It is commonly believed the size of a particular provider of healthcare services can make a significant difference to both the quality and the cost of those services. For example, a trust which delivered 8000 births a year might be expected to have both better quality and lower costs than a trust which delivered 3000 births a year. Similarly, it is commonly believed that a healthcare provider who delivers a range of services can deliver better quality and cost overall than if those different services had each been delivered by a different provider. The influence of size and range on the costs of providing healthcare of a given quality – known as effects of "economies of scale and scope" – are, however, not well understood.

We asked Frontier Economics, in partnership with The Boston Consulting Group, to survey the literature on this topic and to provide us with a framework for thinking about economies of scale and scope in the future. The report follows and we would very much appreciate your feedback on the findings and the proposed framework as a starting point for future work.

The issues of economies of scale and scope will be relevant to many of the decisions Monitor will make as a sector regulator. For example:

- Continuity of service: as part of the diagnosis for why a particular trust might be in difficulty and the possible implications of changes in their pattern of services; and
- Pricing: determining the appropriate structure of prices for particular services given the pattern of fixed and variable costs.

We do not underestimate the complexity of this topic, including the interactions between costs and quality, and realise that it will take time for us to understand better the nature of economies of scale and scope in our healthcare services. But we do believe that the case studies in the attached report show that much better understanding is both feasible and potentially useful. Following your feedback on the report, Monitor will be considering how best to undertake future work in this area.

Adrian Masters
Director of Strategy

How you can respond

Monitor welcomes your comments on this report. In particular, readers are asked to consider the following questions:

1. Do you think the proposed framework for measuring the extent of economies of scale and scope is robust (and why)?

2. What are you views on the initial case study evidence identified on economies of scale and scope?

3. What are the key modelling improvements that should be made when gathering evidence on economies of scale and scope?

4. Do you have any ideas on how changes in clinical quality can be measured and accounted for in future work?

5. Do you think there are any other issues, not covered by this work, which should be considered with regard to economies of scale and scope in healthcare services in the UK?

Interested parties are invited to share their views on this issue via our website.

If you do not have internet or email access please write to: Special Projects Team, Monitor, 3rd Floor, Wellington House, 133-155 Waterloo Road, London, SE1 8UG.

This document was published on Thursday 16 August 2012. Please submit your responses to the questions and any other comments that you have **by 5pm on Thursday 18 October 2012.**

Please note that we may use your details to contact you about your responses or to send you information about our future work. We do not intend to send responses to each individual respondent. However, we will analyse responses carefully and give clear feedback on our website and through other channels later in 2012.

You can sign up to receive emails when we publish information on economies of scale and scope, and on our prosed new role in general, here on our website.

A study investigating the extent to which there are economies of scale and scope in healthcare markets and how these can be measured by Monitor

Final report

August 2012

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- Introduction and context
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Executive Summary

The issue of economies of scale and scope will sit at the heart of many of Monitor's decisions as sector regulator. The extent of economies of scale and scope will be important for the:

- continuity of service regime: as part of the diagnosis for why trusts might be in distress and in the decisions around whether to provide additional funding or change existing services and their likely impact;
- pricing regime: determining the appropriate structure of prices (e.g. whether to have a fixed and a variable element) and the appropriate level of prices (e.g. how best to take any economies of scale or scope into account); and
- competition regime: what advice Monitor will give to the Office of Fair Trading around mergers and economies of scale or scope and how Monitor views complaints about procurement decisions and related issues.

The nature and extent of economies of scale and scope is also crucial to Monitor's on-going role with Foundation Trusts. In particular, it may help to understand the nature of the financial challenges facing particular trusts (e.g. Does trust size matter? Does it matter whether services are split across sites? etc.) and the impact of alternative solutions to financial distress.

Given the importance of economies of scale and scope to so much of the thinking behind each of these areas, it is perhaps surprising that so little is known about their extent and importance. A systematic literature survey as part of this study revealed very little evidence (either positive or negative) about the issue. Many of the existing studies focus on the "whole hospital" rather than particular services and even those studies are often very limited by poor data and methodologies.

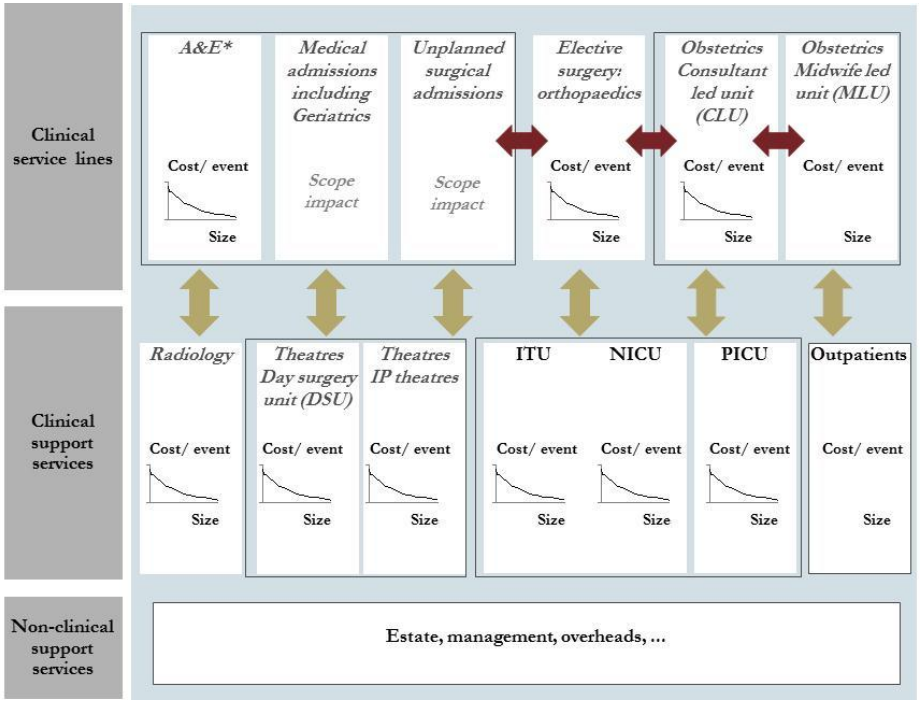
This study is an important and significant step in understanding the nature of economies of scale and scope but it is just a first step. Its most important contribution is to set out, for the first time that we are aware of, a clear framework and guide for how to investigate whether there are economies of scale or scope, and their magnitude, in a particular service for a particular trust. Alongside this framework, it also provides case studies of the nature and extent of economies of scale and scope in three particular services: A&E, obstetrics and orthopaedics. In each case, the specific modelling and resulting analysis and scale curves were primarily intended to verify the framework and ensure it could be implemented. Within the time available for this project the quantitative analysis that is shown should be regarded as a preliminary view of the nature and extent of economies of scale and scope in these areas. This preliminary view does, to the best of our knowledge, represent the most robust analysis of this issue done to-date.

Importantly, this study is focused on economies of scale and scope and not (directly) on the impact of scale and scope on clinical outcomes. We have taken extensive clinical advice on the best practice service configuration in order to then assign appropriate costs and determine issues of economic scale and scope. But, we do not directly investigate whether a particular scale is needed to deliver certain levels of clinical outcomes.

The framework and analysis presented in the report were tested repeatedly. We have tested the framework and analysis with 6 NHS trusts as well as through discussions with 9 Royal Colleges and other stakeholders and experts. Finally, we have drawn on UK independent sector and international expertise from the US in order to ensure the framework can capture alternative models of care.

The basic framework for thinking about economies of scale and scope is illustrated on the right. It is composed of three important elements:

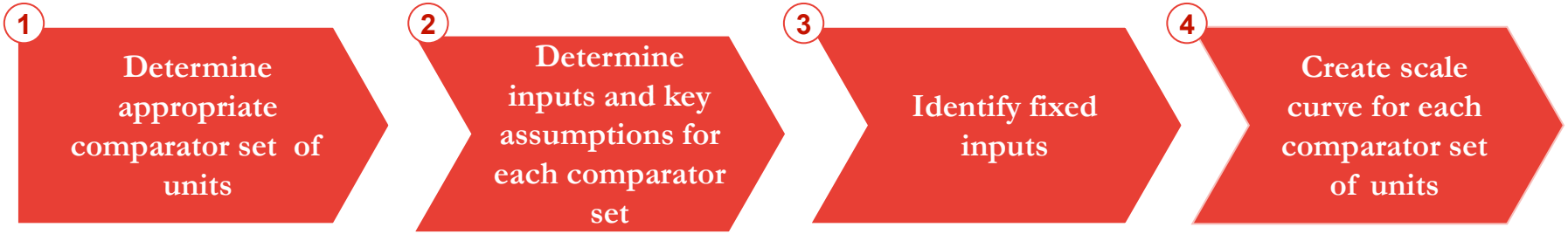
- **Scale:** the effect of volumes on cost per unit in each service (as shown by the cost curves in the diagram opposite). For example, the cost per attendance in A&E, cost per birth in Obstetrics and cost per hour of theatre time may decline as volume increases.
- **Primary scope** (shared fixed inputs between service lines): the effect of shared inputs on viability of adjacent service lines (as shown by the horizontal red arrows on the diagram opposite). For example, A&E may require support from key specialist service lines such as general surgery to be financially viable.
- **Secondary scope** (flows between service lines and shared support services with fixed inputs): the effect of volumes on viability of support services (as shown by the vertical gold arrows on the diagram opposite). For example, Obstetrics may ensure sufficient volumes in NICU to ensure financial viability



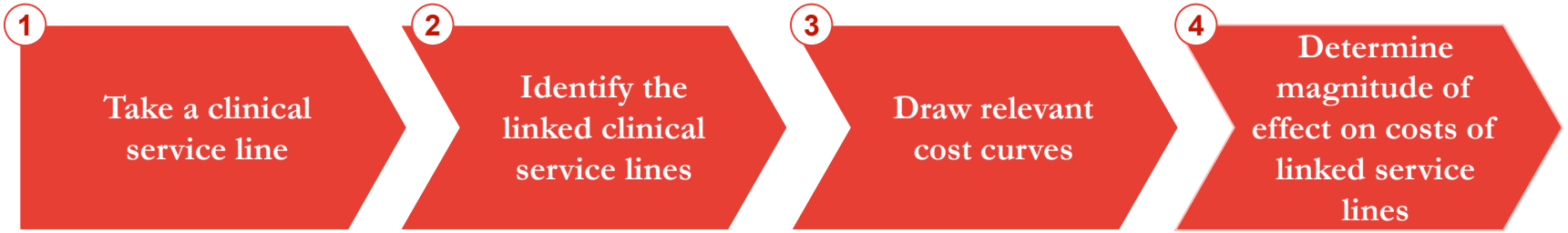
There are two further issues that are central to determining the extent of economies of scale and scope:

- **Timeframe:** in general, the longer the timeframe under consideration the more costs are variable (i.e. more can be changed) and the lower the degree of economies of scale and scope.
- **Comparator:** in general, the more flexible both the workforce and machines, equipment and buildings the lower the degree of economies of scale and scope. Depending on which comparator is used, different ways of working (e.g. variations in practice across the NHS, between the NHS and the independent sector, between England and other countries) may affect the extent to which economies of scale and scope are thought to exist.

The main report sets out four detailed steps to determine the extent of economies of scale. They are summarised below:



The main report also sets out four detailed steps to determine the extent of economies of scope, which are summarised below:

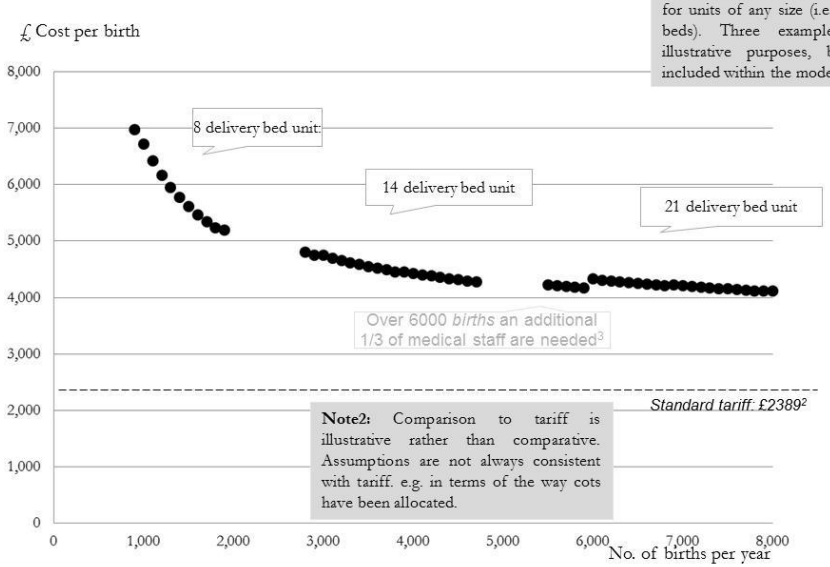


We have implemented the steps set out in the report for three services: A&E, obstetrics and orthopaedics. Where appropriate, we have undertaken separate analyses within those areas (e.g. for A&E with and without trauma, for consultant-led versus midwifery-led obstetrics unit) to ensure like-for-like comparisons. Indeed, this first step of choosing appropriate comparator units is critical to the analysis. Units with significantly different capabilities (that affect the inputs required to deliver the service) cannot be compared. For example, the inputs required to run a Level 1 A&E with a trauma specialisation capability are significantly different to those required to run a standard A&E and the resulting cost curves reflect this.

As noted earlier, the resulting analysis is, we believe, the most detailed to be made public but, within the timeframe for this project, should be regarded as a first step. On the next page we provide two examples of the wider analysis presented in the main report. We provide examples for:

- a consultant-led obstetrics unit; and
- an A&E service with a trauma specialisation.

Consultant-led obstetrics unit

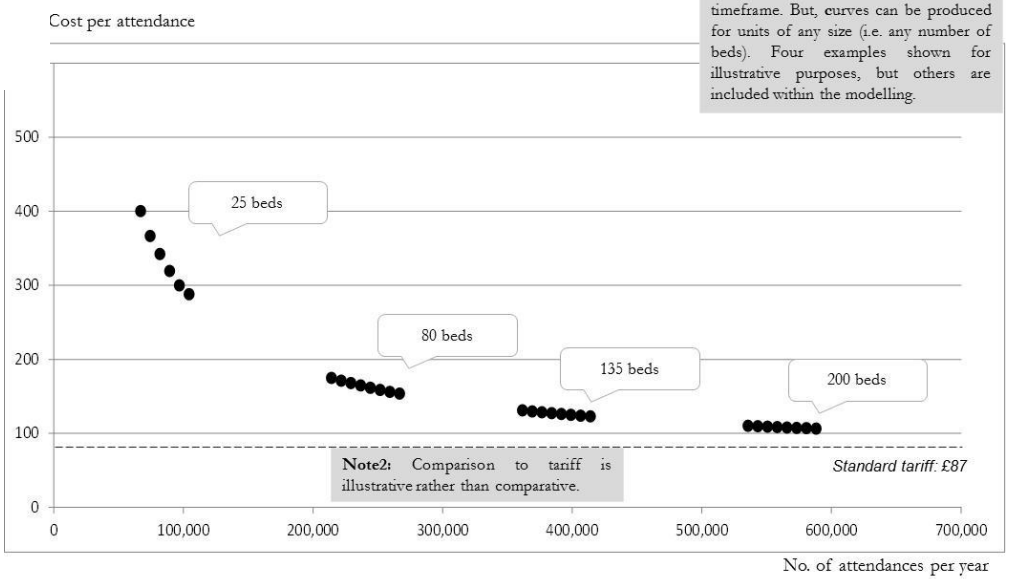


Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, curves can be produced for units of any size (i.e. any number of beds). Three examples shown for illustrative purposes, but others are included within the modelling.

The main report provides the full details of assumptions and analysis that underpin these curves. It also provides curves for other types of A&E and obstetrics units, as well as for orthopaedics and some clinical support services.

In developing this analysis a number of issues stand out. Importantly, the extent of both economies of scale and scope depend crucially on what range of services is considered to be clinically necessary to support a particular clinical service line. That decision then underpins the analysis of the cost-volume relationships. In each of our cases we have taken that view based on expert advice, but that advice does vary.

Level 1 A&E with trauma specialisation



Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, curves can be produced for units of any size (i.e. any number of beds). Four examples shown for illustrative purposes, but others are included within the modelling.

The development of the framework and associated analysis has highlighted a number of specific issues that merit more detailed analysis by themselves. These include the:

- link between minimum efficient scale and clinical guidance about minimum volumes required for acceptable clinical standards, and more generally between scale, scope, cost and clinical quality;
- link between current tariff levels and structures and the cost structures that arise from an analysis of economies of scale and scope;
- relationship between what is considered best practice in the organisation of healthcare services (and how quickly that can change) and economies of scale and scope;
- impact of multi-site operation versus single-site operation on the nature and extent of economies of scale and scope; and
- role of teaching and research in how we consider economies of scale and scope.

