Appendix D: Financial analysis[1]

This appendix describes the financial model used to value potential productivity improvements in elective care pathways identified in this study and presents the model's outputs.

The financial model

We built a provider cost model for six elective procedures in ophthalmology and orthopaedics that together represent the range of outpatient, day case and inpatient elective procedures. The six procedures are:

- outpatient procedures: (1) injections for wet age-related macular degeneration (AMD)
- day case procedures: (2) cataract surgery
- simple inpatient procedures: (3) total knee replacements and (4) total hip replacements
- complex inpatient procedures: (5) revisions to total knee replacements and (6) revisions to total hip replacements.

The model was used to analyse costs for six steps in the clinical pathway for each procedure: (1) outpatients, (2) preassessment, (3) preoperative inpatient stay, (4) theatre, (5) postoperative inpatient stay and (6) readmission.

We calculated the value of potentially achievable improvements in national productivity across the range of elective procedures in five stages.

1. Identify variations in the efficiency of practices between UK sites or between UK and international sites
From looking at data from the UK and international sites studied, we identified where there were variations in efficiency at each step in the pathway: the number or duration of patient contacts, staff costs and overhead costs.

Where we found large variations in these three sources of efficiency, we calculated the potential for improving national productivity from the 'current state' (see stage 2) to an achievable improved 'future state' (see stage 3) by:
- reducing the number or duration of patient contacts (eg by increasing number of cases per four-hour theatre list, by reducing number of follow-up outpatient appointments)
- reducing staff cost per contact (eg by decreasing the number of staff, skill mix or grade of staff per activity)
- reducing overhead cost per contact (eg by increasing theatre opening hours).

[1] This financial analysis was externally commissioned by Monitor.

The financial model (continued)

2. Calculate the 'current' state of productivity at each step in the pathway for each procedure

Current national productivity at each step in the pathway was determined either from national data where these were available (eg data on length of stay) or if not, from the average practice at our co-development sites (eg number of cases per theatre list, number and type of staff in the theatre team). Information on practice at our co-development sites was collected through a data request to each site; this was supplemented with a follow-up interview.

3. Define the potential 'future' state of productivity at each step in the pathway for each procedure

The scale of potential 'future' productivity was debated with clinical sponsors, clinicians and managers at specialty-specific workshops. The variability in key sources of efficiency between UK sites and UK and international sites was presented, followed by discussion of what could feasibly be implemented across England. These discussions formed the basis of the assumptions we used to calculate the value of improving productivity to an implementable 'future level'. This is not the same as 'best' or highest observed practice. For example, some sites were able to deliver 12 to 15 cataract procedures per four-hour theatre session, but the consensus was that eight procedures per four-hour theatre session was a more appropriate measure of good practice, taking into account the typical casemix of routine and complex cases, and training versus non-training lists. This is the 'future level' that we used in this analysis. At this stage, any co-dependent elements of the 'future level' were identified and their analyses linked, eg increasing throughput per theatre list for cataract surgery requires a higher staff cost per list.

4. Calculate the potential national gain in productivity from moving to the 'future state' for each procedure

For each step in the pathway for each procedure, we calculated the difference in cost between 'current state' and 'future state' where there were variations in key sources of efficiency (eg number of patient contacts). The values for all the cost differences at each step were summed to give an overall value for the potential improvement in efficiency per individual procedure. By dividing the sum of all efficiency improvements by the reference cost for a procedure, we arrived at a percentage expressing the potential national productivity gain from achieving the 'future state' across the NHS for that procedure.

5. Calculate the potential national productivity gain across elective care

The potential national gain from improving productivity to the 'future state' across elective care as a whole was determined by applying the potential gain calculated at the procedure level for each of the two specialities analysed to the value of activity within that type of elective care activity nationally (eg outpatient procedure, day case, inpatient procedure).

We recognise the limitations of extrapolating our findings to the national level and acknowledge the need for further research to understand how far the findings of this study can be generalised to other specialties and procedures. We hope our findings encourage trusts and professional bodies to undertake the research for more specialties.

Simplifying assumptions used in the financial model

Every model describes a simplified view of the world. The key simplifying assumptions within this model and their likely impact on the calculation are:

The 'current state' of practice is equal to the average of our co-development sites where national data are not available. National data were not available for most of the calculations in the outpatients and theatre steps of the pathways examined. We assumed our small sample of co-development sites (five in orthopaedics, six in ophthalmology) were indicative of the average for the NHS. These sites were chosen because they provide high quality care and the vast majority were in good financial health. Therefore, the average of their practice may well be higher than the NHS average and this simplifying assumption could **understate** the productivity potential in elective care.

The productivity potential observed in our six representative procedures is likely to be present in other elective care procedures. Each elective procedure is substantially different from all other elective procedures. Despite these differences, the potential productivity gain calculated for the six procedures we modelled fell consistently between 13% and 20%. However, the main driver of productivity was very different for each procedure. For example, in cataract surgery, increasing throughput per theatre list is a big driver of productivity, but it is not in total knee and hip replacements. Given the relative consistency in the potential percentage productivity gain identified across procedures despite the difference in their drivers of productivity, it is reasonable to assume that equivalent productivity potential is likely in other elective procedures. This can only be verified by further modelling.

Semi-variable costs are incurred on a marginal rather than a step cost basis. Semi-variable costs are incurred by providers as step costs. For example, providers can't reduce the cost of a single staff member by 10% as staff costs can often only be reduced 100% of a full-time equivalent member of staff (FTE) at a time. An individual trusts' step costs can only be understood by looking at staff members' job plans and potential for part-time work. This was beyond the remit of this financial model, which consequently treated semi-variable costs as behaving like variable costs. Therefore, depending on individual trusts' cost structures, some of the potential productivity gains calculated using this model will not translate into immediate cost reduction. However, they will still enable trusts to absorb growth in elective surgical volumes at minimal cost improvement.

Outputs from the financial model

1. Ophthalmology calculations:

- cataract surgery
- injections for age-related macular degeneration (AMD)

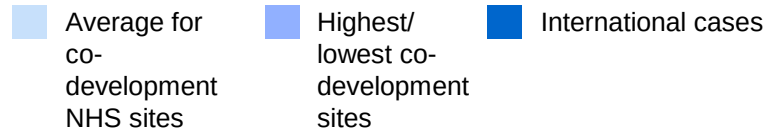
Ophthalmology: Cataract and AMD surgery – we identified opportunities for efficiency by comparing data from UK and international sites (1/2)

Element of the pathway	Operational improvement	Potential source of efficiency	Was variability identified across co-development providers and international sites? ✗ Limited variability ✓ Substantial variability	
First specialist input	1 Stratification of patients by risk and alignment of resources to risk	**Preadmission assessment**		
		• Number or duration of patient contacts:		
		○ decreased number of preassessment appointments per procedure	✗	
		○ increased throughput per pre-assessment clinic	✗	
		• Decreased staff costs per patient contact	✗	
		• Decreased overhead cost per patient contact	✗	
Outpatient preop and postop care	2 Streamlined diagnostics, outpatients and preassessment 9 Follow-up of outpatients aligned to risk profile of patient	**Outpatients**		
		• Number or duration of patient contacts:		
		○ decreased number of new outpatient appointments in patients undergoing bilateral cataracts	✓	
		○ decreased number of follow-up outpatient appointments per procedure	✓	
		○ increased throughput per outpatient clinic	✓	
		• Decreased staff costs per patient contact	✗	Cataracts
			✓	AMD
		• Decreased overhead cost per patient contact	✗	

Ophthalmology: Cataracts and AMD surgery – we identified opportunities for efficiency by comparing data from UK and international sites (2/2)

