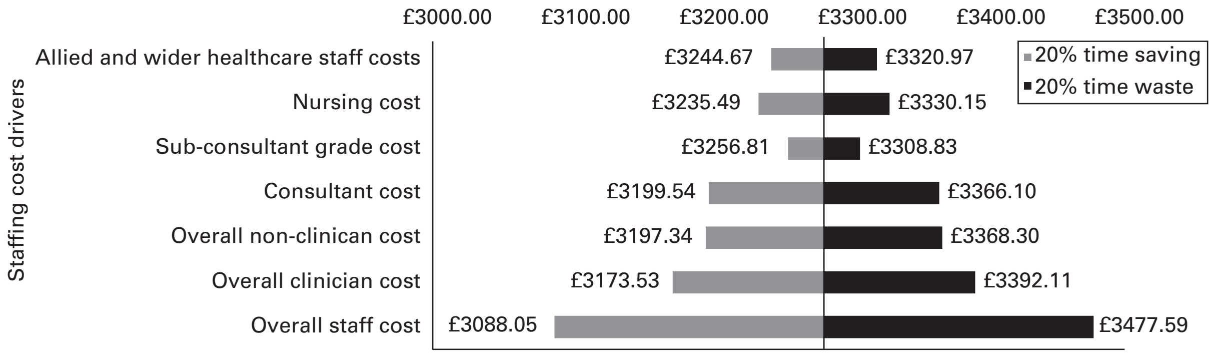

Fig. 5

One-way sensitivity evaluating 20% changes in staffing time on the overall cost of treatment.

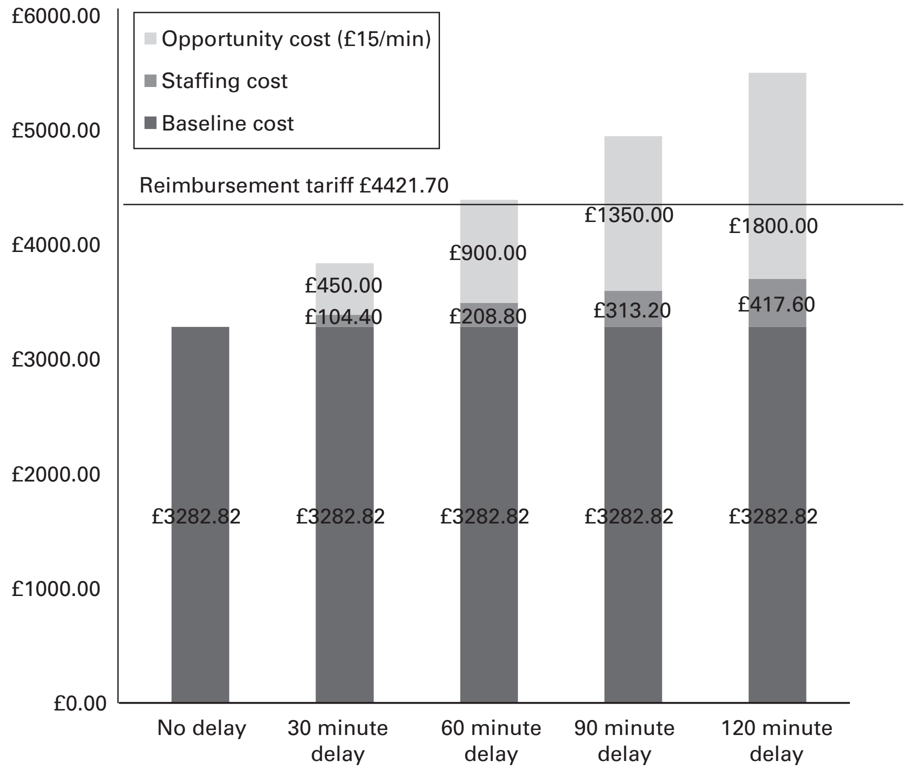

Fig. 6

Threshold analysis of the effect of theatre delays on overall cost of treatment and opportunity costs.

Lean theory and six sigma are increasingly applied to clinical pathways in surgical practice in order to deliver efficiency savings.[33] It is possible that such cost minimisation approaches applied to a CDVC such as ours, where surgical treatment can significantly improve patient outcomes,[34] would improve theatre use or implant procurement discounts to the point that the overall cost of surgery falls, and the resulting incremental cost effectiveness ratio is deemed acceptable to the health service within which the analysis is performed. In the United States, TDABC has proved to be a valuable tool for achieving efficiency savings in surgical treatment,[35] and it has also underlined the limitations of existing healthcare accounting methods.[36] In the United Kingdom, questions remain about whether the structure of the NHS would allow this tool to apply more accurate costs of treatment to tariff benchmarking. The basis of this position is that the existing purchaser-provider means that the financial interests of hospitals and commissioning groups do not have to be aligned. Institutional profitability and efficiency will not necessarily benefit CCGs unless it is financially incentivised, in the same way that improvements in their health outcomes are rewarded with ‘quality premiums’.[37] Furthermore, where future TDABC research demonstrates substantial financial losses for specific orthopaedic treatments, English Trusts may not be in the same position as hospitals in Scotland, Wales or Northern Ireland. In these countries, financial reimbursement provided by local health boards that are directly responsible for the hospital means that it should be easier to re-negotiate tariffs that TDABC research has demonstrated to be insufficient. The need for improved methods of costing and the potential limitations of their application within the NHS is particularly important at a time when it has recently been shown that approximately two thirds of English Trusts are forecasting a deficit within the next year.[38]