The report also makes **two cross-cutting recommendations**. The **first** is for Monitor to consider the benefits of generating cost curves for a range of services that it could use as a screening device and starting point for issues that arise in each area of its responsibility. Developing a set of curves would also allow Monitor to see how the extent of economies of scale and scope vary by service and start to classify trusts and services based on the nature of economies of scale and scope. Which leads to the **second** recommendation which is that Monitor use the evidence to develop clear guidance about when economies of scale and scope are sufficiently material to merit careful consideration in the context of pricing, competition, continuity of service and other discussions. Initial evidence from this work suggests that the materiality of economies of scale and scope is very likely to vary from service-to-service and may also (for reasons both within and outside their control) vary from trust-to-trust.

The report also makes a series of recommendations specific to different workstreams. These include:

- **Competition:** using this work as the basis for developing a package of evidence that Monitor can use to help the OFT with its Phase 1 investigations; and to develop initial views of which bundles of services might be acceptable and which not from a competition perspective.
- **Continuity of service:** many of the links between economies of scale and scope and continuity of service issues also touch very closely on Monitor's compliance function. With that in mind, the development of 'benchmark' agreed cost curves would form part of an initial diagnosis of trusts in financial distress. The framework will also provide something commissioners could use to consider which services to add to their list of commissioner requested services, and needs to be integrated into Monitor's wider work on essential services.
- **Pricing:** the analysis of economies of scale and scope has immediate implications for local modifications and when they might be used. It also provides an evidence base for considering the use of two-part tariffs for some services and the appropriate level of prices. The analysis also provides the basis for categorising both trusts and services to allow fair comparison between providers.
- **On-going role:** finally, extending this analysis provides support for Monitor's on-going role in assessment and compliance. It is likely to allow a more detailed understanding of whether financial difficulties are related to particular types of trusts, to assess the impact of mergers on trust finances and provide a lens through which to consider trusts' 3 year models during the assessment process.

Issues of economies of scale and scope will pervade Monitor's areas of responsibility

Monitor is in the process of becoming sector regulator

It has four main areas of work:
(1) Continuity of service
(2) Pricing
(3) Competition
(4) Integration

Issues of economies of scale and scope pervade all of these areas

Continuity of service	• Crucial for determining knock-on impact of reconfiguring specific service lines in the case of distress or failure • Key to understanding the implications for essential services that do not reach minimum efficient scale for example, in terms of local modifications e.g. due to location
Pricing	• Development of new tariffs will depend, in part, on the extent of such economies • Relationship between tariff and efficient costing crucial for understanding potential pricing remedies/subsidy requirements for essential services and the importance of local modifications
Competition	• Allow Monitor to fulfil its role advising the Office of Fair Trading and understand which bundles of services may be cost-effective • Help in determination and enforcement of complaints relating to commissioner decisions
Integration	• Help to understand potential consequences for costs of various approaches to integration • Implications of moving services out of hospital to provide integrated local offer
On-going functions	• Economies of scale and scope help to understand trust finances, particularly the link between trust finances, commissioner requests and tariff • An input into diagnoses of whether particular types of trusts in some circumstances are likely to face difficulties

Our work is limited to thinking about the cost implications of changes in volume rather than the clinical implications, but the two are related.

The central issue in understanding economies of scale and scope is how a relevant measure of unit cost changes in response to changes in a relevant measure of volume of clinical services. It is that cost-volume relationship that is the focus for this study.

This study does not directly investigate the issue of clinical quality and volumes. There are different models and research relating to that issue. However, there are two areas where it is not possible to completely divorce cost-volume relationships from the issue of clinical quality:

- **Definition of required services:** to establish the relevant cost-base to model we need to first establish precisely which clinical services are necessary to carry out the specified activities. For example, what support services must be on-site and always accessible in order to run a particular type of A&E to meet clinical standards? Or, what staffing is necessary to run a consultant-led obstetrics unit? The required clinical services have a fundamental impact on the cost-base against which we can then examine the extent of economies of scale or scope. In the framework we set out the questions that need to be addressed to provide the initial basis for modelling. In the case studies, we have sought clinical advice in order to define the relevant group of services. Each of these is discussed in more detail in the report.
- **Link between volume and clinical quality:** the derivation of "scale curves" in this and subsequent work would allow trusts to compare themselves against such curves in order to understand whether they are operating at, above or below efficient scale. That does imply a comparison in which quality is held constant. If a trust is operating below minimum efficient scale but still has a low cost base it may be because it is not delivering the right level of clinical quality. We discuss how we have incorporated the issue in the framework.

The second point above is linked to the fact that for some services as scale increases (i.e. the volume of patients treated increases) the quality of clinical outcomes may improve. This is because, there may be a link between the number of patients seen by a service line and the ability of staff to draw on previous experience of similar cases, potentially leading to improved patient outcomes. One extension of the work undertaken here would be to consider the relationship between minimum efficient scale and clinical guidance about the number of cases required to achieve acceptable clinical outcomes.

The existing literature provides limited practical guidance and generally mixed messages around economies of scale and little evidence of economies of scope

A full summary of the literature is provided in the Annexe.

We found no clear message on economies of scale or scope

- Difficulties around design of studies, for example it was unclear how case mix was accounted for
- High degree of circularity as many documents cite similar documents rather than primary sources
- Evidence of economies of scale was often based on high level outcome measures (e.g. mortality), quality of care and training rather than costs
- Mostly at a "whole hospital level" rather than examining specific service lines and linkages between them

Most literature around economies of scale is mainly at a hospital level, e.g.

- Optimal size for acute hospitals is 200-400 beds – which would suggest that many NHS hospitals are too small or large[1] but studies subject to caveats set out above
- Economies of scale shown to exist in hospitals < 200 beds. If output doubled unit cost would increase by ~95% for clinical functions and 65-85% for non clinical functions
- Above a certain size unit costs shown to either increase or remain constant, but unclear what bed size is referred to by 'large' and 'small' hospitals
    - evidence attributes this to the increased complexity of running a large hospital or case mix in large hospitals

Less primary research available at service line or procedure level

- Scale suggested in Coronary Artery Bypass Grafts (CABG); hip surgery; clinical support functions

No consistent evidence that large units produce better outcomes although some positive links for specialties e.g. surgery, cardiovascular and paediatrics.

Literature around scope of hospital services is dominated by clinical/expert view of what services need to be connected to deliver safe care, little economic evidence on the impact of such decisions on costs

1. 149 hospitals are <200 beds, 26% are between 200-400 beds, 38% are larger than 400 beds

This project provides Monitor with a framework and approach to thinking about economies of scale and scope

A framework and approach to thinking about economies of scale and scope

The existing literature on economies of scale and scope provides very little guidance to assist Monitor and Commissioners with the decisions they must take.

The framework we have developed as part of this short study adds significant value by providing a set of tools that include:

- a **technical overview of the key issues** relating to economies of scale and scope in hospitals;
- a **step-by-step methodology** for **developing cost curves** and identifying economies of scale in clinical services and support services; and
- a **step-by-step methodology** for identifying **scope implications** of changes to service lines.

The framework provides an approach to thinking that can be applied on a case-by-case basis by Monitor. To illustrate the power of its tools we have applied them to four illustrative scenarios that Monitor might face

- a decision about the future of a financially unviable A&E;
- understanding the scope implications of closing/downgrading an A&E;
- understanding the implications of economies of scale and scope in price setting ; and
- understanding the implications of economies of scale and scope for merger advice.

The development of the framework has been guided by the participation of 6 trusts as well as an extensive series of interviews with experts and stakeholders.

Models of a number of key clinical service lines and support services have been developed to inform the framework

A number of qualitative models have been developed to assist with the development of the framework and illustrate that it is possible to build models that help to provide a picture of economies of scale and scope. The main purpose of these models was to ensure that the framework methodology captured the main issues related to economies of scale and scope. In developing the framework we used the models to:

- develop the set of considerations that needed to be addressed within the framework e.g. capability of units, division of inputs;
- test whether the questions within the framework fully addressed these considerations;
- test whether the framework questions were generic enough to apply to each service line being considered (and therefore to extend to other service lines);
- identify any areas of ambiguity or complexity; and
- test whether it was possible, and what were the difficulties, with creating cost curves and scope diagrams for a number of service lines.

As an additional benefit, the models also provide an important output in their own right. They provide a preliminary set of information about the extent of economies of scale and scope in the clinical service lines that have been examined. These may be areas that Monitor may with to examine in future work.

The clinical service line models that have been created are for:

- A&E and acute services;
- Obstetrics; and
- Elective orthopaedic surgery.

Where relevant and where time has allowed we have also examined clinical support services.

These models can be used as a basis for beginning to answer specific questions about these services. They provide initial answers to questions such as:

- the volume of patients required for a Level 1 A&E to reach minimum efficient scale;
- the volume of patients required for a Level 1 A&E with a trauma specialisation to reach minimum efficient scale;
- the volume of births required for an obstetrics unit to reach minimum efficient scale;
- the extent of scope links between A&E and other service lines;
- the extent of scope links between orthopaedics and other service lines; and
- the extent of scope links between primary clinical service lines and support services.

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Our approach to this work has been based around four key stages of work

Stage 1: Literature review

We have conducted a high level literature review with a view to:

- understanding the current research on economies of scale and scope in hospitals; and
- gathering inputs and data points for our framework and model.

Stage 2: Bottom up desktop and literature based framework and models

Using the information gathered as part of the literature review, we developed an initial bottom up framework and models for each selected service line and support service. These models comprised cost bases and scale curves as well as patient flows and scope implications.

Stage 3: Case studies and expert interviews

The initial framework and model were tested repeatedly to ensure that we were capturing:

- all the relevant inputs for the service lines models;
- the extent to which inputs are fixed; and
- the links between service lines.

We have tested the framework and models with 6 NHS trusts as well as through discussions with 9 Royal Colleges and other stakeholders and experts. Finally, we have drawn on UK independent sector and international expertise from the US in order to ensure the framework can capture alternative models of care.

Stage 4: Final report

The final report draws together the framework and the model outputs to provide:

- a clear framework for Monitor to think about issues of economies of scale and scope;
- applications of the framework to four key scenarios Monitor may encounter in the future; and
- illustrative modelling outputs for A&E, orthopaedics, obstetrics and selected support services.

We have developed an approach to understanding economies of scale and scope based on segmenting the hospital into key building blocks

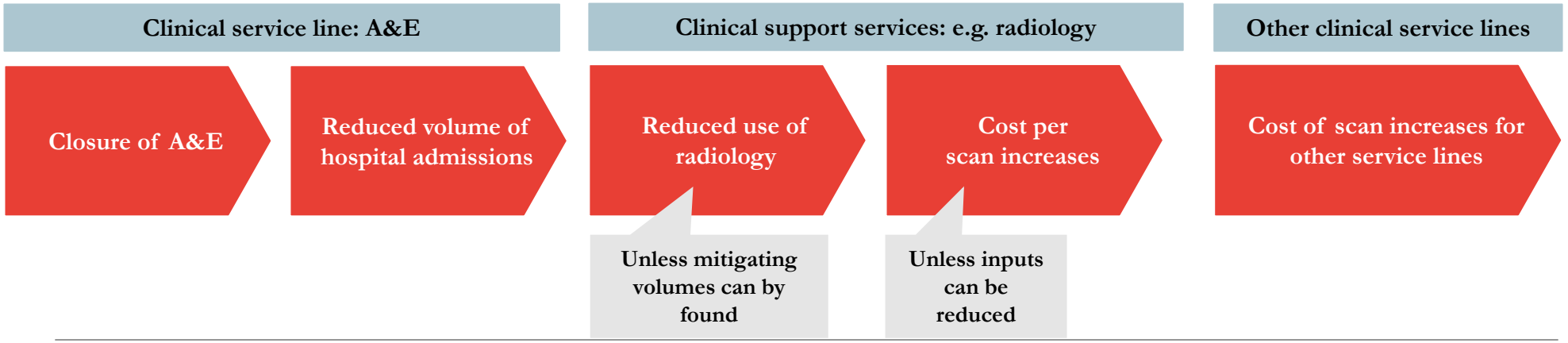
We have segmented hospitals into three key building blocks

- **Clinical Service lines**: for example, A&E, orthopaedics and obstetrics
- **Clinical support services:** for example, radiology and theatres
- **Non clinical support services:** for example, management, cleaning, catering

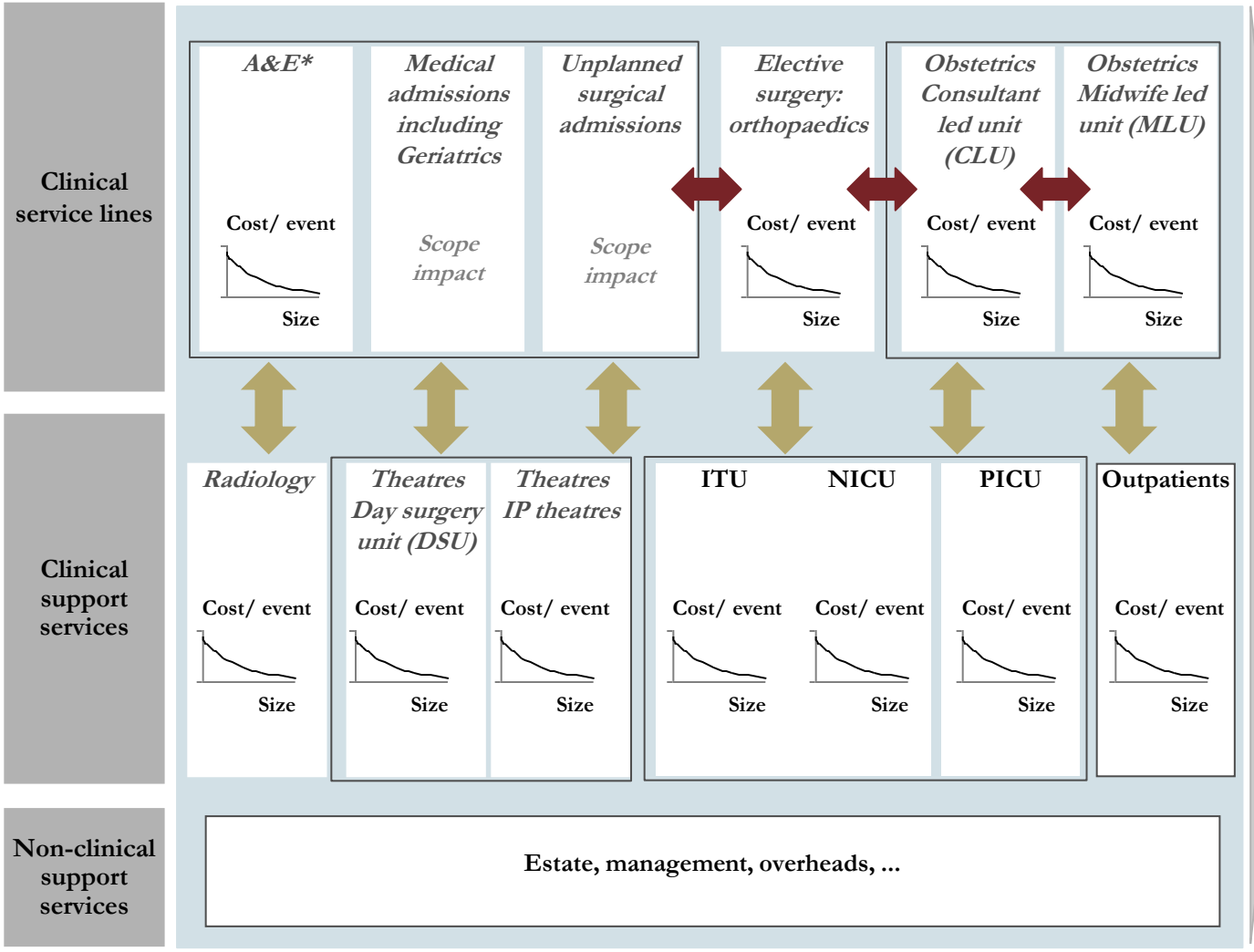
We have done that because…

It is the question of whether individual clinical service lines exhibit economies of scale that is of importance to Monitor rather than a hospital as a whole. Also, it is only by segmenting clinical service lines that we can understand the links (economies of scope) between them.

Segmenting clinical and non-clinical support services (inputs that tend to be fixed and shared between service lines) from service lines is the only way of truly understanding the impact of scope economies these support services generate - separate modelling of clinical support services should help Monitor to understand the potential knock on impacts of changes to **service lines**, such as the potential closure of an obstetrics unit or A&E (see below); the downgrading of an A&E; or the appropriate tariff for an obstetrics procedure or A&E attendance



The following segmentation has been developed to guide the framework and case studies



Scale effects for each service
Effect of volumes on cost per unit in each service modelled, e.g. Obstetrics unit may require minimum volume to be financially viable

Primary scope: *shared* fixed inputs between service lines
Effect of shared inputs on viability of adjacent service lines – e.g. A&E may require key specialist service lines (e.g. general surgery) to be financially viable

Secondary scope: flows between service lines and *shared* support services with fixed inputs
Effect of volumes on viability of support services modelled, e.g. Obstetrics may ensure sufficient volumes in NICU to ensure viability

Note: there will also be flows of patients to service lines where inputs are not fixed and shared (e.g. from obstetrics to paediatrics). Whilst there may be clinical grounds for co-location, without fixed, shared inputs there is no reason for these services to be co-located from a cost perspective.

*A&E Level 1 will be the main focus of the work.