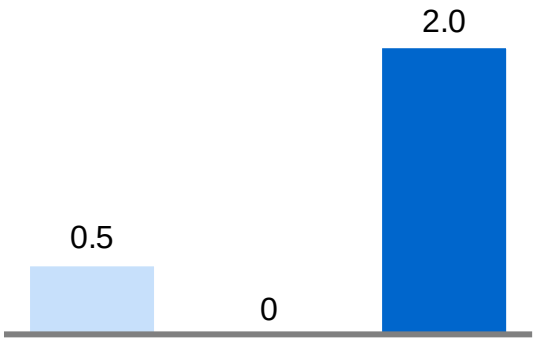
Element of the pathway	Operational improvement	Potential source of efficiency	Was variability identified across co-development providers and international sites? ✗ Limited variability ✓ Substantial variability	
Inpatient preop care	3 Day of surgery admission	**Preoperative stay** • Duration of patient contact: ○ decreased preoperative length of stay	✗	Nationally, 98% of cataracts are day case procedures
		• Decreased staff costs per patient contact	✗	
		• Decreased overhead costs per patient contact	✗	
Surgery	4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgeons incentivised to use theatres efficiently	**Theatre** • Duration of patient contact: ○ increased throughput per hour in theatre	✓ Cataracts	
		• Decreased staff costs per hour in theatre	✓ Cataracts	
		• Decreased overhead costs per hour in theatre	✓ Cataracts	
Inpatient postop care	7 Standardisation of ward care and enhanced recovery	**Postoperative stay** • Duration of patient contact: ○ decreased postoperative length of stay	✗	Not applicable to cataracts or AMD
		• Decreased staff costs per day in hospital	✗	Not applicable to cataracts or AMD
		• Decreased overhead costs per day in hospital	✗	Not applicable to cataracts or AMD

Key sources of variability: Cataracts

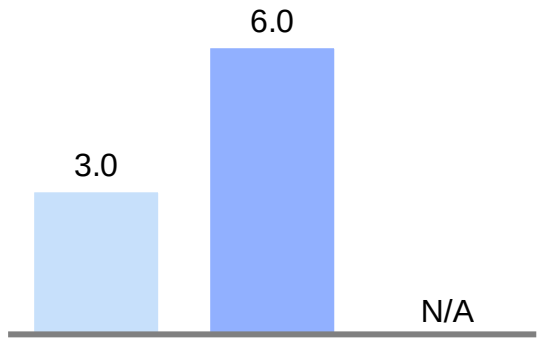


Outpatients: variability in number or duration of patient contacts

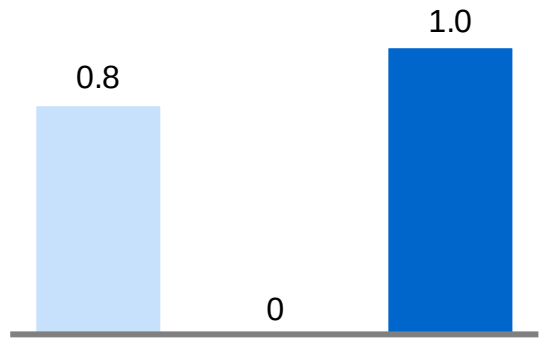
Number of follow-up appointments per procedure



Throughput per clinician per clinic hour

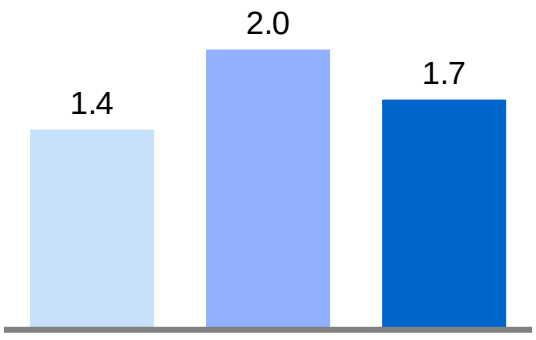


Number of new outpatient appointments in bilateral cataracts

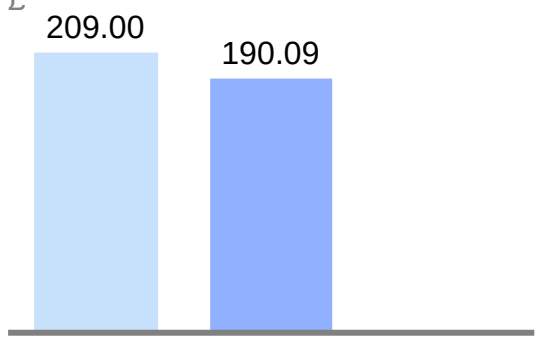


Surgery: variability in duration of patient contact, staff cost and overhead cost per case

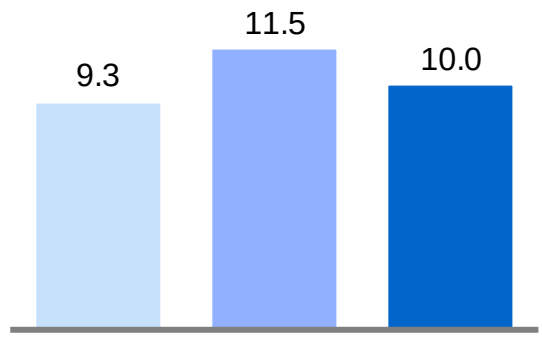
Number of procedures per hour in theatre



Total theatre staff costs per hour, £



Number of hours theatres are open per day for elective surgery



Key sources of variability: AMD

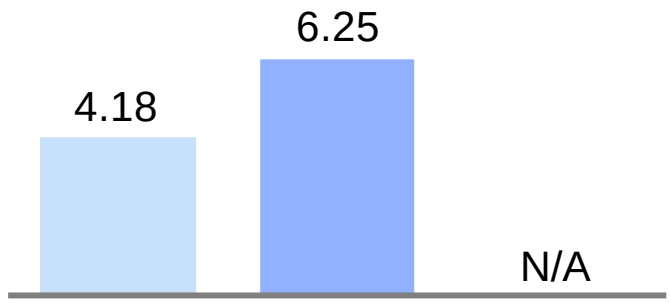
Average for co-development NHS sites

Highest/ lowest co-development sites

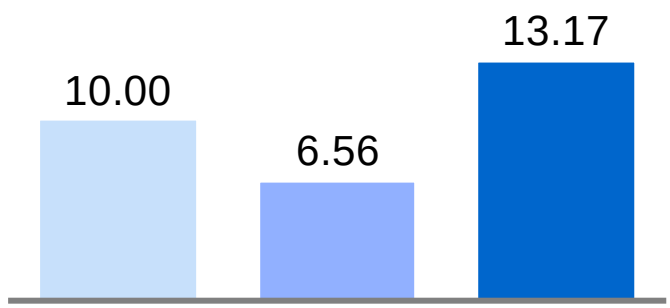
International cases

Outpatients: variability in duration of patient contact and staff cost per contact

Average number of patients per doctor/ nurse per hour of clinic



Staff costs per patient contact, £



Potential ‘future state’: Cataracts

Optimised care pathway

First specialist input	Outpatients (pre- and post-operative)	Inpatient pre-operative care	Surgery	Inpatient post-operative care
1 Stratification of patients by risk and alignment of resources to risk	2 Streamlined diagnostics, outpatients and preassessment 9 Follow-up of outpatients aligned to risk profile of patient	3 Day of surgery admission	4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgeons incentivised to use theatres efficiently	7 Standardisation of ward care and enhanced recovery 8 Low rates of infection and readmissions
Sources of efficiency				
• No variability identified	• Optometrist-led follow-up • No new patient appointment for second cataract surgery • 12 patients per clinician per clinic • Outpatient clinics open eight hours a day	• No variability identified	• Eight cataract procedures per four-hour theatre list • Theatre staffing levels similar to those units currently undertaking eight cataracts per list • Theatres open 11.5 hours a day, four days a week	• Not applicable to cataracts
Potential for efficiency across all procedures in the UK				
• £0	• £26.3 million	• £0	• £22.4 million	• £0

Total: £48.7 million

Potential ‘future state’: AMD

Optimised care pathway

First specialist input	Outpatients (pre- and post-operative)	Inpatient pre-operative care	Surgery	Inpatient post-operative care
1 Stratification of patients by risk and alignment of resources to risk	2 Streamlined diagnostics, outpatients and preassessment	3 Day of surgery admission	4 Specialisation and extended roles within team	7 Standardisation of ward care and enhanced recovery
	9 Follow-up of outpatients aligned to risk profile of patient		5 Optimised scheduling and management	8 Low rates of infection and readmissions
			6 Surgeons incentivised to use theatres efficiently	