The overall institutional financial surplus for what is a complex upper limb procedure appears to be at odds with recent research in orthopaedics that has concluded that national reimbursement is often inadequate in orthopaedic surgery.[6,7] However, the range of treatment costs that were calculated based on acceptable variations in staff activity times and procedural choices, shows that the national tariff is inadequate for benchmarking at a patient level. As such, our findings add credence to the belief that the tariff is often an unsuitable and inaccurate method for determining the cost of health care in the United Kingdom.[6,39] Furthermore, while existing research has determined that the tariff undervalues the cost of surgical treatment, those analyses are based on joint reconstruction surgery,[6,7] where implants can be up to four times the cost of an implant which is used for osteosynthesis. Our findings support those results. Despite the average cost of treatment being relatively profitable, the cost when performing a hemiarthroplasty results in institutional loss of revenue. Although the choice of procedure may be based on the preferences or experience of the surgeon, there are clearly defined indications where hemiarthroplasty is the treatment of choice.[40] In such cases, data from recognised joint registries[41] should inform decisions on the choice of implant and institutional procurement based on single-supplier or volume-based discounting may drive prices down considerably.

Consideration must also be given to the use of reverse arthroplasty for fractures of the proximal humerus. Even though its long-term cost effectiveness has yet to be established, there is growing advocacy for this procedure in a trauma setting,[42] with a recent randomised trial showing improved patient outcomes for the reverse prosthesis over hemiarthroplasty.[43] We excluded this implant from our analysis because at the time of our study, on the basis of surgeon preference within our institution, reverse shoulder arthroplasty was not performed for fractures of the proximal humerus. Should our current practice change, we are likely to incur substantial financial losses because the procurement cost for a reverse arthroplasty at our hospital is approximately £1000 more than that of a hemiarthroplasty. The higher cost of this implant is also likely to have financial implications for other orthopaedic departments in the NHS where reverse arthroplasty is currently performed for some patients with a fracture of the proximal humerus. The potential for such losses raises more questions on the suitability of a national tariff system in adapting to, and financially supporting, evolving surgical practice.

There are four main limitations to our study. First, the overall costing model is specific to our institution and therefore the estimates of costs derived from our methodology lack external validity. As such, it would be inappropriate to generalise these results for the purpose of research into cost effectiveness performed at other institutions in the United Kingdom or abroad. This highlights the complexity of determining costs for health economic research, especially if costs are derived from a single institution. In the future, national health economic research will continue to be based on tariff costs unless more robust systems are developed. Emerging costing tools such as PLICSs may be the solution once validated. Secondly, this study was not conducted as a prospective observational TDABC analysis. Although such a perspective would have been useful in the analysis of the use of resources and staff efficiency, prospectively accounting for every inpatient minute for a large group of trauma patients would require significant financial and staff resources. Thirdly, our calculations of cost may be conservative given the hypothetical type of patient used to characterise the care pathway adopted in the study. This is more likely to be the case for physically frail patients. The implications of increasing medical complexity and comorbidities are beyond the scope of this study. The financial impact of treating more complex patients warrants further investigation because, although it might appear intuitive that the treatment costs are higher, illness-specific HRG codes should provide increased reimbursement for patients with concomitant medical conditions. Furthermore, reimbursement for patients with increased comorbidities undergoing surgery will be higher, based on a separate HRG code for upper limb trauma that takes into account comorbidities. On the basis of these additional reimbursements, it is feasible that patients with substantial comorbidities who are treated with a hemiarthroplasty might attract a reimbursement that is surplus to treatment costs. Finally, the assumptions for overhead costs were based on overall financial ledger estimates. Although such assumptions are generally excluded from TDABC methodology, these costs comprise a substantial proportion of expenditure and we believe that their exclusion would significantly underestimate the overall costs. Unfortunately, other comprehensive micro-costing approaches that account for them at a patient level are lacking, and therefore less rigorous methods were adopted to generate these estimates.

In conclusion, our findings suggest that the national reimbursement tariff does not accurately represent the breadth of different surgical treatments which are available for this condition. Furthermore, this study has shown that effective use of the operating department, appropriate implant procurement and staff efficiency are likely to be more important for cost containment than control of bed-day costs.

Author contributions:
S. Sabharwal: Data collection, analysis and writing up of paper.
A. W. Carter: Study design, data analysis, health policy input and editing the manuscript.
A. Rashid: Data collection, data analysis and editing the manuscript.
A. Darzi: Study design, health policy input and editing the manuscript.
P. Reilly: Study design, data analysis, and editing the manuscript.
C. M. Gupte: Study design, data analysis, editing the manuscript, final approval of paper.

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