Six trusts have contributed to our understanding of the modelled service lines and support services

Six trusts have contributed to our understanding of the modelled service lines and support services. As part of the process and them agreeing to share data and evidence with us we have promised their anonymity. However, later we set out the criteria used in their selection. See Annexe on Case Study Selection.

We have also consulted with experts on English independent sector and US models for hospital operations in order to ensure the framework reflects different operating models.

Trusts have been able to provide a range of information of use, including:

- Hospital/unit floor plans;
- Staffing levels and rotas;
- Volume and outcome measures (length of stay, turn away rates, case mix);
- Costs (Patient Level Information and Costing Systems data (PLICS), Service line reporting, cost centre data, relevant business cases, reconfiguration plans); and
- Patient flows (referrals between services, method of admission, support service usage).

We have also completed interviews with a range of stakeholders and experts

Name	Specialty	Affiliation / college
Jon Sussex	**Health economist**	Deputy Director, Office for Health Economics
Dr David Richmond	**Obstetrics**	Vice President (Standards), Royal College of Obstetrics and Gynaecology Consultant at Liverpool Women's Hospital
Dr Mike Gill	**Geriatrics**	Medical Director, Geriatric Medicine, Barts Health NHS Trust Honorary Clinical Director for Elderly Care at NHS London
Dr Kerri Jones	**Theatres and elective care**	Member, British Association of Day Surgery National Clinical Advisor to Dept Health Elective Care & Diagnostics Branch at Dept of Health
Dr Sara Lightowlers	**Geriatrics**	Clinical Director, Geriatric Medicine, Barts Health NHS Trust
Vanessa Harris	**Obstetrics (costs)**	Director of Finance, Liverpool Women's NHS Foundation Trust
Professor Matthew Cooke	**A&E**	National Clinical Director for Urgent and Emergency Care, DH Professor of Emergency Medicine and Director of the Emergency Care and Systems Improvement Group at the University of Warwick Medical School Consultant at Heart of England NHS FT
Mr Steve Cannon	**Orthopaedics**	Elected member, Royal College of Surgeons Consultant at the RNOH
Dr Linda Patterson	**Acute medicine**	Clinical Vice President, Royal College of Physicians
Dr Mary Stocker	**Day surgery**	Council Member, British Association of Day Surgery
Sandra Boosey	**Theatres**	Project manager for Productive Theatre Programme, South Devon Healthcare NHS Foundation Trust

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Framework overview

The framework that has been developed as the output from this work is made up of four components. Depending on the question to be addressed, Monitor should be able to make use of one or more of the components of the framework to assist them. We illustrate the way in which they can use the framework in the application section that follows this section.

In this section we cover:

- Economies of scale and scope in healthcare - technical overview;
- Factors to consider when setting the timeframe and comparative context;
- Methodology for developing cost curves; and
- Methodology for identifying primary and secondary scope implications (support services, direct inputs e.g. specialist staff) ;
    - **Primary scope:** links between service lines that result from fixed inputs that they share e.g. paediatric consultants providing 24/7 cover to A&E as well as running the paediatric service line.
    - **Secondary scope:** links between service lines that result from the use of shared support services (with largely fixed inputs) where loss of volume from one service line may affect the viability of others.

The slides that follow provide details for each of the components set out above.

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Economies of scale are present when the cost per patient declines as the number of patients treated increases

Economies of scale are present when the cost per patient declines as the number of patients treated increases.

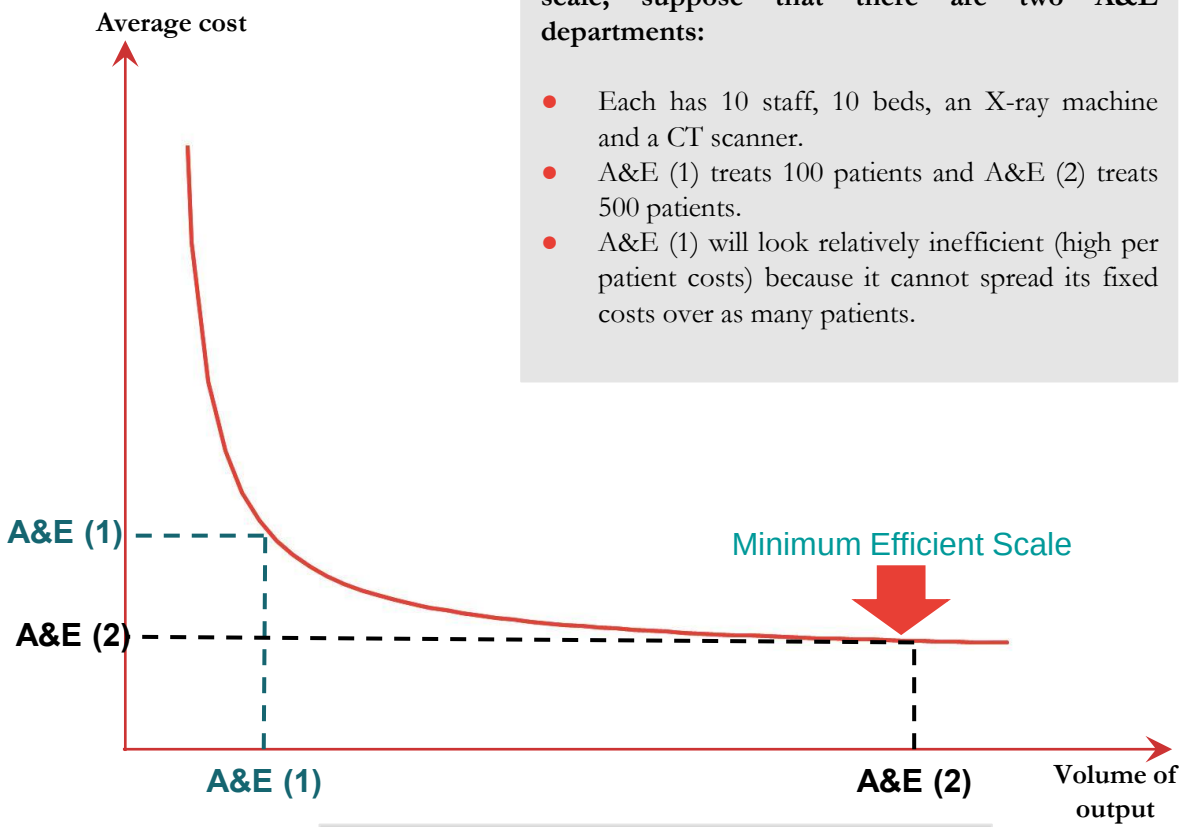
Economies of scale exist when there are costly fixed inputs. The more patients the costs of these inputs can be shared between, the lower the cost per patient. Examples of fixed inputs include:

- a minimum rota of staff to provide a 24/7 service; or
- an expensive piece of equipment such as an MRI scanner.

Economies of scale may also exist if there is purchasing power from being a big purchaser. For example, if the price per MRI scanner declines the more MRI scanners that are purchased (bulk buying discounts).

Key issues for Monitor that flow from Economies of Scale include understanding whether:

- Some units are too small in patient volumes to be cost efficient e.g. A&E(1) in diagram is below Minimum Efficient Scale.
- Continuously increasing the size of a unit leads to better and better efficiency – does the average cost curve continue to fall, flatten out or start rising again (diseconomies of scale)?



As an illustration of the existence of economies of scale, suppose that there are two A&E departments:

- Each has 10 staff, 10 beds, an X-ray machine and a CT scanner.
- A&E (1) treats 100 patients and A&E (2) treats 500 patients.
- A&E (1) will look relatively inefficient (high per patient costs) because it cannot spread its fixed costs over as many patients.

Note: There may be a point at which average cost starts to increase with large volumes (diseconomies of scale set in) for example, if the cost of managing a large and complex unit starts to increase. We have no firm evidence to identify whether and, if so, where this effect might kick in.

Economies of scope are present when it is cheaper to produce two or more clinical services together than to produce them separately

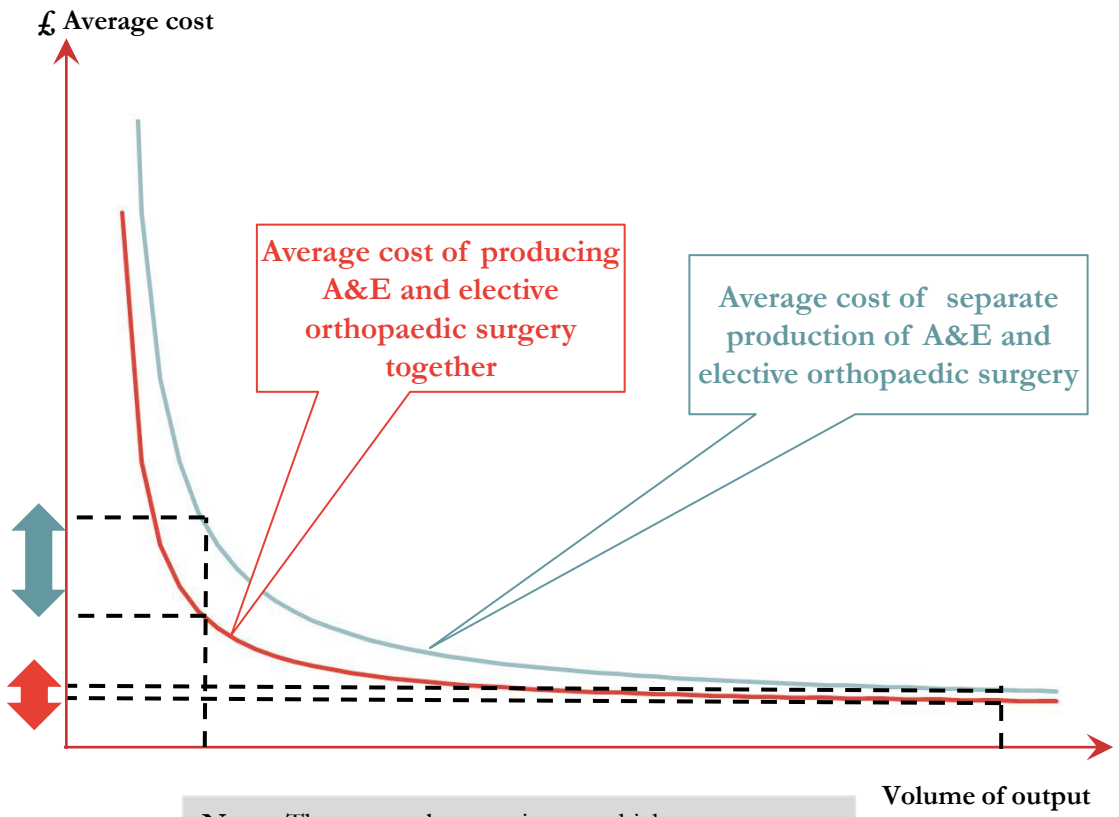
Economies of scope are present when the *combined* average cost of producing two or more services together is less than the *combined* average cost of producing those services separately

For example, it may be cheaper per patient if elective orthopaedic surgery is undertaken in the same setting as an A&E than if those services were offered in separate locations, because of shared support services.

Economies of scope exist when there are costly fixed inputs that are shared between service lines. For example, if radiology is required for A&E as well as for elective orthopaedic procedures, sharing these fixed inputs between A&E and orthopaedics may be cheaper than having separate radiology departments for each.

Key issues for Monitor that flow from Economies of Scope include understanding whether:

- Closing one service line in a hospital has a domino effect on the viability of other service lines or can be replaced by something else.
- Pricing that fails to remunerate *adequately* an *efficient* service line has implications for the viability of other service lines.



Note: There may be a point at which average costs starts to increase with large volumes (diseconomies of scale set in) for example, if the cost of managing a large and complex unit starts to increase. We have no firm evidence to identify whether and, if so, where this effect might kick in.

The relationship between capacity and demand is the key to understanding economies of scale and scope in a hospital setting

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- **Capacity:** The maximum number of patients that *could be treated* within a unit of a given size (e.g. the total number of patients that could be treated within an A&E unit whilst adhering to clinical quality and waiting list guidelines).
- **Demand:** The number of patients that are *actually treated* within a unit of a given size

Large fixed inputs tend to have substantial capacity

Both economies of scale and economies of scope are driven predominantly by the presence of large fixed inputs, whose cost must be spread over a large number of patients to be cost efficient. Large fixed inputs tend to have substantial capacity (e.g. (i) the maximum number of patients that can be scanned by a given MRI scanner in a working week is high, (ii) the maximum number of patients that can be treated in an A&E in a given week is high).

The better utilised this capacity (the higher the demand relative to the capacity), the lower the per patient costs. Whether it is economies of scale that are present or economies of scope depends on whether the input is service line specific or not (see illustrative example).

- Economies of scale exist when the capacity of a fixed input can only be utilised by one service line (e.g. a minimum fixed rota of staff for A&E)
- Economies of scale become economies of scope when three conditions hold i) the fixed input is not service line specific, (ii) the fixed input is not fully utilised (demand is less than fixed capacity), and (iii) that capacity cannot be filled with volume from one service line alone.

Illustrative example of when economies of scale become economies of scope: A&E department with fixed (service line agnostic) costs

Take an A&E department

- It has a fixed cost of £1000 because of an MRI scanner that it uses (no variable costs for simplicity)
- The scanner can scan a maximum of 50 patients per year – it does not matter whether these patients are from A&E or not.

- If 25 A&E patients are scanned (utilisation of 50%), the per patient cost is £40
- If 50 A&E patients are scanned (utilisation of 100%), the per patient cost is £20

Economies of scale are clearly present because of the fixed input – the better utilised the capacity the lower the per patient cost.

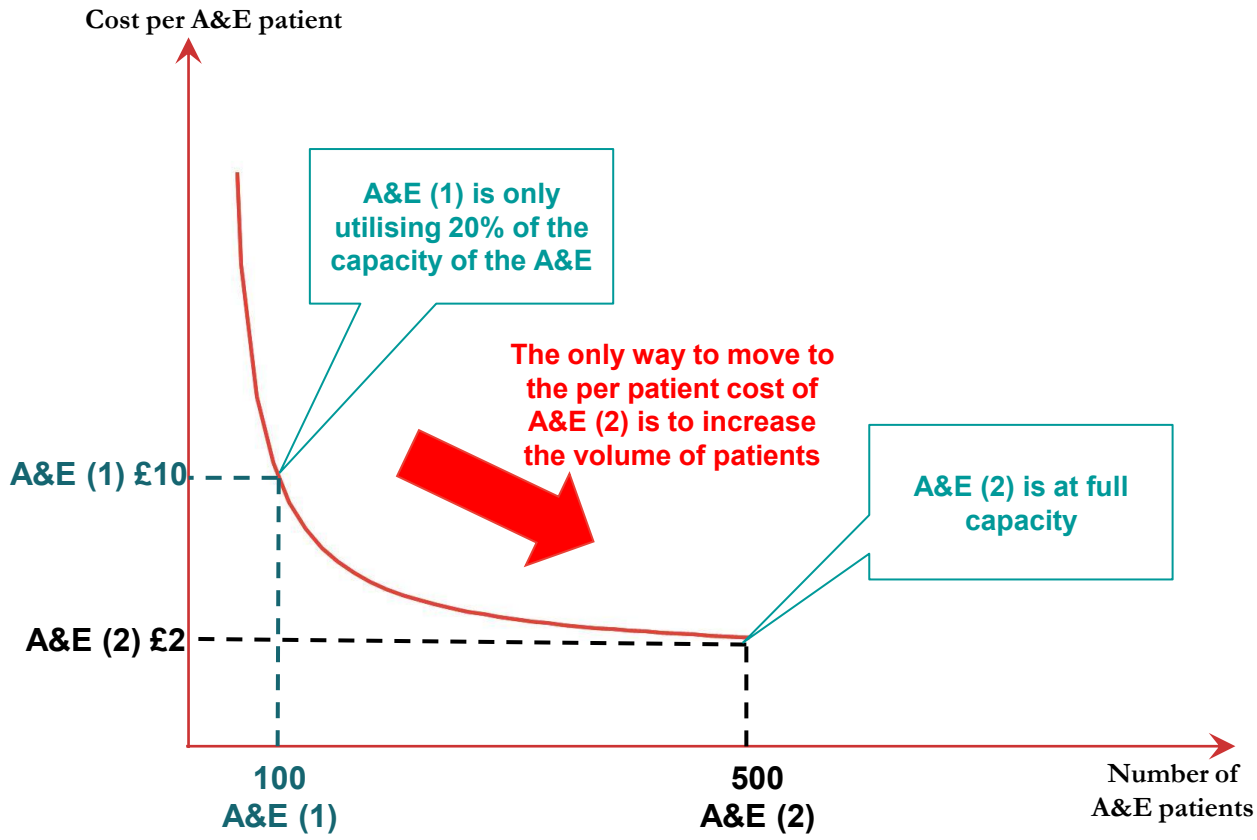
But, there are also potential economies of scope.

- Suppose it is not possible for the number of patients in A&E to be increased above 25 (with a per patient cost of £40).
- Because the scanner is service line agnostic, a cost of £20 per patient could be achieved by 25 patients from another service line making use of the scanner.