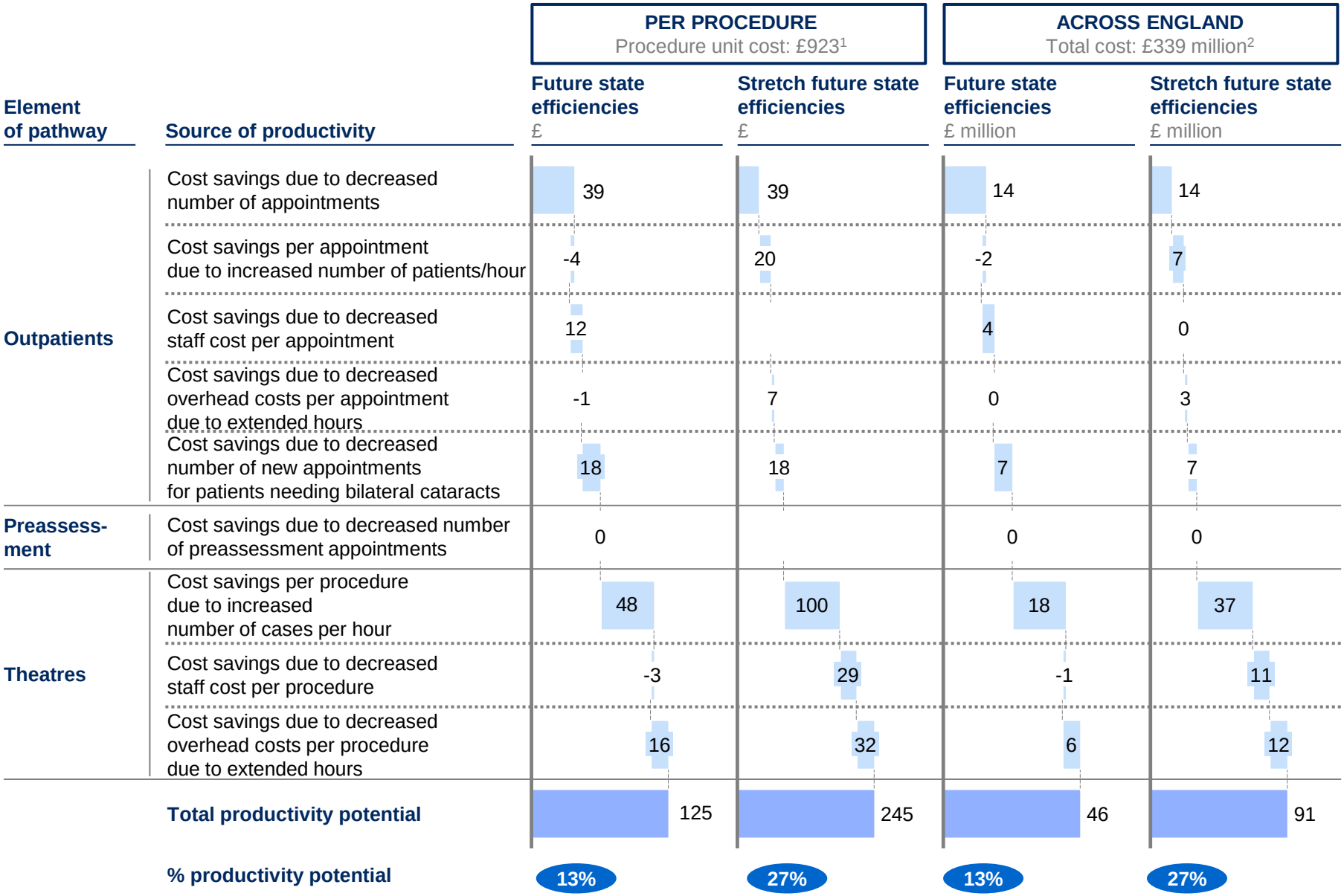
Sources of efficiency

• No variability identified	• Extended role: nurses undertake 95% of injections • Nurses inject on average 17.5 patients per four-hour clinic • Clinics are open for 10 hours per day, five days a week	• Not applicable to AMD	• Not applicable to AMD	• Not applicable to AMD

Potential for efficiency across all procedures in the UK

▪ £0	▪ £24.2 million	▪ £0	▪ £0	▪ £0	**Total: £24.2 million**

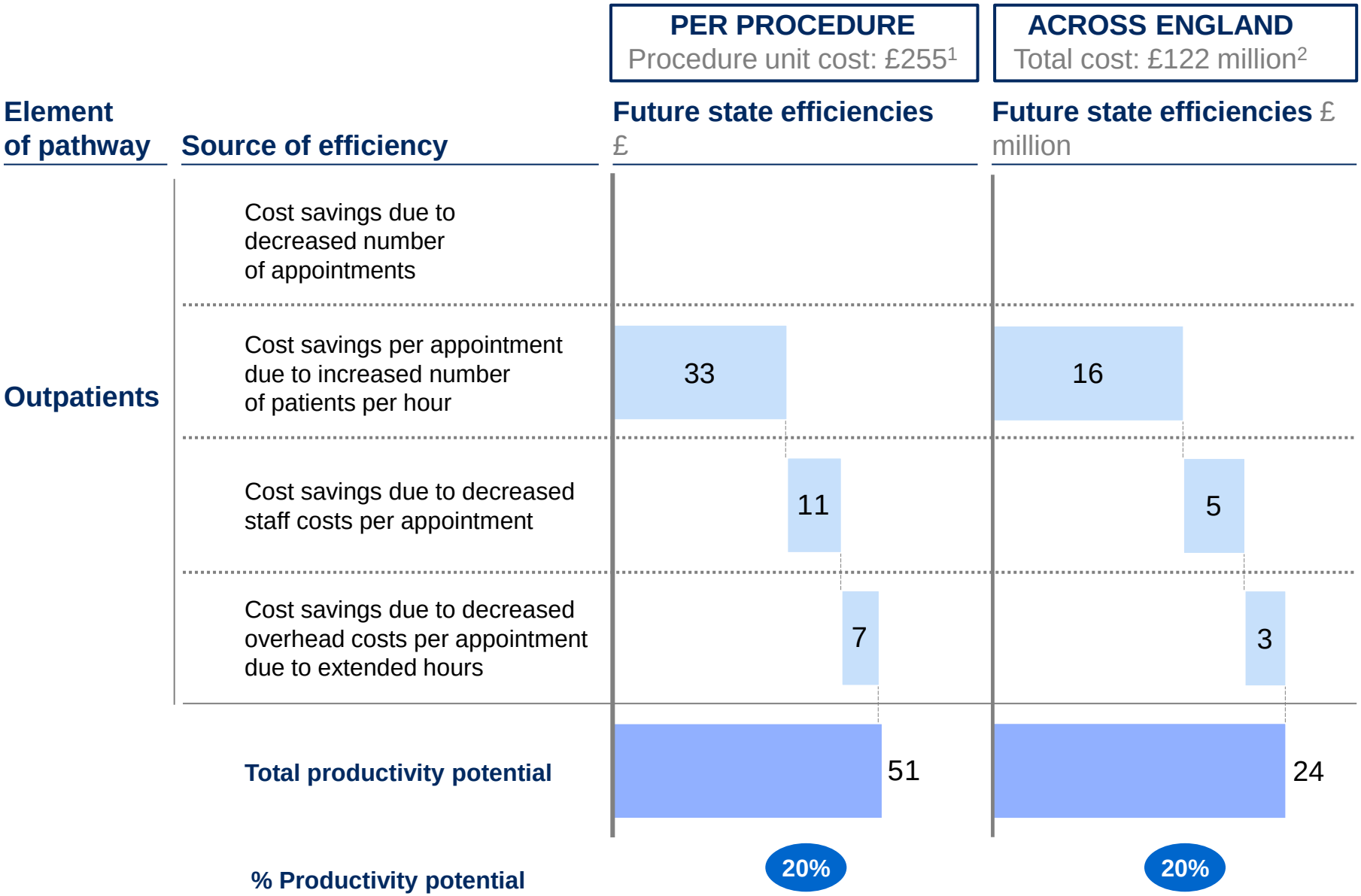
Productivity potential: Cataracts



[1] Reference cost per cataract procedure 2013/14 + average cost of follow-up appointments

[2] Total cost of cataracts in England in 2013/14 (reference cost per cataract multiplied by the number of elective cataract surgery **spells** in England in 2013/14)

Productivity potential: AMD



[1] NICE Costing Template, Technology Appraisal 294, July 2013
[2] Total cost of AMD in England in 2013/14 (estimated cost based on NICE costing template multiplied by incidence of 20,000 per year with 12 injections over five years)

Outputs from the financial model

2. Orthopaedics calculations:

- total knee replacement
- total hip replacement
- revision of total knee replacement
- revision of total hip replacement

Primary hip and knee replacements and revisions – we identified opportunities for efficiency by comparing data from UK and international sites (1/3)

Element of the pathway	Operational improvement	Potential source of efficiency	Was variability identified across co-development providers and international sites? ✗ Limited variability ✓ Substantial variability: Primary	Revisions
First specialist input	1 Stratification of patients by risk and alignment of resources to risk	**Preadmission assessment**		
		• Number or duration of patient contacts:		
		○ decreased number of preassessment appointments per procedure	✗	✗
		○ increased throughput per preassessment clinic	✗	✗
		• Decreased staff costs per patient contact	✓	✓
		• Decreased overhead costs per patient contact	✗	✗
Outpatient preop and postop care	2 Streamlined diagnostics, outpatients and preassessment 9 Follow-up of outpatients aligned to risk profile of patient	**Outpatients**		
		• Number or duration of patient contacts:		
		○ decreased number of follow-up outpatient appointments per procedure	✓	?
		○ increased throughput per outpatient clinic	✗	✗
		• Decreased staff costs per patient contact	✓	✓
		• Decreased overhead costs per patient contact	✓	✓
Inpatient preop care	3 Day of surgery admission	**Preoperative stay**		
		• Duration of patient contact:		
		○ decreased preoperative length of stay	✗	✓
		• Decreased staff costs per patient contact	✗	✗
		• Decreased overhead costs per patient contact	✗	✗

Primary knee and hip replacements – we identified opportunities for efficiency by comparing data from UK and international sites (2/3)

Element of the pathway	Operational improvement	Potential source of efficiency	Was variability identified across co-development providers and international sites? ✗ Limited variability ✓ Substantial variability: Primary	Revisions
Surgery	4 Specialisation and extended roles within team	**Theatre** • Duration of patient contact: ○ increased throughput per hour in theatre	✓	✗
	5 Optimised scheduling and management	• Decreased staff costs per hour in theatre	✓	✓
	6 Surgeons incentivised to use theatres efficiently	• Decreased overhead costs per hour in theatre	✓	✓

Primary knee and hip replacements – we identified opportunities for efficiency by comparing data from UK and international sites (3/3)

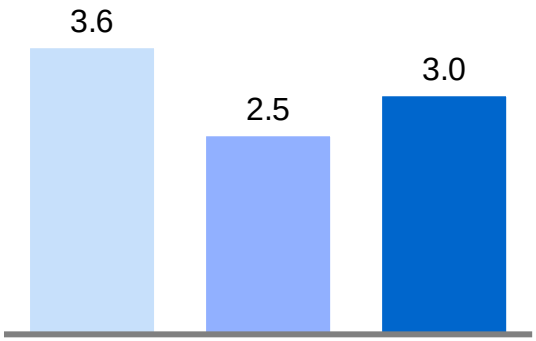
Element of the pathway	Operational improvement	Potential source of efficiency	Was variability identified across co-development providers and international sites? ✗ Limited variability ✓ Substantial variability: Primary	Revisions
In-patient postop care	7 Standardisation of ward care and enhanced recovery	**Postoperative stay**		
		• Duration of patient contact:		
		○ decreased postoperative length of stay	✓	✓
		• Decreased staff costs per day in hospital	✗	✗
		• Decreased overhead costs per day in hospital	✗	✗
Post dis-charge	8 Low rates of infection and readmission	**Readmissions**		
		• Duration of patient contact:		
		○ decreased number of readmissions	✓	?
		○ decreased postoperative length of stay	✗	✗
		• Decreased staff costs per day in hospital	✗	✗
		• Decreased overhead costs per day in hospital	✗	✗

Key sources of variability: Primary knee and hip replacements (1/2)

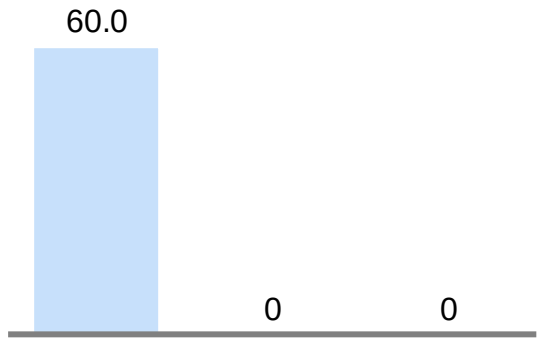
Average for co-development sites
Highest/ lowest co-development sites
International cases[1]

Outpatients and preassessment

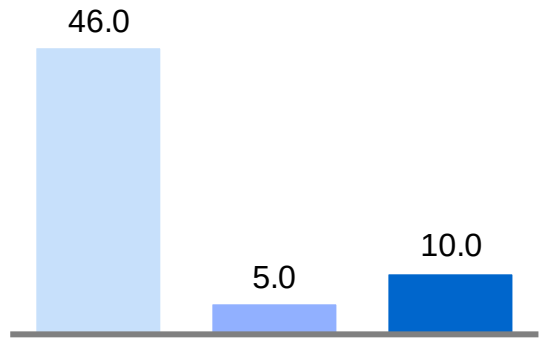
Number of follow-up appointments per procedure



% Patients seeing a consultant at follow-up appointments

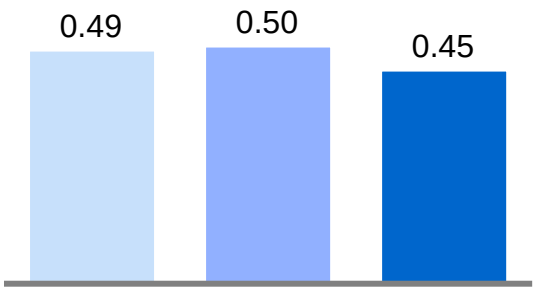


% Patients seeing an anaesthetist at preassessment appointments

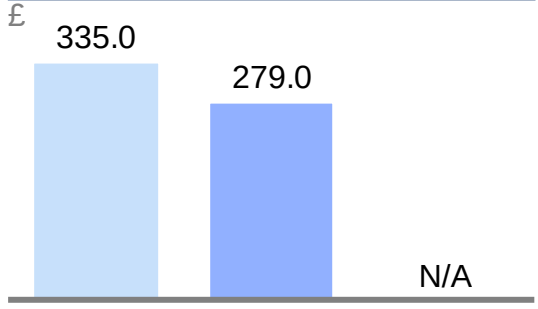


Surgery: variability in duration of patient contact, staff costs

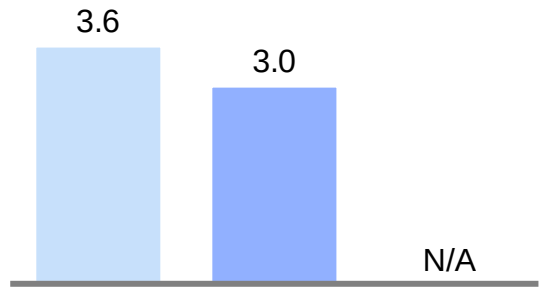
Number of procedures per hour in theatre