To the extent that there are fixed service-specific inputs for some hospital services, underlying economies of scale *will not* differ between hospitals offering equivalent services

Example using an illustrative A&E

- Suppose there are two equivalent A&Es, A&E (1) and A&E (2), each with a fixed minimum rota of 10 staff which costs £1000. A *maximum* of 500 A&E patients could be seen in either A&E with this staffing arrangement.
- A&E (1) treats 100 A&E patients and A&E (2) treats 500 A&E patients.
- A&E (1) has high per patient costs (£10) because it cannot spread the fixed rota cost over as many A&E patients. A&E (2) has a per patient cost of (£2).
- The only way A&E (1) could achieve the same average cost as A&E (2) would be to treat an additional 400 A&E patients

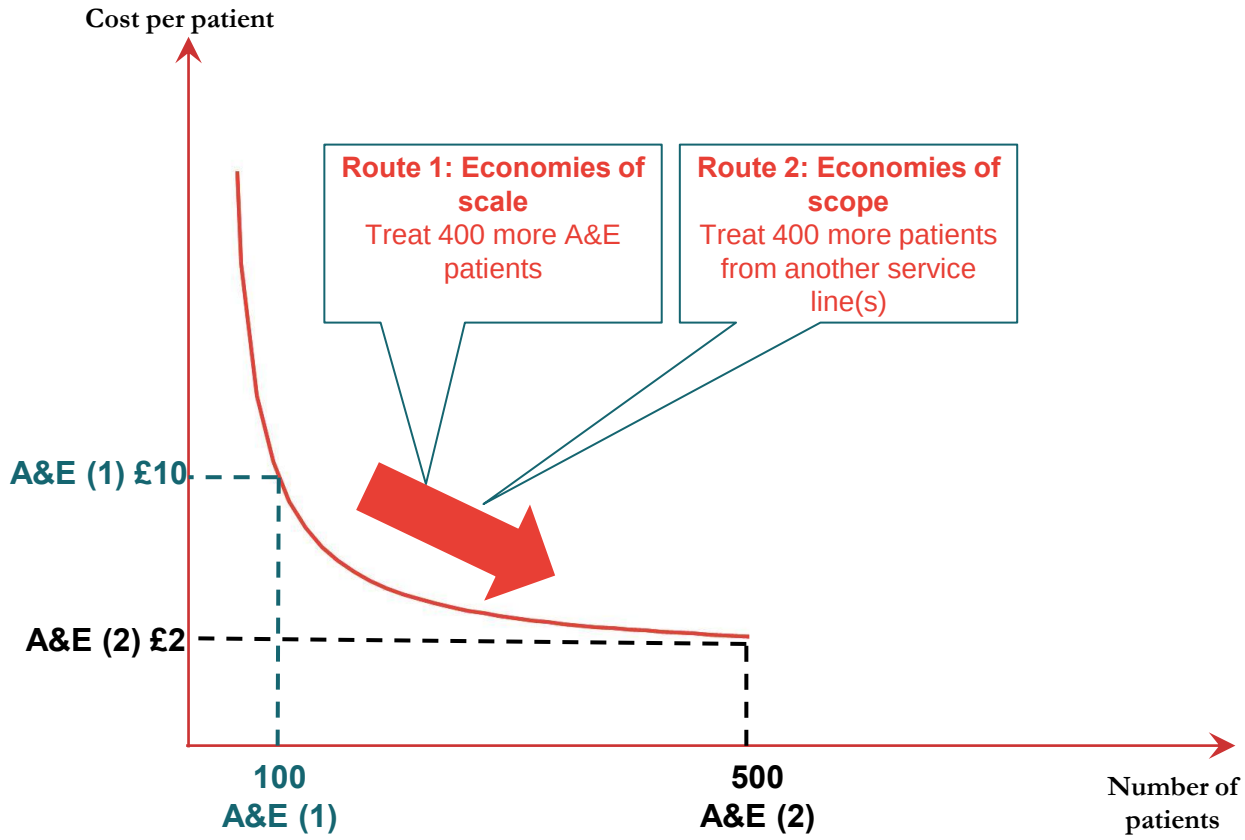


What *will* differ between trusts/configurations is the extent to which patient volumes allow the *efficient* utilisation of these inputs

However, the extent of economies of scope will differ between hospitals because they depend on whether service-agnostic inputs need to be shared to ensure utilisation

Example using an illustrative A&E

- Suppose an A&E has a MRI scanner which costs £1000 and can scan a maximum of 500 patients
- As before, A&E (1) treats 100 A&E patients and A&E (2) which is equivalent to A&E (1) treats 500 A&E patients.
- As before, A&E (1) has high per patient costs (£10) because it cannot spread this fixed costs over as many A&E patients. A&E (2) has per patient costs of £2.
- A&E (1) has two routes to achieving the same average cost as A&E (2)
  1. scan an additional 400 A&E patients; or
  2. scan an additional 400 patients from another service line(s)



The key

1. The service line you start with when examining economies of scope is important because it is the starting service line which determines the level of spare capacity that exists if the volume of patients treated changes
2. The extent of economies of scope will differ between hospitals because the extent of spare capacity on potentially shared inputs will differ

There is a further complicating factor when the cost curve is very lumpy – there are semi-fixed costs – the closeness of the match between patient numbers and capacity matters

Up until this point, we have assumed that the cost curve is smooth i.e. that there are only large fixed inputs that need to be accounted for.

In reality, hospitals have a large number of semi fixed inputs – those that are fixed for a certain volume of patients but then must increase. For example, a nurse may be able to treat 10 patients but a second nurse is needed if 11 or more patients need to be treated.

Semi-fixed inputs are represented as jumps in the cost curve (see opposite).

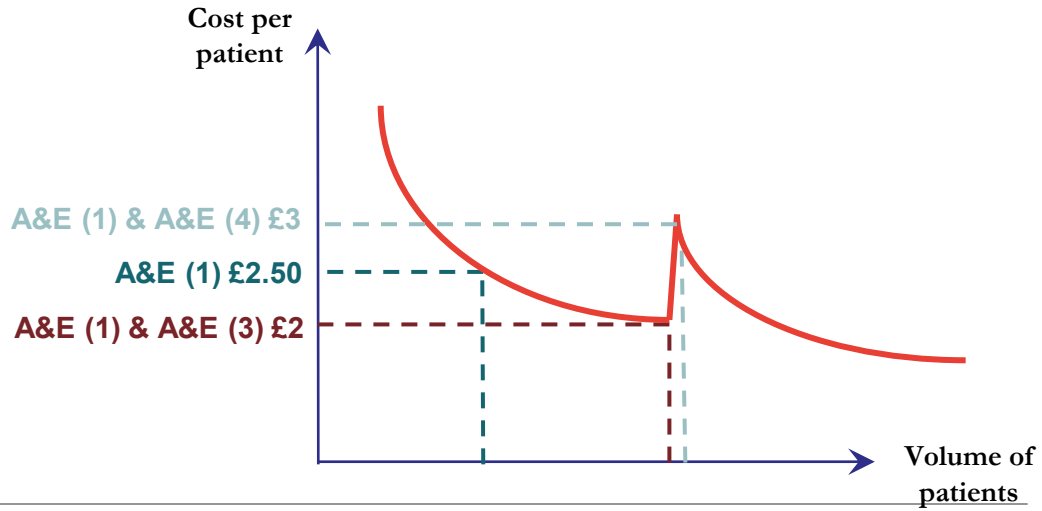
They matter for the discussion about the relationship between capacity and demand. This is because if there is spare capacity in the use of a fixed input then the cost per patient declines as the volume of patients increases up to full capacity.

However, once full capacity is reached, additional patient volume *may* lead to an increase in per patient costs because additional inputs are required. (see example opposite).

The extent to which costs may increase will depend on how closely matched changes in patients numbers are to spare capacity in existing inputs.

Example using an illustrative A&E

- Suppose an A&E has a fixed minimum rota of 10 staff which costs £1000 and can see a maximum of 500 A&E patients. If more than 500 A&E patients come to A&E, an additional member of staff costing £500 is needed for every additional 10 patients.
- Suppose that A&E (1) treats 400 A&E patients at a cost per patient of £2.50
- Suppose that A&E (1) could merge with one of two alternative A&Es, A&E (3) and A&E (4).
  - A&E (3) treats 100 A&E patients
  - A&E (4) treats 105 A&E patients
- If A&E (1) were to merge with A&E (3) it would treat a total of 500 A&E patients and would achieve a cost per patient of £2.
- If A&E (1) were to merge with A&E (4) it would treat a total of 505 A&E patients and its cost per patient would be £3.



Cost curves are dynamic and change as a result of innovation or other changes to hospital services

The average cost of treating a patient can change for one of three main reasons (i) the cost curve shifts (ii) a hospital moves along the cost curve or (iii) the inputs to the service line become less fixed

Factors that might shift the cost curve include – anything that changes the number or cost of inputs required to see a given volume of patients:

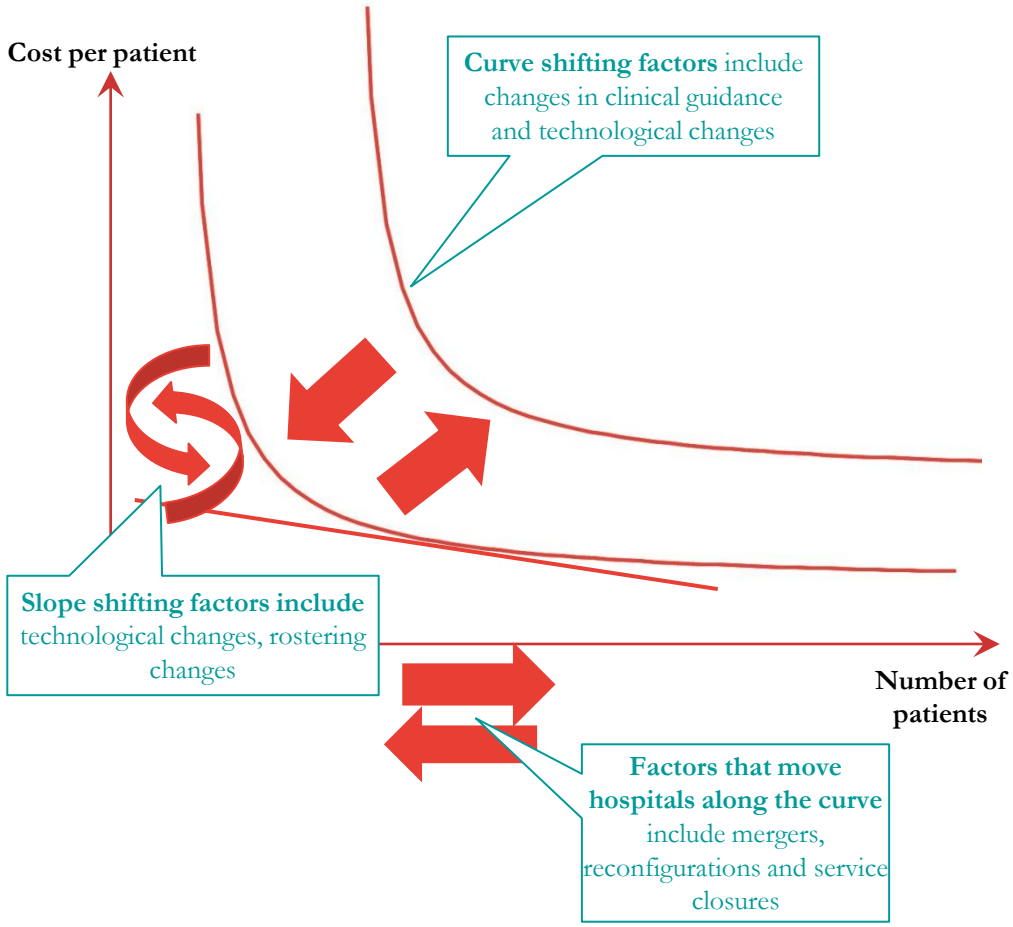
- a change in best practice guidance that means more inputs are required to run a service; or
- a change in technology that means that fewer inputs are required to perform the same service or the cost of the inputs changes.

Factors that might shift a hospital along a curve include – anything that changes the volume of patients seen in a given setting:

- a merger that changes the volume of patients treated in a particular hospital;
- changes in demographics such that the volume of patients changes e.g. a surge in the birth rate; or
- preventative measures that mean that less individuals need to be treated for a condition.

Factors that shift the slope of the cost curve include – anything that causes inputs to a service to become more or less fixed:

- technological changes that change the capacity of equipment; or
- staff rostering changes such that it is easier or harder to change the number of staff in response to changes in patient numbers.



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In any context where economies of scale and scope are potentially important, Monitor needs to understand the extent to which inputs are truly fixed and shared or whether bulk purchasing benefits exist

Three questions must be decided upon before the extent of fixed, shared inputs or bulk purchasing economies can be assessed – (1) the timeframe, (2) the comparative context and (3) the way in which costs should be measured.

Timeframe: Deciding the timeframe for consideration has a critical impact on determining the extent of economies of scale and scope – whether or not an input can be varied according to volume changes depends on whether we are asking whether it can be changed within a month, a couple of years or many years. The relevant timeframe is likely to be different for every context Monitor is faced with. For example, if considering the implications of maintaining continuity of service for key services in a trust in financial distress, Monitor may wish to know what can be achieved in a relatively short timeframe as well as what might be a realistic longer term goal. If it is a question of understanding the potential economic benefits from a merger between trusts, the timeframe for realising those benefits may be a relatively long one.

Comparative context: What can be varied within a given timeframe by one trust is likely to be very different to what could be varied by another or by a private sector firm in a similar situation. When considering the extent of underlying economies of scale and scope in a service line, it does not make sense to consider a single trust in isolation. What they may deem to be fixed in that timeframe may not reflect what other trusts would be able to adjust. The relevant comparator depends on how challenging Monitor would like to be in terms of what can be achieved. Best practice in the NHS would seem to be an obvious comparator and even that will be extremely challenging for some trusts. However, there are cases where even best practice in the NHS may still fall short of what can be achieved in the private sector, for example on staffing where, in the private sector more flexible contracts are used for permanent staff to ensure greater ability to adjust staffing according to volume of patients.

Clearly there is an interaction between the timeframe and the comparative context chosen, so the two need to be chosen at the same time. For example, whether the analysis considers what could be achieved in 5 years by a best practice NHS trust or what could be achieved in 2 years by a private sector comparator.

Cost measurement: The way in which costs are measured is also important. It is possible to model costs in one of two main ways - average *incremental* costs and average *total* costs. Incremental costs tend to be of use when a set of "core services" in a hospital can be defined. The costs of providing services which are "incremental" to the core will depend on the extent to which shared assets can be better utilised by an additional service line. Average total costs are of most use when this set of core services cannot be defined and therefore all services are considered incremental (see next slides for further discussion).

In any situation, a decision must be made as to whether Monitor is interested in total service line costs or incremental costs; the short run or the long run

	Cost and output definition	Variable inputs	Illustrative example
Long run average total cost (LRAC)	**Total service line cost** (e.g. A&E, orthopaedics) shared between **all** units of output of service line	The levels of **all inputs can be varied**	**AC:** The cost of A&E specific inputs is added to the cost of A&E's share of shared inputs (e.g. theatres, radiology). The average cost is generated by dividing by total A&E volume. **LR:** All inputs can be varied with volume.
Short run average total cost (SRAC)	**Total service line cost** (e.g. A&E, orthopaedics) shared between **all** units of output of service line	The levels of **only some inputs can be varied**, others are fixed	**AC:** The cost of A&E specific inputs is added to the cost of A&E's share of shared inputs (e.g. theatres, radiology). The average cost is generated by dividing by total A&E volume. **SR:** Some inputs can be varied with volume.
Long run average incremental cost (LRAIC)	Total cost of **incremental service line** given that one service line is already produced, shared over the **additional units of output** from extra service line	The levels of **all inputs can be varied**	**AIC:** The provision of A&E and all associated support services taken as given (core service). The cost of incremental orthopaedic surgery is the cost of orthopaedic specific inputs and any increment to A&E inputs from the additional orthopaedic volume. **LR:** All inputs can be varied with volume.
Short run average incremental cost (SRAIC)	Total cost of **incremental service line** given that one service line is already produced, shared over the **additional units of output** from extra service line	The levels of **only some inputs can be varied**, others are fixed	**AIC:** The provision of A&E and all associated support services taken as given (core service). The cost of incremental orthopaedic surgery is the cost of orthopaedic specific inputs and any increment to A&E inputs from the additional orthopaedic volume. **SR:** Some inputs can be varied with volume.

For the purposes of the modelling contained within this report, we have focused on average total costs and not average incremental costs

As described on the previous slides it is possible to model average costs in one of two main ways - average *incremental* costs and average *total* costs

Average incremental costs could be used if it is possible to define a "core" set of services which must be provided in a hospital e.g. an A&E department and its associated support services. Incremental costs then refer to other non-core services provided on the same site. The use of this concept becomes of particular interest if there is spare capacity in the core services such that incremental services could be added at very low cost, even zero cost (as they make use of the spare capacity).