Total theatre staff costs per hour, £



Number of nurses per theatre list



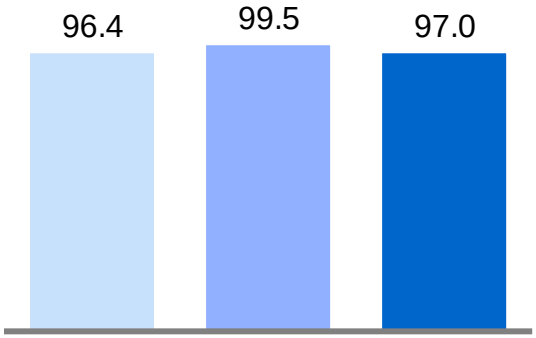
[1] International case studies include: Capio, Coxa, Emory and Alfred Health

Key sources of variability: Primary knee and hip replacements (2/2)

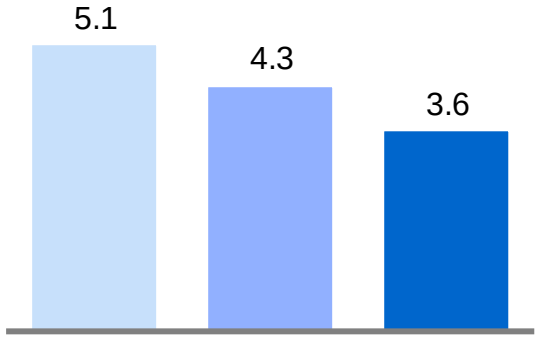
Average for co-development sites
Highest/ lowest co-development sites
International cases[1]

Inpatient pre- and post-operative care

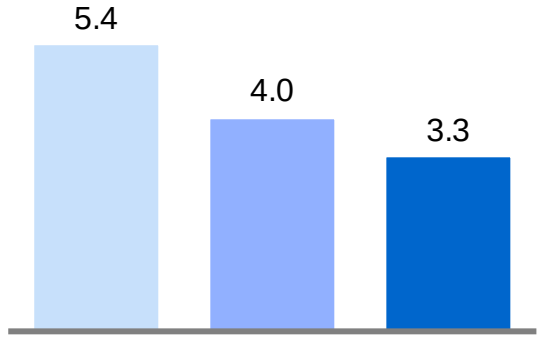
% Patients admitted on day of surgery – hips and knees



Average postop length of stay – knees, days

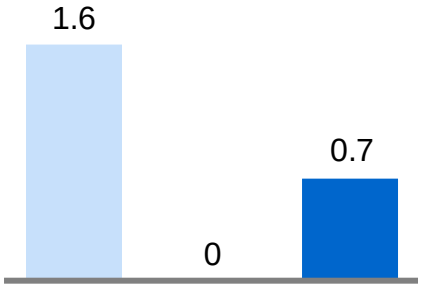


Average postop length of stay – hips, days

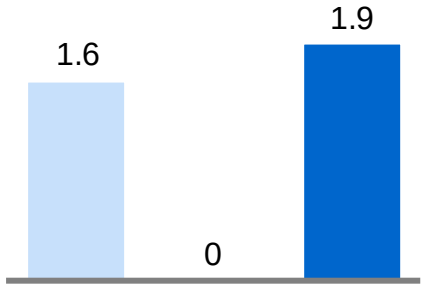


Readmissions

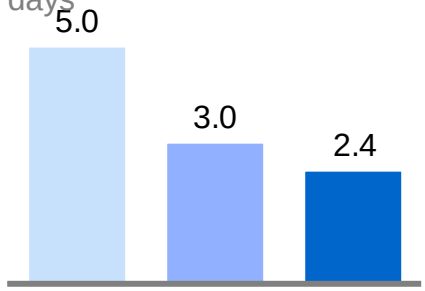
% Patients readmitted at 30 days – knees



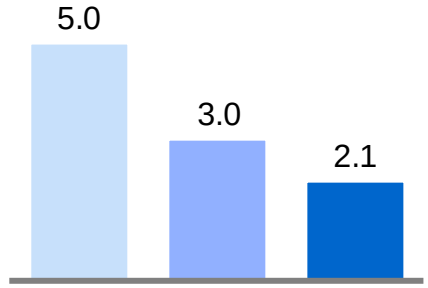
% Patients readmitted at 30 days – hips



Average length of stay readmissions – knees, days



Average length of stay readmissions – hips, days



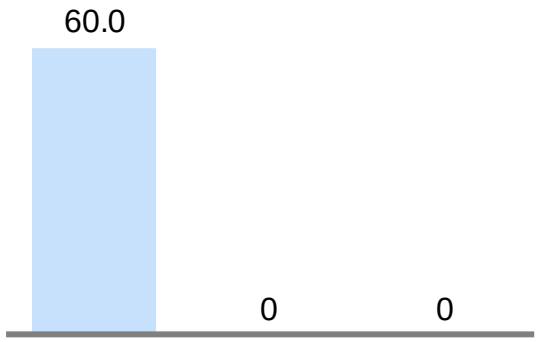
[1] International case studies include: Capio, Coxa, Emory and Alfred Health

Key sources of variability: Revisions of knee and hip replacements (1/2)

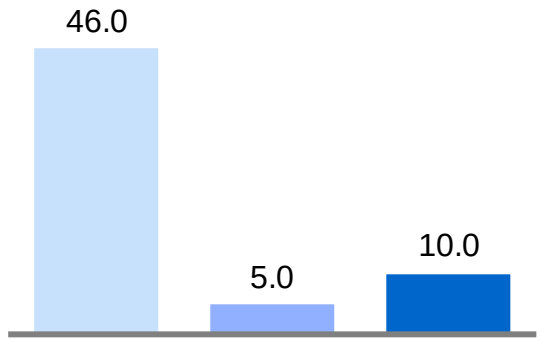
Average for co-development sites
Highest/ lowest co-development sites
International cases[1]

Outpatients and preassessment

% Patients seeing a consultant at follow-up appointments

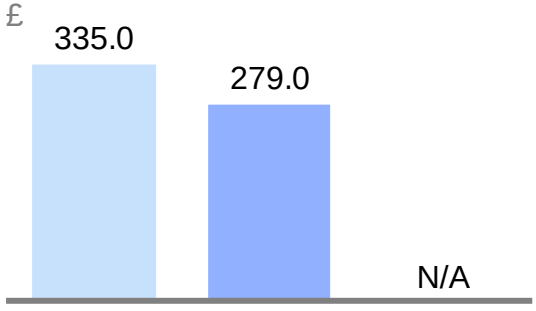


% Patients seeing an anaesthetist at preassessment appointments

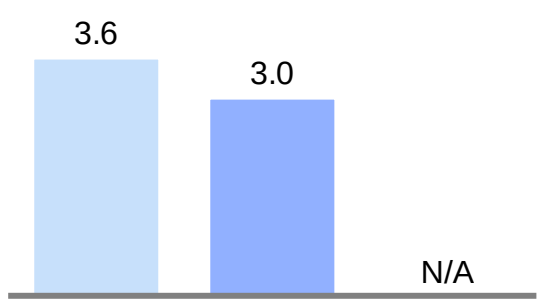


Surgery: variability in duration of patient contact, staff costs

Total theatre staff costs per hour, £



Number of nurses per theatre list



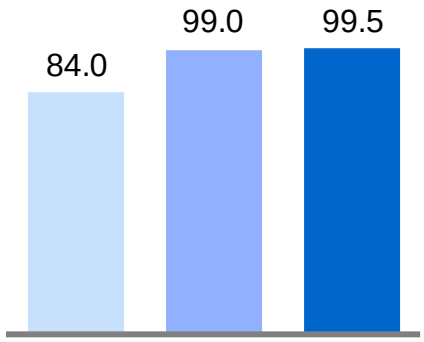
[1] International case studies include: Capio, Coxa, Emory and Alfred Health

Key sources of variability in revisions: Knee and hip replacements (2/2)

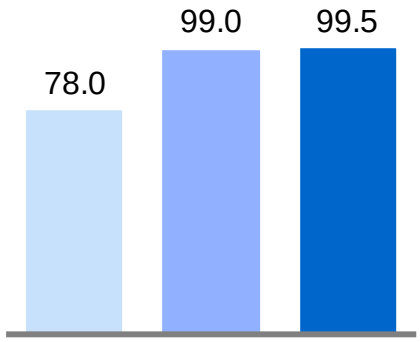
Average for co-development sites
Highest/ lowest co-development sites
International cases[1]

Inpatient pre- and post-operative care

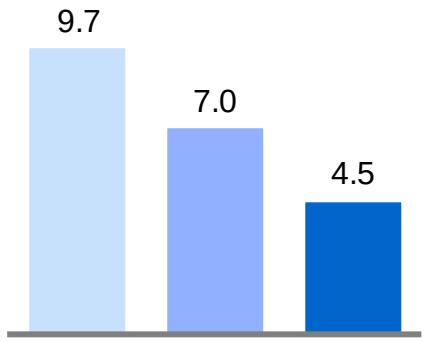
% Patients admitted on the day of surgery – knees



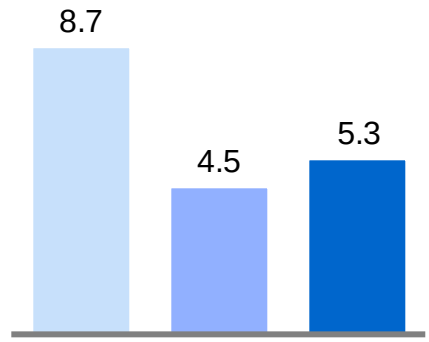
% Patients admitted on the day of surgery – hips



Average postop length of stay – knees, days

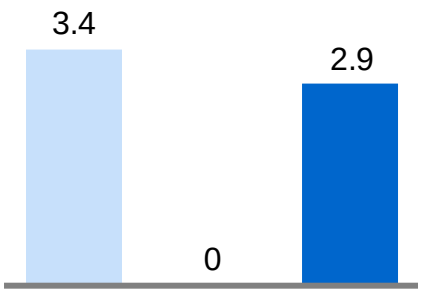


Average postop length of stay – hips, days

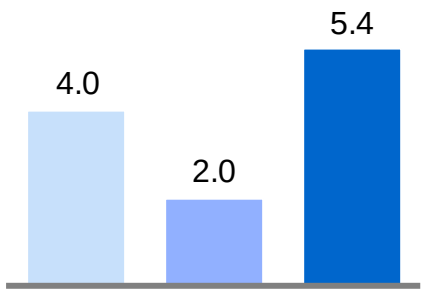


Readmissions

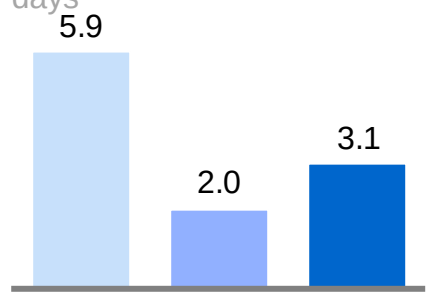
% Patients readmitted at 30 days – knees



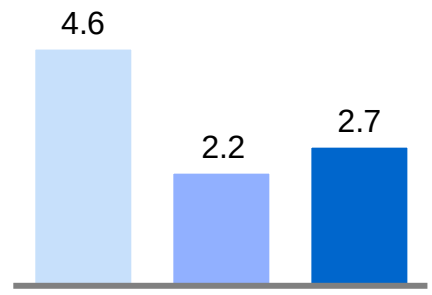
% Patients readmitted at 30 days – hips



Average length of stay readmissions – knees, days



Average length of stay readmissions – hips, days



[1] International case studies include: Capio, Coxa, Emory and Alfred Health

Potential future state: Primary knee and hip replacements

Optimised care pathway

First specialist input	Outpatients	Inpatient pre-operative care	Surgery	Inpatient post-operative care
1 Stratification of patients by risk and alignment of resources to risk	2 Streamlined diagnostics, outpatients and preassessment	3 Day of surgery admission	4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgeons incentivised to use theatres efficiently	7 Standardisation of ward care and enhanced recovery
	9 Follow-up of outpatients aligned to risk profile of patient			8 Low rates of infection and readmissions

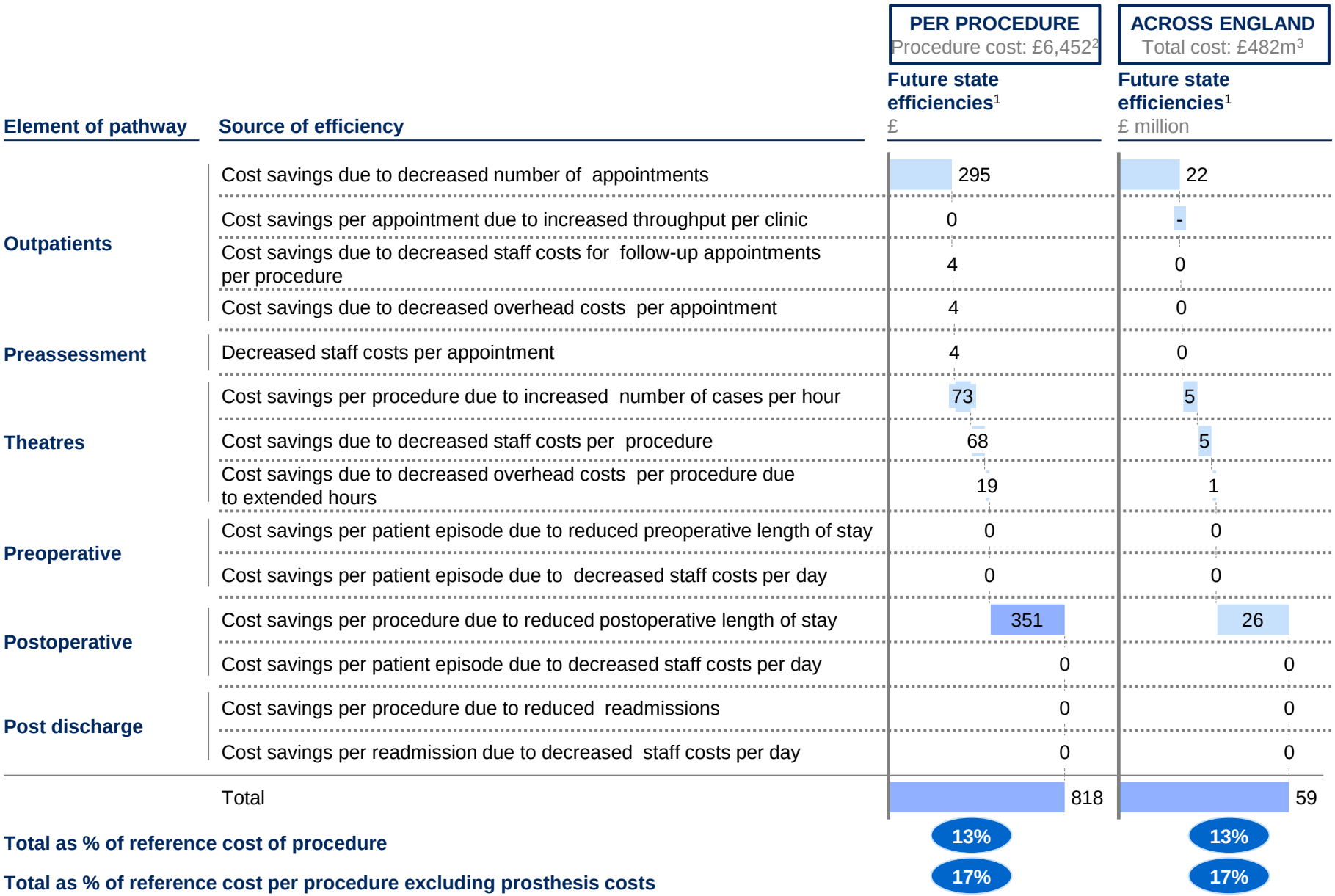
Sources of productivity

• 90% of patients undergo nurse-led preassessment, 10% anaesthetist-led pre-assessment	• Single preoperative outpatient appointment • One follow-up appointment postop • Outpatient clinics open six days a week	• No variability identified	• 20% of eight-hour lists manage five arthroplasties and 80% manage four arthroplasties • Two scrub nurses and one circulating nurse/list • Theatres open six days a week	• 50% of patients able to be discharged within three days • Reduced readmission rate to average of co-development sites, 1.6%