For the purposes of the modelling we have undertaken, we have focused on average total costs as it has not been possible, at this stage, to define a "core" set of services. Furthermore, this core set of services may differ from hospital to hospital

Example 1: average total costs

- Suppose there is an A&E and an orthopaedic department in a hospital.
- They are both supported by a full set of support services (radiology, theatres, ITU etc.).
- The fixed costs are as follows:
  - A&E is £800
  - Support services is £200
  - Orthopaedic department is £500
- The A&E treats 500 patients (50% require the support services) and the orthopaedic department treats 200 patients (50% require the support services). This means that 70% of the patients in the support services come from A&E and 30% from orthopaedics.
- The average cost in A&E is £1.90 (£800/500 + 0.7*£200/500)
- The average cost in orthopaedics is £2.80 (£500/200 + 0.3*£200/200)

Example 2: average incremental costs

- Suppose an A&E is built with a full set of support services – this is equivalent to saying that the A&E is the *core* service.
- The fixed cost of the A&E and support services (assuming no variable costs for simplicity) is £1000
- The A&E department treats 500 A&E patients at a cost of £2 per patient.
- It is then decided that an orthopaedic department is required on the same site to treat 200 patients. The orthopaedic department also wants to make use of the support services.
- **Scenario 1: there is spare capacity in the support services** and they could treat a further 500 patients without incurring any additional costs. In this case the average *incremental* cost of the support services for orthopaedics is £0 per patient.
- **Scenario 2: there is only spare capacity for 100 patients** after which an additional theatre is required at a cost of £200. The average *incremental* cost of the support services for orthopaedics in this case is £2 per patient.

Once the timeframe, comparative context and cost measurement have been fixed, inputs need to be divided in to those which are variable and those which are fixed

	Type of inputs	Scale	Scope
Variable inputs	• Can be adjusted to fully reflect the change in the number of patients given timeframe and context • e.g. fewer drugs / medications are used if fewer patients are treated	• Number of patients seen (scale) has no impact on average costs if all inputs are variable.	• No scope effect as not shared with other service lines (unless very strong purchasing economies)
Semi fixed inputs	• Can be adjusted to reflect changes in patient numbers given timeframe and context, but are indivisible • e.g. the number of theatres can be reduced from 2 to 1 or 1 to 0, but cannot be reduced from 1 to 0.5 or 2.5 to 1.5.	• Number of patients seen (scale) has an implication for the efficient use of these inputs as their cost needs to be shared amongst patients	• Cost implications for other service lines if inputs are shared and volume of patients is changed. But may be possible to change inputs to reflect some change in volume. Depends on how well change in volume maps to changes in inputs.
Fixed inputs	• Cannot be adjusted to reflect changes in patient numbers at all – are completely indivisible – you either have one and run the service or don't have one and don't run the service • e.g. a fixed basic rota of staff for a 24/7 A&E	• Number of patients seen (scale) has a clear implication for the efficient use of these inputs as their cost needs to be shared amongst the patients seen	• If these inputs are shared, there are clear cost implications to other service lines if volume of patients from one service line is changed.

Details of how to make this division are in the next section, "developing cost curves".

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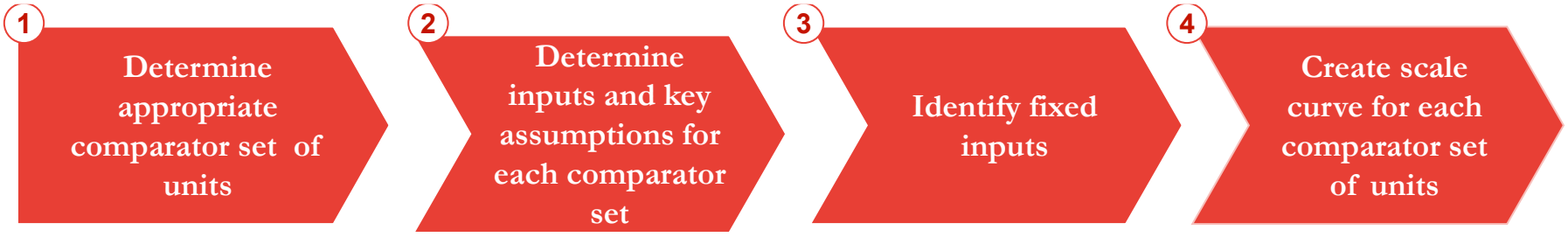
Overview of the Step-by-Step guide to developing cost curves and identifying economies of scale

There are four main steps to identifying economies of scale in a particular service line. These are based around developing a cost curve for the service line in question. The slides that follow outline how to undertake this exercise. It is worth pointing out that in developing cost curves we are not attempting to precisely replicate how individual hospitals are structured. *We are attempting to understand what a best practice trust of different sizes would look like.* We do this by following best practice guidance regarding inputs (for example, published by the Royal Colleges) rather than specific operating models of particular trusts. This has implications for how the curves can be interpreted, which we outline later.



The aim of the scale curve is to indicate what the production model for a unit looks like. To make this meaningful, we need to capture all key factors that may cause inputs or unit costs to vary between units e.g. where different unit capabilities would cause key inputs to vary or other cost drivers outside the trusts control which would affect input use of unit costs (e.g. location).

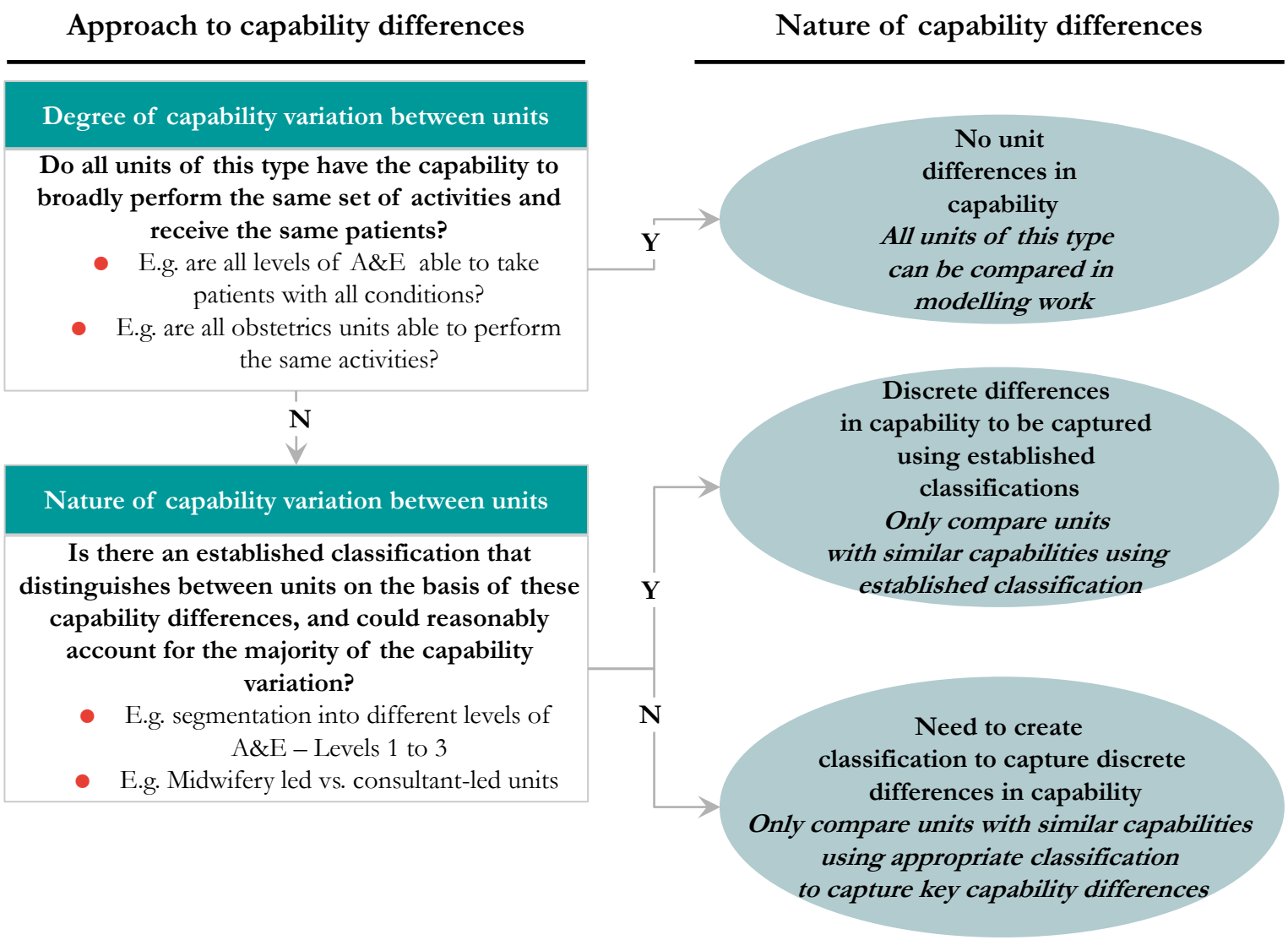
Using a bottom up approach we identify the inputs required to run services of different sizes and the cost per input.
For support services, all service line specific costs are excluded (these are allocated to service lines specifically).

We identify the effect of volume fluctuations on each input using the methodology on page 41.

We segment costs into those which are fixed, semi-fixed and variable.

The cost curves are based on the complete cost base created in steps 1-3.

① Step 1a: Determine whether or not all units have the same capabilities and can be modelled in the same way



1 Step 1b: Identify other drivers of cost and determine whether or not they mean that units affected by these factors need to be modelled separately

As well as capability differences, illustrated on the previous slide, decisions have to be taken as to whether or not to account specifically for a range of other factors that could differentially affect costs between units. The key cost drivers we have identified are those highlighted in the table below. The factors that we have included in our models are those which affect best practice *input requirements* and would be reimbursed by the tariff. Factors that affect the price of inputs but not the number or nature of inputs required, do not need to be accounted for in separate models. They may however, need to be accounted for within model as they shift the cost curve generated up or down.

Cost driver	Impact on cost		Inclusion in model
Teaching/research costs	Impact on costs *e.g. can increase inputs and length of stay*		No - assumed to be fully reimbursed by SIFT/MADEL income as per HFMA guidelines
Location • E.g. Market Forces Factor	Impact on cost *e.g. uplift on salaries, uplift on rents, uplift on land*		Yes - Include salary bands for Inner London, Outer London, Fringe and Other. Used to uplift best practice curve rather than modelled separately. Yes – Building costs adjusted to reflect location
Quality differences • E.g. best practice turn away rates (0.01%, 0.1%, 1%)	Impact on input requirements *e.g. lower turnaway rates need more capacity for same number of patients/births*		Yes - Restrict turnaway rates to between best practice parameters
Integrated support services • e.g. dedicated obstetrics HDU	Impact on costs *e.g. presence of HDU means higher cost of equipment*		Model by model – depends on best practice
Case mix within unit type • e.g. with or without complications & co morbidities	Impact on capacity *e.g. complex case mix increases length of stay; more capacity needed*		Model by model – depends on the extent to which case mix will affect input requirements

② For comparable units
Step 2: identify all inputs for a unit

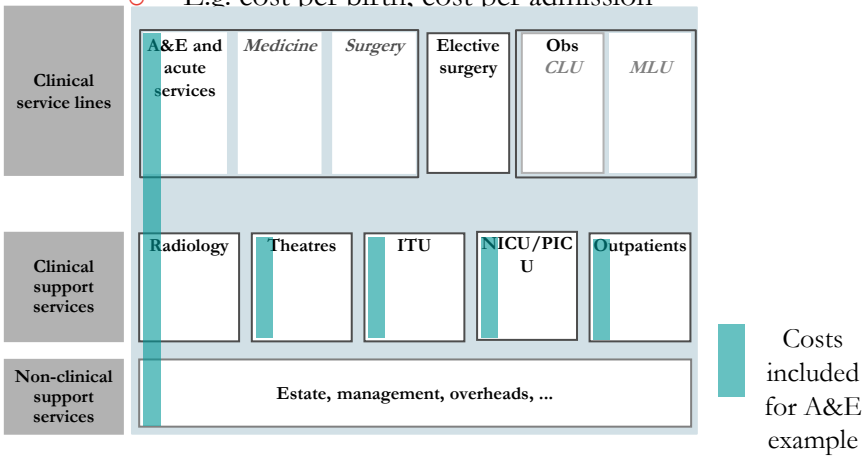
Methodology for service lines

Identify the full set of inputs required to build expected costs for a service line, including support services used

Include <u>all direct, indirect and overhead costs</u>

- Direct costs: all resources directly consumed by individual patients according to guidelines (including service line specific support service inputs)
- Indirect and overhead costs: includes estates, pharmacy, human resources. These are allocated to service line using best practice methods, e.g. square foot, total expenditure, number of bed days.

- Metric will be costs per patient episode (tariff comparable groupings)
  - E.g. cost per birth, cost per admission

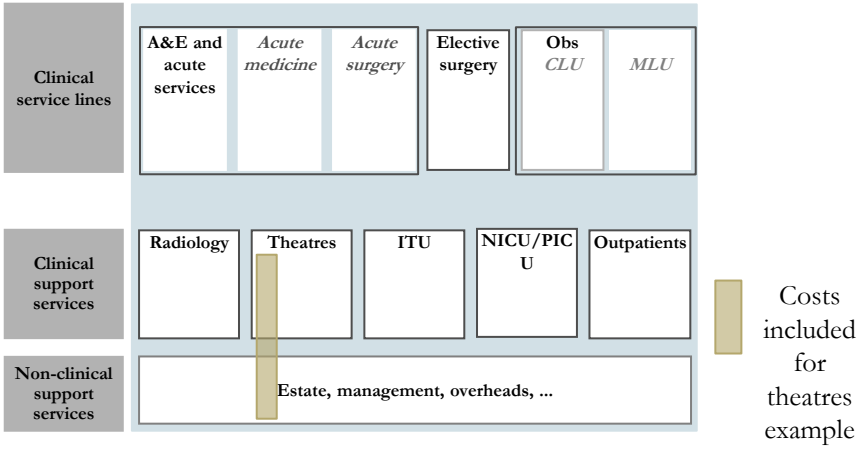


Methodology for support services (shared costs)

Identify the full set of inputs required to build expected costs for a "service line agnostic" support service – i.e. the shared costs of each support service

Include direct, indirect and overhead costs <u>not related to a specific service line</u>

- Direct: all service line agnostic resources directly consumed by patients
  - E.g. theatre costs would include scrub nurse (required for all service lines) but not orthopaedic ventilator (required only for orthopaedics)
- Indirect and overhead costs: as for service lines
- Metric will be output, rather than patient, specific
  - E.g. theatre cost per hour, cost per scan



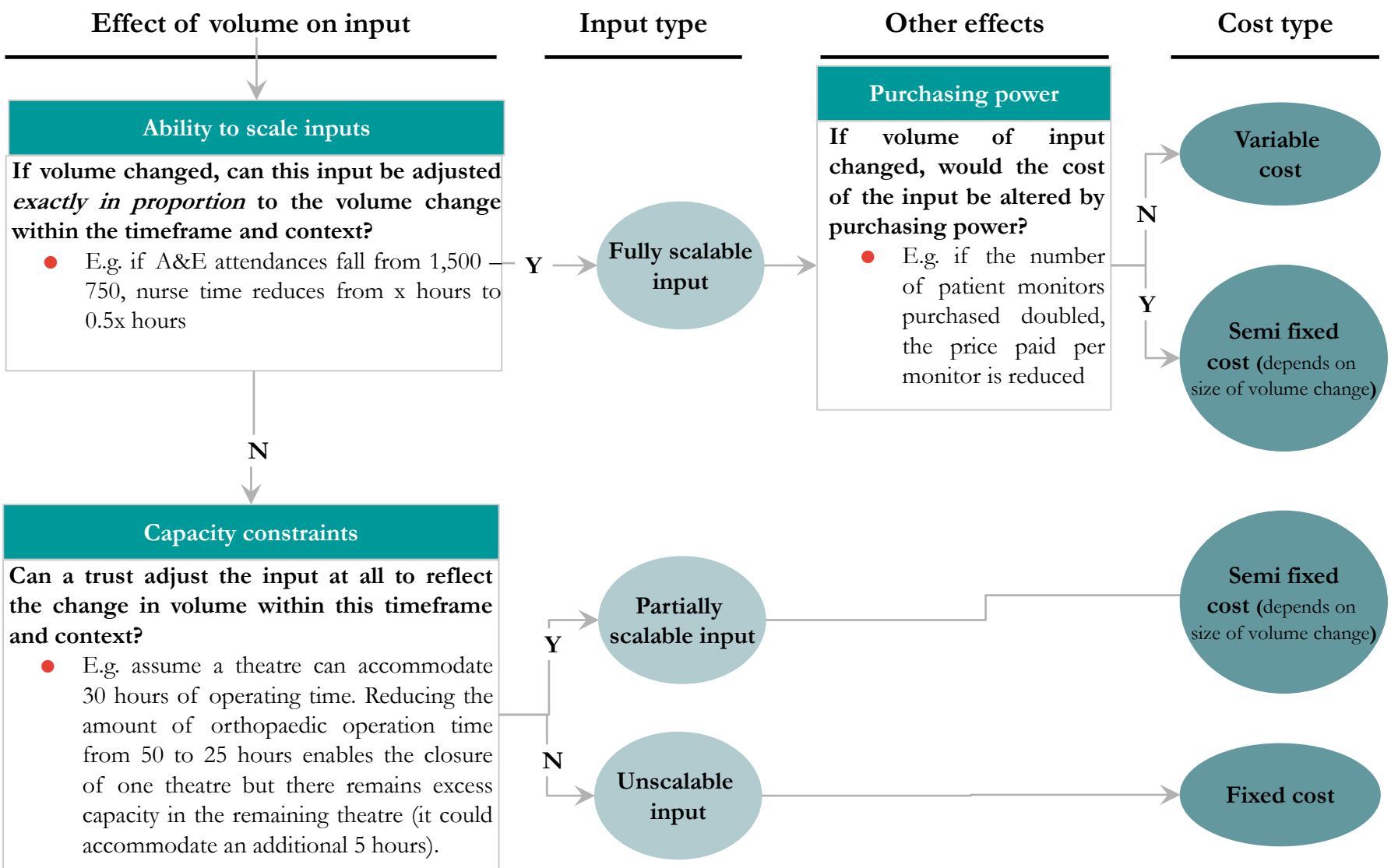
② Step 2: Sources

Gather information and data to build a picture of best practice use of inputs for different sizes of unit

The aim of building each scale curve is to identify what a best practice NHS trust (or equivalent comparator if different comparative context selected) would require in terms of inputs for different volumes of patients. This involves collecting and combining information from a range of sources. The boxes below indicate some of the key sources we have used to inform our models.

College guidelines	Royal College of Obstetricians and Gynaecologists Royal College of Midwifes British Orthopaedic Association Royal College of Surgeons College of Emergency Medicine Nursing and Midwifery Council Royal College of Physicians Royal College of Nursing British Association of Day Surgery
Other best practice guidelines/evidence	Department of Health NICE guidelines NHS Litigation Rotas/staffing guidance Patient pathways Audit Commission reports Healthcare Commission reports
Interviews with clinicians/key opinion leaders in the field	National Clinical Directors Royal Colleges Case study interviews with hospital clinicians and managers
Case study evidence from top performing trusts (data requested)	Hospital/unit floor plans Staffing levels and rotas Volume and outcome measures (length of stay, turn away rates, case mix) Costs (PLICS, Service line reporting, cost centre data, relevant business cases, reconfiguration plans) Patient flows (referrals between services, method of admission, support service usage)

③ For comparable units
Step 3: decide which inputs are fixed with respect to volume



Factors that might cause the cost curve to look different in the future should also be considered and noted

When identifying the inputs to a service line and classifying them according to how fixed they are, it is important to pay attention to any factors that might cause inputs or costs per input to look different in the future or in a different comparative context. These include:

Factors that might shift the cost curve include – anything that changes the number or cost of inputs required to see a given volume of patients:

- a change in best practice guidance that means more inputs are required to run a service e.g. requirements for greater input from consultants in supervising junior doctors, reductions in hours junior doctors can work;
- rising patient expectations leading to a focus on higher quality care; or
- a change in technology that means that fewer inputs are required to perform the same service or the cost of the inputs changes.

Factors that shift the slope of the cost curve include – anything that causes inputs to a service to become more or less fixed:

- technological changes that change the capacity of equipment;
- staff rostering changes such that it is easier or harder to change the number of staff in response to changes in patient numbers;
- changes to staff contracts such that they are more flexible in response to demand.

It may not be possible to fully identify the extent the change will affect the cost curves, but it will be important to know the nature in which it will affect the curve;

- **Shifts:** if the curve shifts up or down this will have implications for the minimum efficient scale of a service line
- **Slope:** if the change is to the slope of the curve, this will have implications for the extent of economies of scale present – the fewer fixed inputs involved in providing the service, the less significant are any economies of scale

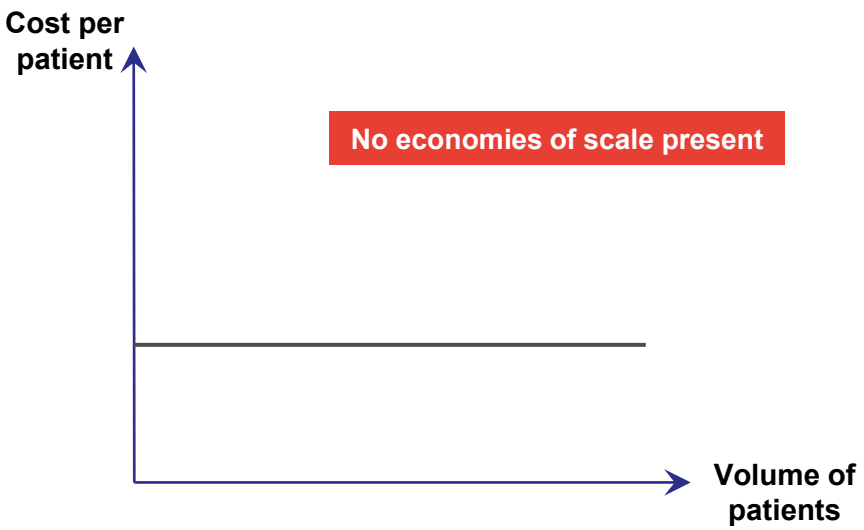
As an illustration, costs have been categorised as follows for two contrasting model examples

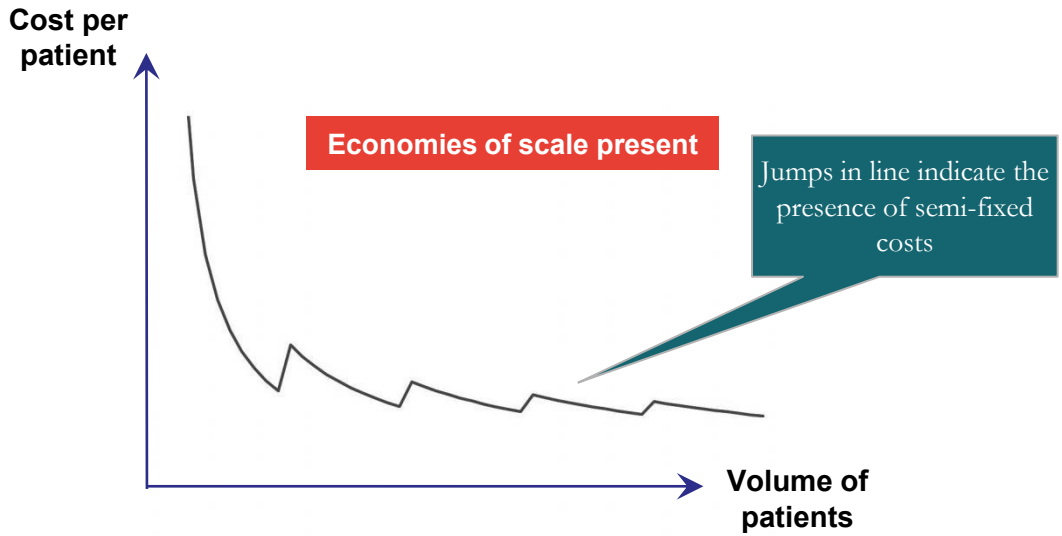
	"Standard" Level 1 A&E	Elective orthopaedics ward
Fixed cost	• **Capacity** –size of unit can not be changed easily (beds in A&E are not interchangeable with beds elsewhere). • **Fixed Minimum A&E and Acute Medical Unit staffing** –Minimum levels required for 24/7 presence • **Fixed Minimum Specialist staffing cover** – Paediatrics, Orthopaedics, General Surgery General Medicine, Radiographers, Radiologist • **Fixtures and fittings** for department • **Fixed minimum equipment** requirements • **Cleaning, property, management and administration**	• **Ward medical equipment** - would be fixed for the unit • **Orthopaedic specific theatre fittings** – would be fixed for the unit
Semi fixed costs	• **Other staffing** – consultant staffing above minimum levels, Nurses, Clinical Support Workers can be changed to reflect the number of attendances. Consultant staff can be changed to the nearest 1 WTE required, Nursing staff to the nearest 0.5 WTE. • **Equipment** – above minimum levels	• **Staffing for ward -** varies with number of patients – Consultant staff to the nearest 1 WTE required, Nursing staff to the nearest 0.5 WTE. • **Staffing for theatre** • **Fixtures and fittings** – varies according to the number of beds dedicated to orthopaedics within the hospital • **CNST** – fixed per WTE consultant on ward • **Cleaning, property and administration**
Variable costs	• **Drugs and medicines** • **Medical supplies** • **Catering, portering and laundry** • **Pathology**	• **Capacity** – beds in orthopaedics ward are interchangeable with beds elsewhere • **Drugs and medicines** • **Medical supplies** • **Catering, portering and laundry** • Cost of using **Pathology, Radiology, Theatres, ITU Orthopaedic theatre consumables and kit** • **Physiotherapy**

④ Step 4: create scale curve for comparable units

Using the information from steps 1 to 3, a scale curve for the service line can be plotted

Illustrative scale curves



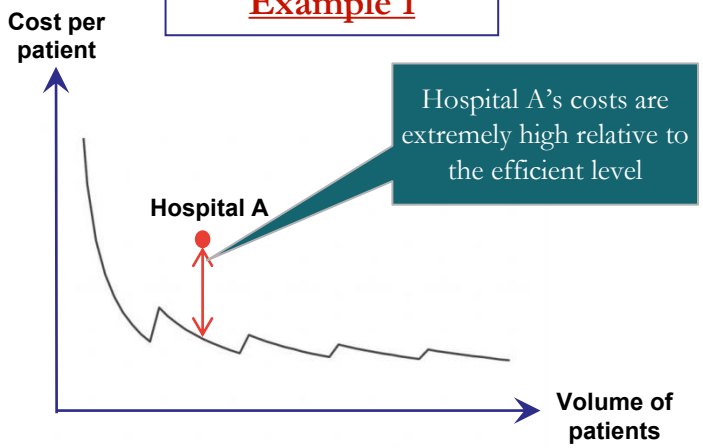


Interpreting cost curves when economies of scale are present

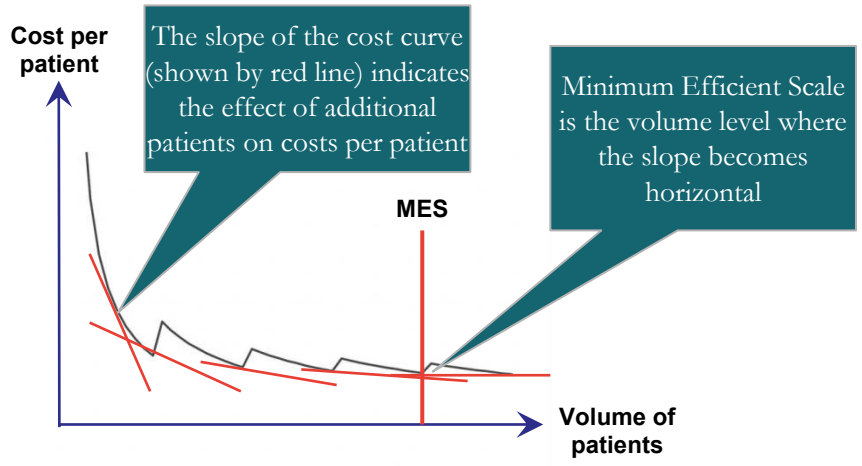
Once the cost curve for a service line have been generated, it can be combined with information on the actual costs of hospitals that offer that clinical service. This combination of information can be used to answer questions such as:

- **Are the costs of hospital A as expected for a unit of its size?** (this is seen by comparing the hospital's costs with the cost curve - see Example 1)
- **What is the Minimum Efficient Level for this service line?** (this is seen by identifying where the slope of the cost curve becomes zero – see Example 2)
- **Do any hospitals operate at or above the Minimum Efficient Scale level?** (this is seen by comparing the volume of patients seen by all hospitals that offer this service line against the MES volume level – see Example 3)

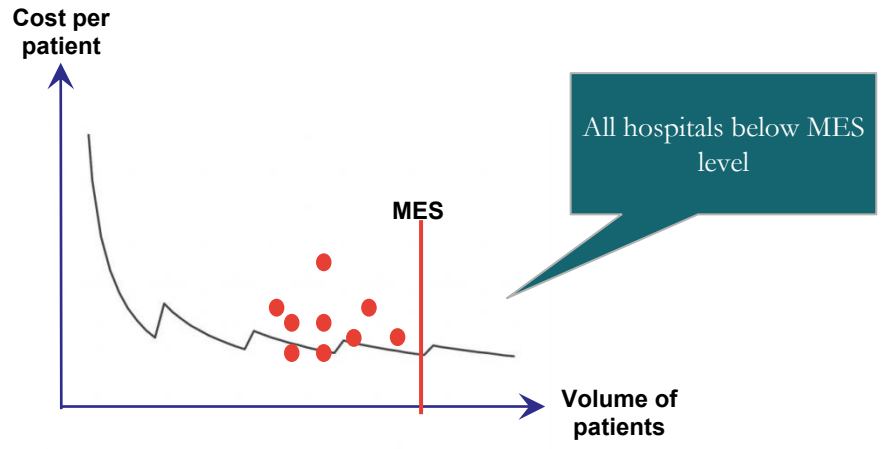
Example 1



Example 2



Example 3



More around interpreting curves combined with real cost information from trusts

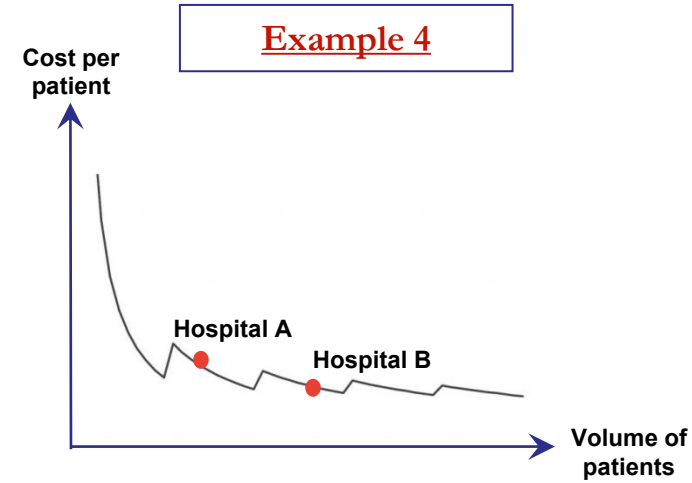
As described earlier, cost curves are generated using best practice guidance regarding inputs rather than specific operating models of particular trusts. This has implications for how we interpret the curves and, in particular, how we combine the curves with real information on costs provided by individual trusts. We consider two key questions Monitor might pose.

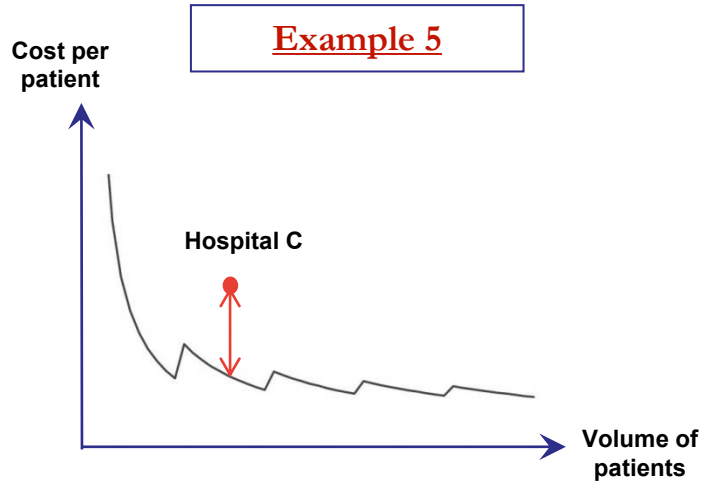
1. Could the unit in Hospital A be changed to look like the unit in Hospital B (see example 4)?

- This is not a straightforward question. Firstly, Hospital B has a much higher volume of patients than Hospital A. Assuming that additional volumes of patients could be available to Hospital A under a reconfiguration of services, then two further questions become relevant.
- **Timeframe:** Our curves are based on what a best practice NHS trust could achieve in a 2 to 3 year timescale. The same underlying curve could apply to a private sector comparator but they may be able to make the change in a shorter timeframe, perhaps under a year.
- **Capacity:** the key constraining factor in many instances is likely to be capacity. Units are of fixed sizes, so whilst it may be possible to incrementally increase the number of beds in a unit, whole scale change (such as doubling the size of a unit) may be much more difficult and costly. In several of our models, (Obstetrics, A&E) a continuum of overlapping but separate curves have been created to reflect the changes that could realistically be made by units of given sizes.

2. Is the unit in Hospital C inefficient?

- If the cost curves generated by the modelling were able to fully account for all factors that cause differences between hospitals then the answer to this question would clearly be yes.
- However, in considering any specific instance, Monitor must also consider, and seek evidence, of the other factors that could be causing this hospital to look inefficient. For example, extremely complex case mix or high quality (above best practice). If these factors can be ruled out, Hospital C does appear to be inefficient.





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Overview of the Step-by-Step guide to identifying economies of scope

There are four main steps to identifying economies of scope across a hospital. These are based around understanding the direct links between service lines and the indirect links (i.e. via use of the shared support services) and determining the extent to which inputs are genuinely fixed and shared. The slides that follow outline how to undertake this exercise.

1 Take a clinical service line

This is the clinical service line for which the extent of economies of scope is being investigated e.g. A&E, obstetrics, orthopaedics

2 Identify the linked clinical service lines

The next step is to identify which inputs (or groups of inputs) to the chosen service line are fixed or semi-fixed with volume and shared with other service lines.