Potential for efficiency across all procedures in the UK

Hip	• £0.3 million	• £22.1 million	• £0	• £10.5 million	• £28.4 million	**Hip total: £61.3 million**
Knee	• £0.3 million	• £22.6 million	• £0	• £12.0 million	• £26.2 million	**Knee total: £61.1 million**

Productivity potential: Primary knee replacement

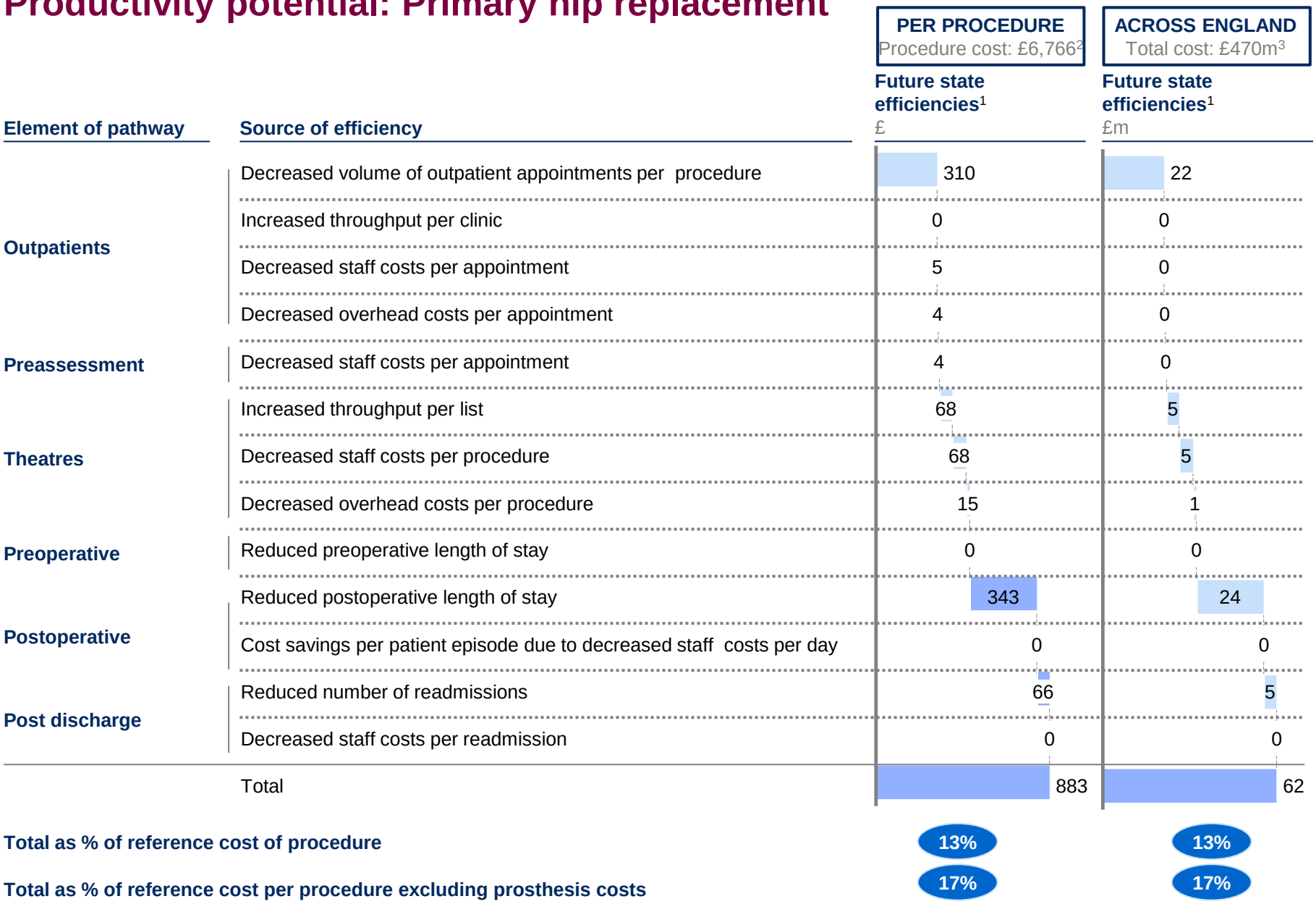


[1] 'Implementable' and 'stretch' future state scenarios were developed. However, workshop participants suggested that the 'stretch' future state could reasonably be implemented; therefore, only this scenario is presented

[2] Reference cost per primary knee replacement, 2013/14 (weighted average of HB21A, HB21B and HB21C) + 3.5 follow-up appointments

[3] Total cost of primary knee replacement in England in 2013/14 (reference cost multiplied by number of **spells** in England in 2013/14, Hospital Episode Statistics)

Productivity potential: Primary hip replacement



[1] 'Implementable' and 'stretch' future state scenarios were developed. However workshop participants suggested that the 'stretch' future state could reasonably be implemented, therefore only this scenario is presented

[2] Reference cost per primary hip replacement, 2013/14 (weighted average of HB12A, HB12B and HB12C) + 3.6 follow-up outpatient appointments

[3] Total cost of primary hip replacement in England in 2013/14 (reference cost multiplied by number of SPELLS in England in 2013/14, Hospital Episode Statistics)

Potential future state: Revision of knee and hip replacements

Optimised care pathway

First specialist input	Outpatients	Inpatient pre-operative care	Surgery	Inpatient post-operative care	Postoperative care in community
1 Stratification of patients by risk and alignment of resources to risk	2 Streamlined diagnostics, outpatients and preassessment 9 Follow-up of outpatients aligned to risk profile of patient	3 Day of surgery admission	4 Specialisation and extended roles within team 5 Optimised scheduling and management 6 Surgeons incentivised to use theatres efficiently	7 Standardisation of ward care and enhanced recovery 8 Low rates of infection and readmissions	