Primary scope:
Direct use of staff used by other service lines e.g. orthopaedic surgeons on call to A&E and working within orthopaedics

Secondary scope:
Use of support services e.g. theatres, and radiology. These are shared with other clinical service lines

3 Draw relevant cost curves

Relevant cost curves will need to be drawn for both the primary and secondary scope effects.

These should identify the extent to which the shared inputs are scalable.

4 Determine magnitude of effect on costs of linked service lines

Using the cost curves for each service line and support service, the following questions can be answered:

- What would be the change in volume of usage of the input if the clinical service line closed?
- How would this affect the costs of the support service (if relevant)?
- What would be the knock on cost impact for other service lines (directly or via a support service)?

① Step 1: Select the unit for which economies of scope are under investigation

The first step is to select a type of unit for which economies of scope may be important. There are a number of possible questions under consideration for which this could be relevant, for example:

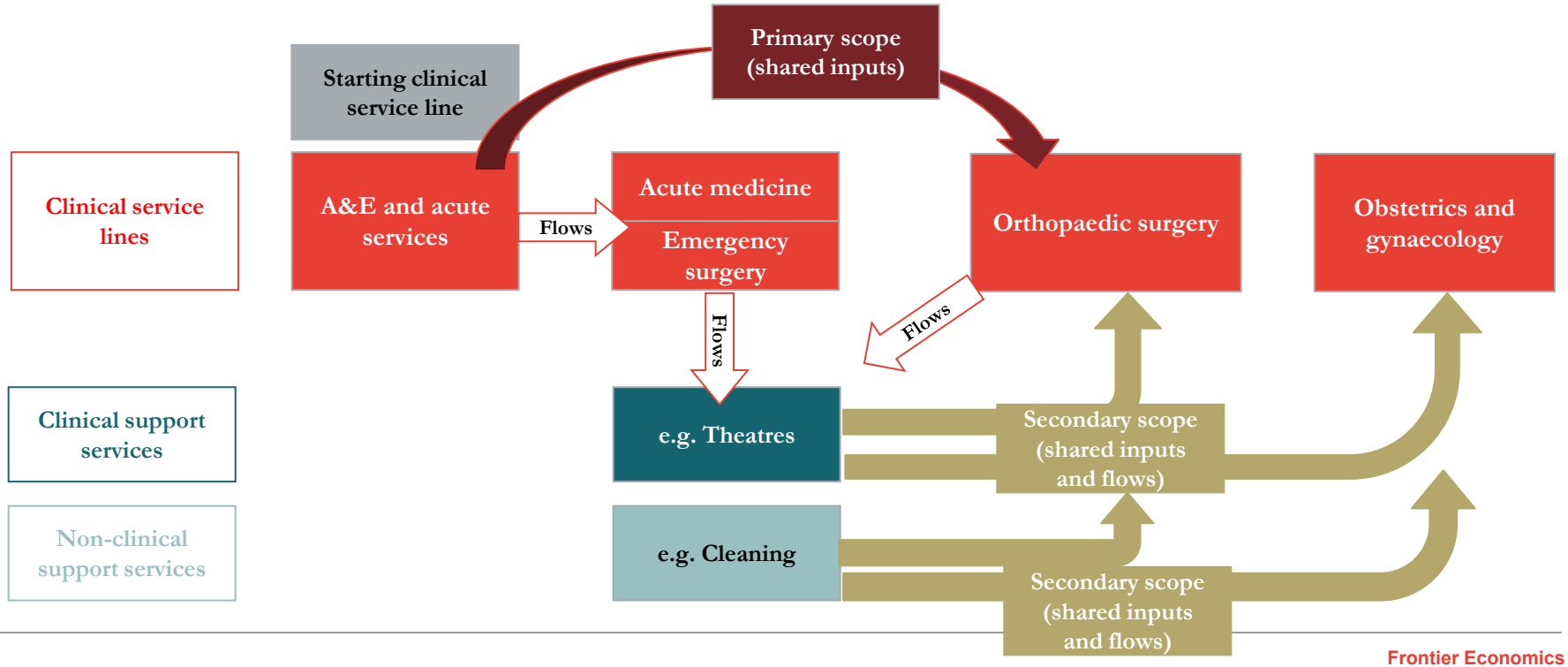
- If we take out elective orthopaedic work from a hospital, do other parts of the hospital remain financially viable such as:
  - the A&E department which relies on cover from orthopaedic consultants; or
  - other service lines that rely on shared support from radiology and theatres?
- If A&E Level 1 services from two separate hospitals are merged on to one site (and hence one A&E department is removed or downgraded), do other parts of the hospital remain financially viable such as:
  - the clinical support services (radiology, theatres, ITU) that rely on volume of patients through A&E to remain cost effective; and in turn;
  - the other clinical service lines that rely on those clinical support services?
- The unit that should be selected, in the first instance, is the one for which the change is being considered e.g. the elective orthopaedic department if it is that element of service that is under consideration or the A&E department if it is that which is under consideration. This should ensure that the relevant links from this starting service line are all considered.

② Step 2: Identify the linked clinical service lines

Step 2 involves identifying the linked clinical service lines. The first step in this process is to generate cost curves for the chosen unit (following the method described earlier as part of the economies of scale section). The process of generating the cost curves for the chosen service line (e.g. A&E) will allow two different types of linked clinical services to be identified:

- **Primary scope (shared inputs):** those service lines for which inputs are directly shared with other service lines (e.g. the use of orthopaedic consultants within A&E). In reality these primary scope effects may only affect a limited number of service lines such as A&E.
- **Secondary scope (shared inputs and patient flows)**: those service lines which share clinical support services with the affected service line (e.g. the shared use of theatres by elective orthopaedic surgery and emergency orthopaedic surgery (admitted via A&E)). To identify these service lines, it will be necessary to identify the other service lines that share the affected service line. Clearly, there is an additional effect across all service lines from the shared non-clinical support service costs.

The diagram below provides an illustrative example of the linked service lines for a Level 1 A&E (it does not capture all the links between A&E and other services (due to space constraints). As A&E requires cover from Orthopaedics there is a primary scope link. There is also a secondary scope link (via support services) to orthopaedic surgery as well as to other service lines such as obstetrics and gynaecology.



③ Step 3: Draw relevant cost curves

Step 3 is to draw the relevant cost curves. Cost curves will need to be drawn for the affected support services and the directly and indirectly affected service lines.

The cost curves can be drawn using the methodology described earlier for economies of scale. The key is to identify those inputs which are genuinely fixed and could not be adjusted to reflect volume changes from the chosen service line.

- Primary scope: the key is to understand to what extent the shared inputs could be scaled back if a service line was closed
  - For example, if elective orthopaedic surgery was taken off site, would the cost of consultant cover to A&E increase as the consultants are no longer shared with orthopaedics (and split their time between elective and emergency workload)?
  - For example, if an A&E was closed, would the same number of orthopaedic consultants be required to offer elective orthopaedic surgery as were required to offer elective and emergency orthopaedic surgery in combination?
- Secondary scope: the key is to understand the extent to which support service shared inputs could be scaled back if a service line was closed
  - For example, if A&E was closed and emergency surgery was no longer undertaken, would the same number of theatres need to be kept open? What would be the effect on the capacity of the remaining theatres? What would be the change in the cost of an hour's theatre use for other service lines following the closure e.g. elective orthopaedic surgery?
  - For example, if obstetrics and gynaecology was closed, would the same size of radiology department be required? Could the number of pieces of equipment and staff be reduced? What would be the change in the cost per scan or X-Ray after the closure?

The key

Is to identify those inputs which are genuinely fixed and could not be adjusted to reflect volume changes from the affected service line e.g. reducing the number of theatres and associated staff

Note: It may not always be necessary to develop cost curves for service lines only affected by secondary scope effects. The key will be identifying:

- the size of the increase in their costs from support service inputs (the number of patients affected and the magnitude of the change);
- whether or not the core service line is affected or specialist services which could be relocated; and
- where the core service line is affected, whether the change in costs is big enough to affect viability.

④ Step 4: Determine the magnitude of effect on costs of linked service lines

Step 4a) Identify patient volume changes as a result of change to chosen service line

- **Primary scope:** Identify the change in the volume of patients that make use of the inputs of the linked service line. For fixed inputs it is the total volume of patients to the service line that is the relevant number. For semi-fixed inputs, it is the number of relevant attendances i.e. those that require that input.
- **Secondary scope:** Identify the change in the volume of use of the support service as a result of the change to the clinical service line (e.g. closure of A&E), for example:
  - the number of radiological procedures that would no longer be required;
  - the number of hours of theatre time no longer required; or
  - the number of bed days in ITU no longer required.
- Also identify whether any potential mitigating volumes could be sought, for example:
  - from an elective or acute source;
  - from an alternative nearby unit; or
  - from increasing the volumes in an existing service line

Step 4b) Determine the magnitude of effect on support service costs (secondary scope only)

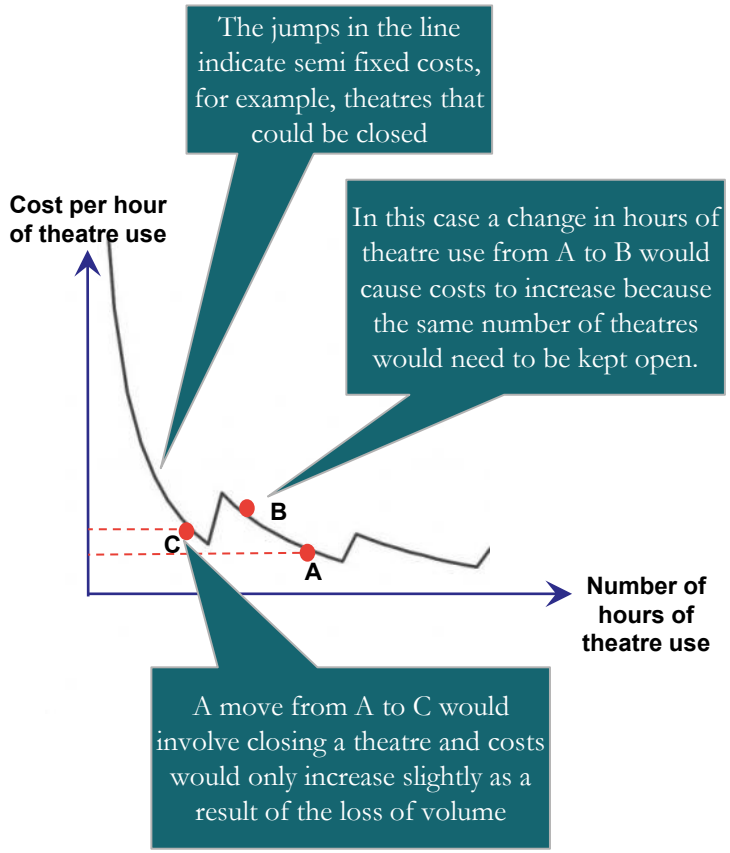
- **Secondary scope:** using the support services cost curve, identify the effect on the costs of support services e.g. increase cost per hour of theatre due to loss of orthopaedic volumes (see Figure 4b).

Step 4c) Determine the magnitude of effect on linked service line costs

- **Primary scope:** using the linked service line cost curve, identify the effect on the per patient costs to that service line
- **Secondary scope:** identify the extent to which the increased cost of support services will affect the service lines – this will depend on how much they use the support services and how big the cost increase is

Step 4d) Consider the extent to which further service lines become unviable and there are further knock on effects – in which case repeat Scope steps 1 to 4 for new service line.

Figure 4b



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Using the framework to address four alternative scenarios Monitor might face

The framework described in the previous slides sets out how Monitor can assess economies of scale and scope across all relevant services

- This may require Monitor to develop its view of cost-volume relationships for A&E, general acute inpatient medicine and surgery including geriatrics, elective surgery, obstetrics, clinical support services, ophthalmology, mental health and possibly others
- The case studies have focused on a selected number of services, but the approach will be applicable to all services

This section examines how Monitor might draw on the framework tools to address four alternative **illustrative** scenarios that Monitor *or other decision makers* might be faced with. The scenarios have been chosen to reflect alternative streams of work where economies of scale and scope may be a pervasive issue.

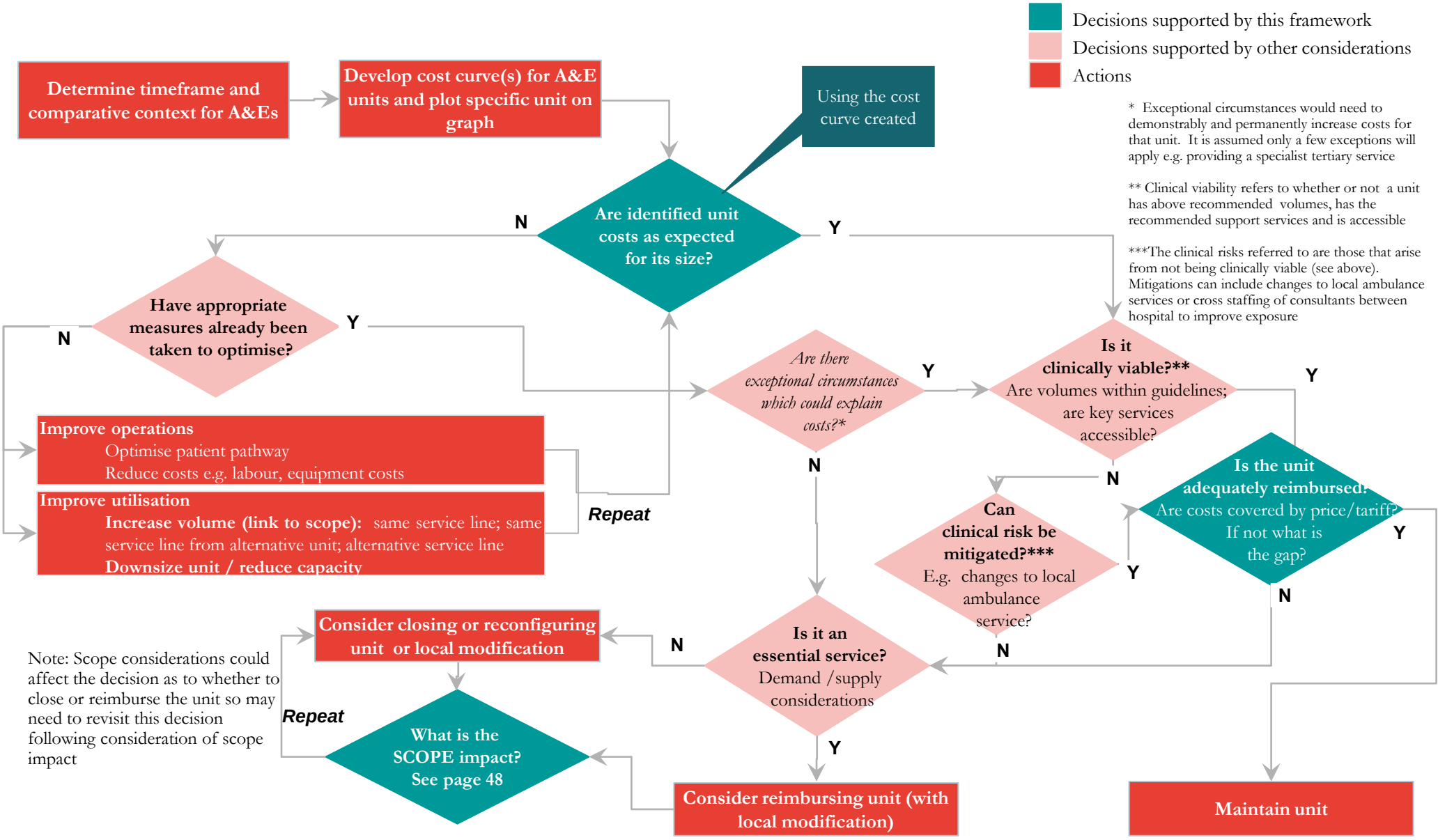
- **Scenario 1:** considering the future of a financially unviable A&E unit
- **Scenario 2:** understanding the scope impacts of closing a financially unviable A&E unit
- **Scenario 3:** considering whether to account for economies of scale in pricing
- **Scenario 4:** considering the implications of economies of scale and scope in healthcare for merger advice

In the slides that follow we set out the key steps that Monitor would need to undertake in considering what questions to ask and actions to take in each of these scenarios.