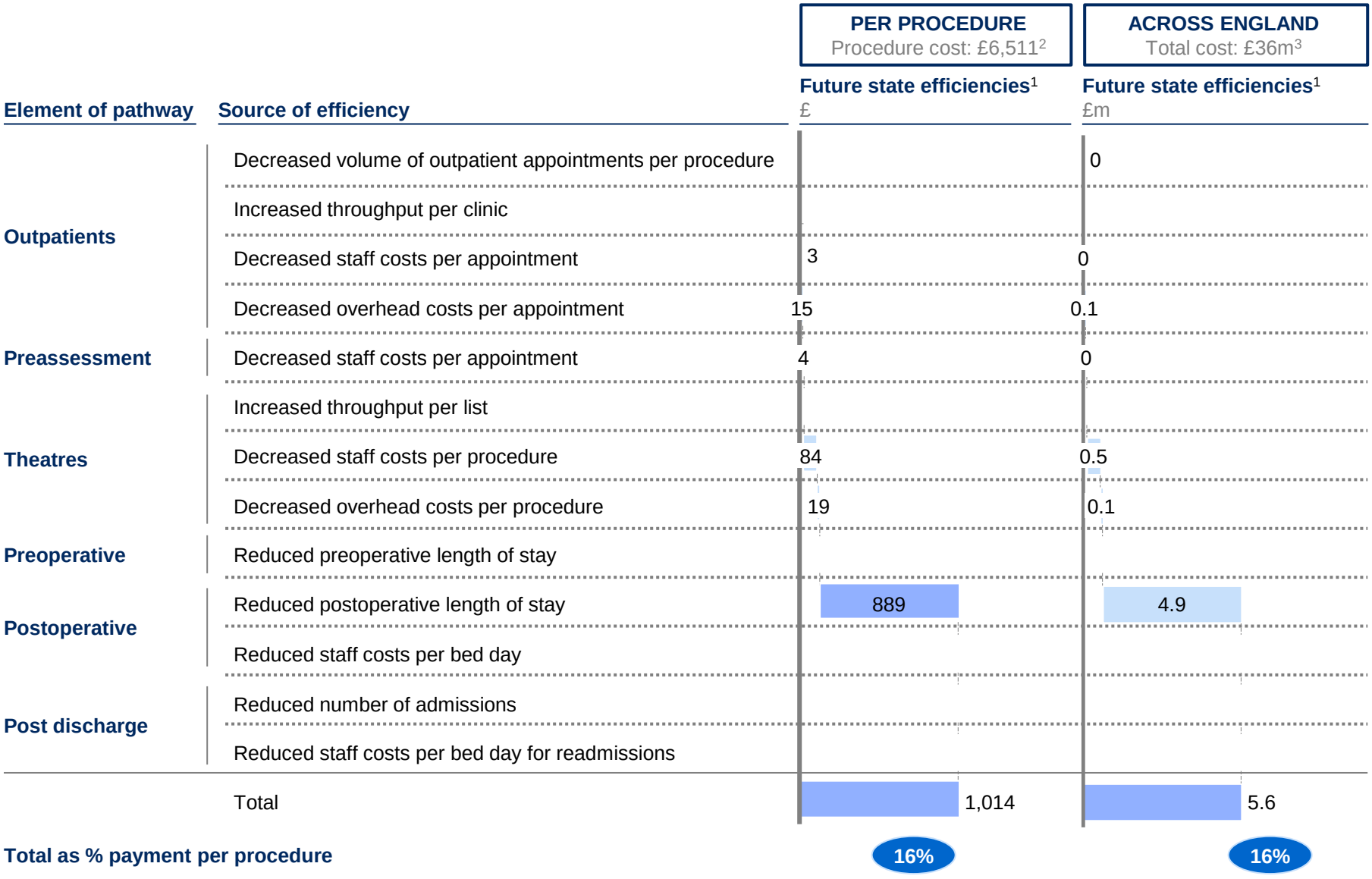
Sources of productivity

First specialist input	Outpatients	Inpatient pre-operative care	Surgery	Inpatient post-operative care
• 90% of patients undergo nurse-led preassessment, 10% anaesthetist-led pre-assessment	• 50% patients have nurse-led follow up • Outpatient clinics open six days a week	• Preop length of stay of 0.5 days	• Reduced theatre staffing costs • Theatres open six days a week	• Postop length of stay equivalent to best of UK and international sites: ○ 5.3 days for hips ○ 4.5 days for knees

Potential for efficiency across all procedures in the UK

Hip	▪ £0.02 million	▪ £0.13 million	▪ £0.7 million	▪ £0.58 million	▪ £4.56 million	**Hip total: £6.0m**
Knee	▪ £0.02 million	▪ £0.10 million	▪ £0	▪ £0.57 million	▪ £4.9 million	**Knee total: £5.6**

Productivity potential: Revision of knee replacement

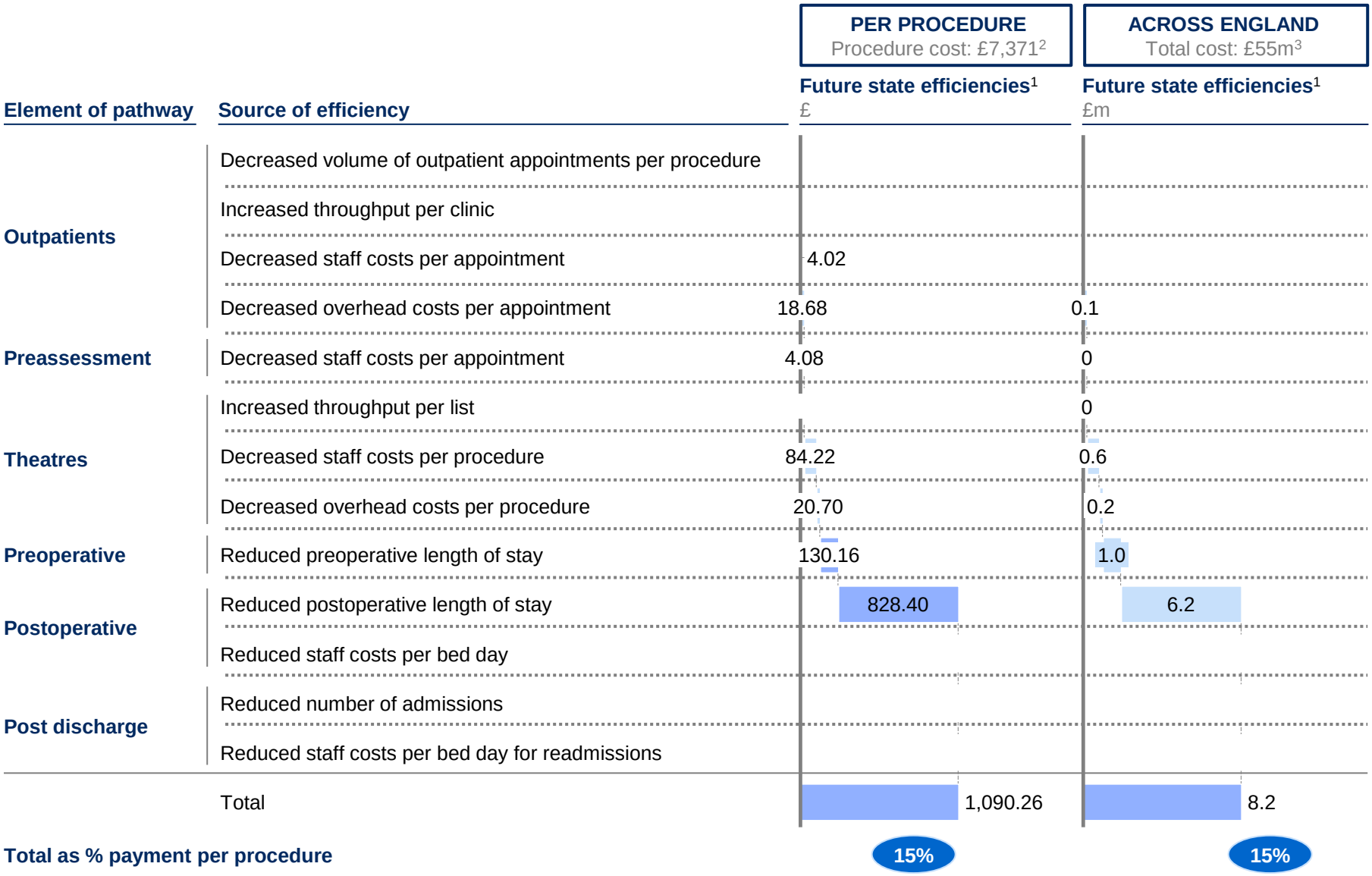


[1] 'Implementable' and 'stretch' future state scenarios were developed. However workshop participants suggested that the 'stretch' future state could reasonably be implemented, therefore only this scenario is presented

[2] Reference cost per revision of knee replacement, 2013/14 (weighted average of HB21A, HB21B and HB21C) + four follow-up appointments

[3] Total cost of revision of knee replacement in England in 2013/14 (reference cost multiplied by number of **spells** in England in 2013/14, Hospital Episode Statistics)

Productivity potential: Revision of hip replacement



[1] 'Implementable' and 'stretch' future state scenarios were developed. However workshop participants suggested that the 'stretch' future state could reasonably be implemented, therefore only this scenario is presented

[2] Reference cost per revision of hip replacement, 2013/14 (weighted average of HB11A, HB11B and HB11C) + four follow-up outpatient appointments

[3] Total cost of revision of knee replacement in England in 2013/14 (reference cost multiplied by number of **spells** in England in 2013/14, Hospital Episode Statistics)