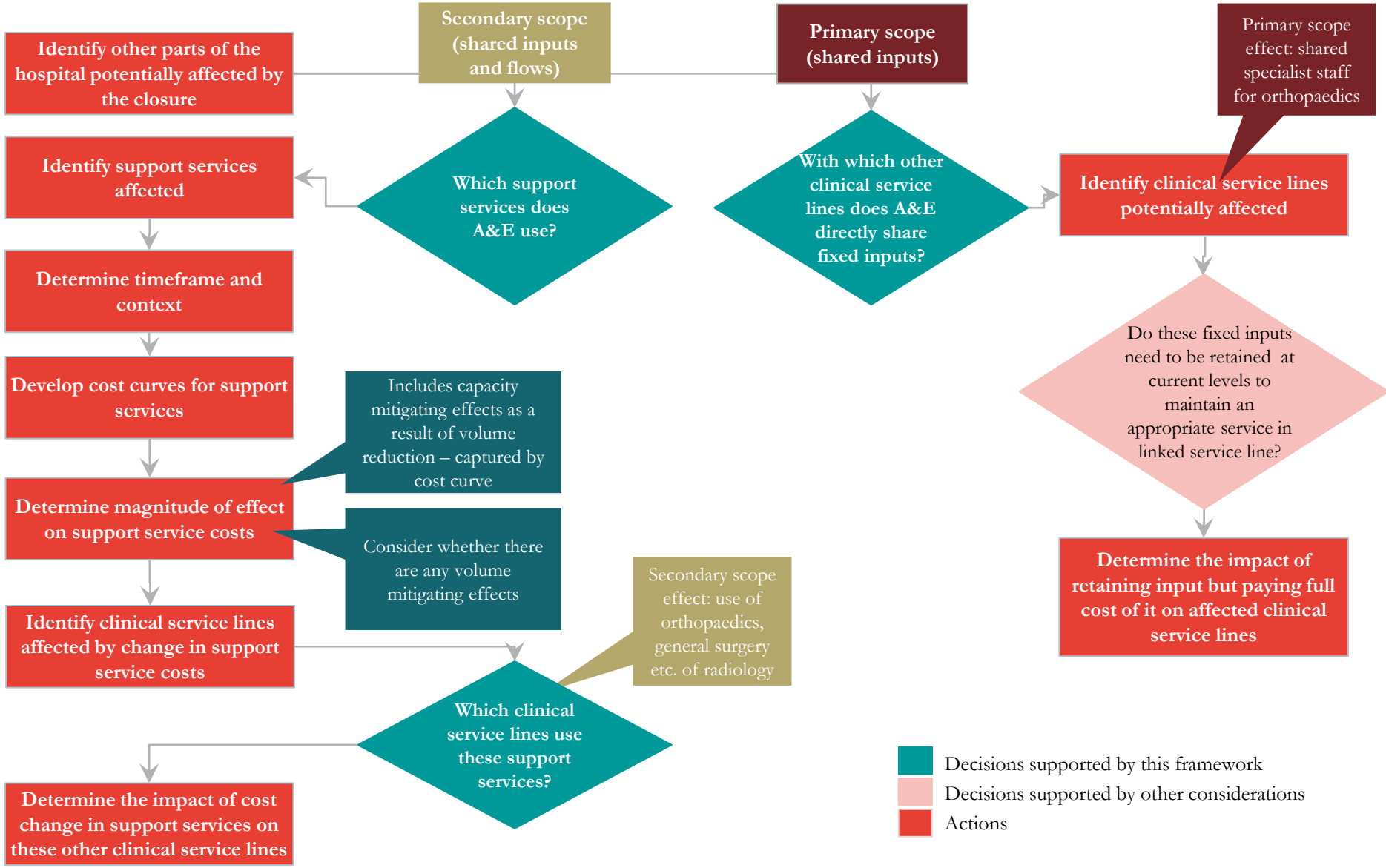
Clearly, there will be additional factors beyond economics of scale and scope that will need to be considered in any scenario. We have not attempted to include all of these factors in to the framework – rather, they should be thought of as separate considerations that need to be layered on top. They include:

- Clinical quality guidelines: requirement to co-locate services, e.g. Level 3 A&E and Acute Medicine
- Staffing guidelines: clinical and cost effects, e.g. 168 hour cover in consultant-led obstetrics units
- Training constraints: clinical and cost effects, e.g. ability to recruit to posts

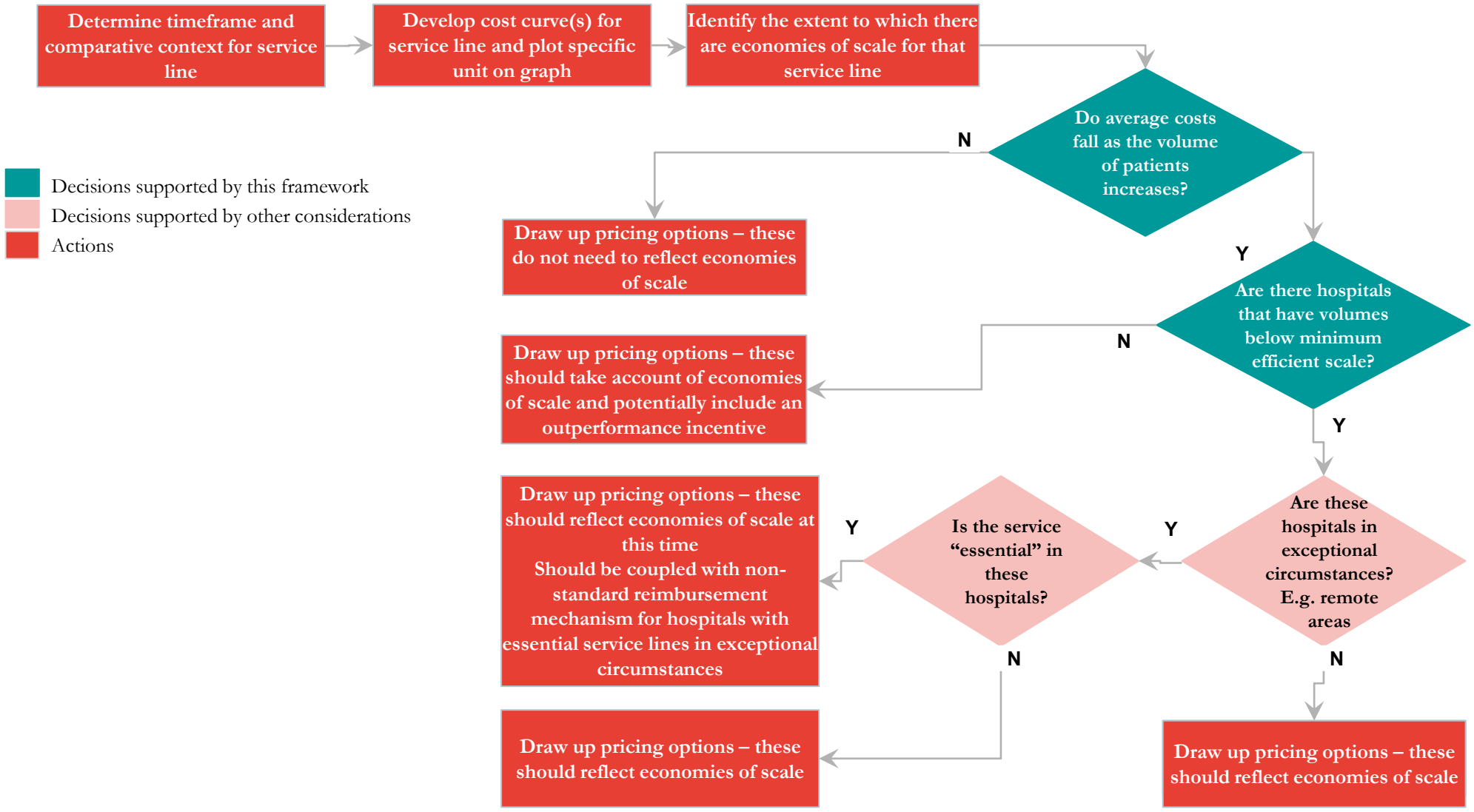
Scenario 1: Considering the future of a financially unviable A&E unit



Scenario 2: Understanding the scope impacts of closing a financially unviable A&E

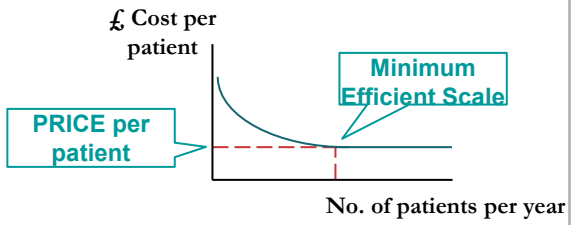
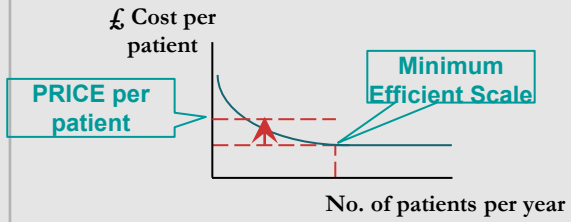


Scenario 3: Considering whether to account for economies of scale in price setting

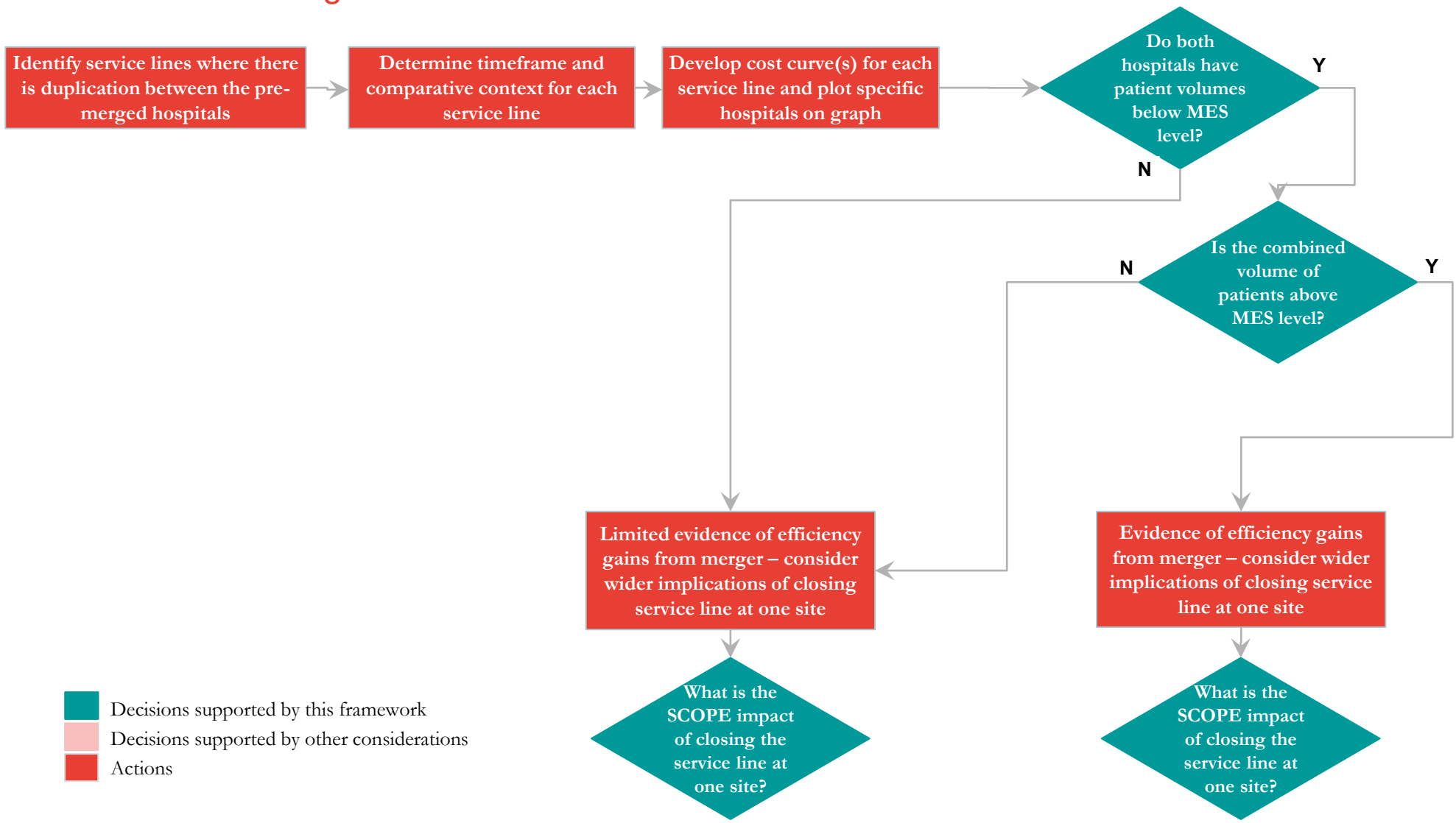


Possible price setting approaches to take account of economies of scale

The right pricing mechanism should balance the need for quality, scale and competition. The table below illustrates three possible pricing options to take account of economies of scale and their advantages and disadvantages.

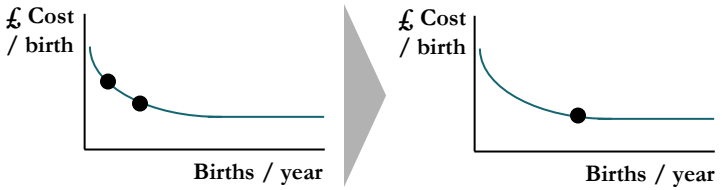
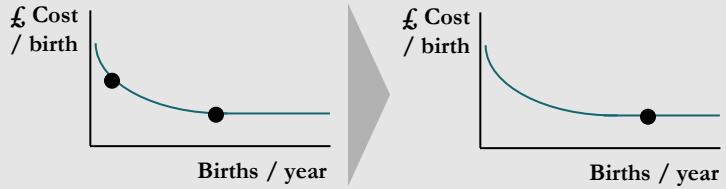
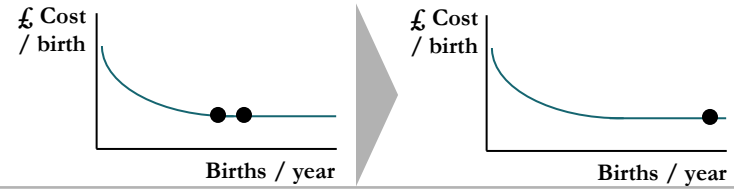
Method	Description	✓	✗
Price is set at the Minimum efficient scale price level		• Encourages static efficiency • Promotes service reconfiguration to larger scale units, with beneficial effects on cost and quality	• Smaller units may require subsidies (to ensure viability and prevent cost cuts which would affect quality) - not necessarily inefficient if clinical and other benefits outweighed efficiency loss. • MES pricing alone does not ensure local competition • Minimum efficient scale may change over time so may not encourage dynamic efficiency without price revisions
An agreed increment above Minimum efficient scale price level		• Ensures that some smaller but essential services are able to maintain viability without affecting quality	• More costly than setting prices at MES level • Does not promote extensive reconfiguration of health services • Does not promote efficiency unless gradually reduced over time • May limit innovation • Does not prompt a proper decision as to which small units are essential
There are different set prices for fixed and variable inputs	Set prices are determined for fixed inputs. These are distinct from those for variable inputs which are remunerated on a per patient basis. For example, a fixed charge to maintain the fixed costs of an A&E e.g. equipment and 24/7 rota plus a variable charge for per patient costs such as drugs, nursing staff above minimum threshold.	• More accurate • Ensures that smaller but essential services are able to maintain viability without affecting quality	• More complex to determine (requires a good understanding of the fixed and variable elements of the service) • More complex to determine as a decision will be required as to which small units are essential • More costly than setting prices at MES level (without accompanying subsidies) as likely to directly include subsidies for essential small units • Does not promote reconfiguration of health services

Scenario 4: Considering the implications of economies of scale and scope in healthcare for merger advice



An illustration of the alternative merger situations that could arise

Decisions about whether to allow two or more trusts to merge must take account of a range of factors. One such factor is whether the merger will bring about cost benefits. Cost benefits may arise in cases where economies of scale exist and existing units are sub-scale. The illustration below focuses on mergers to a single site. The extent to which mergers that retain multiple sites bring about cost savings via economies of scale and scope will depend on the extent to which there are fixed inputs that can be shared (not duplicated) across sites.

Scenario	Illustration of economic impact	Comments
Merger of two small obstetrics units on to a single site		• Cost per birth will decrease for all births – clear economic benefits • Competition may be reduced as fewer units competing. • But, a decrease in the cost per birth may bring about wider competitive or other benefits
Merger of one large and one small obstetrics unit on to a single site		• Cost per birth decreases for a smaller volume of births (those previously in the smaller unit) • Competition may be reduced as fewer units competing • But, a decrease in the cost per birth may bring about wider competitive or other benefits
Merger of two large obstetrics units on to a single site		• Cost per birth is unchanged • Competition may be reduced as fewer units competing

For the models we have created, we have made the following decisions about costs, timeframe and comparative context

	Units of output considered	Which inputs can be varied	Illustrative example
Short run average total cost (SRAC)	• Effectively, we are treating all units of output as incremental. Total cost of production shared between **all** units of output • In the future, when essential services have been designated, it might make sense to look at incremental costs for non-essential services.	• We are considering all inputs that can be varied within a **2-3 year period by a best-practice NHS Trust** as variable or semi fixed (i.e. where there is a degree of inherent indivisibility.	• The cost of A&E specific, orthopaedic specific and shared inputs are spread over combined A&E and orthopaedic volumes.
Timeframe: short run is 2-3 years	• Most cost improvement plans for NHS Trusts take place within the context of 2-3 years. This timeframe should allow a sufficient numbers of inputs (including labour) to be varied.		
Comparative context: NHS best-practice trust	• NHS best-practice is a realistic starting point for considering input changes within a 2-3 year period. There is also scope for considering private sector or US practice as a further marker.		

Other high level modelling assumptions

The slides that follow provide an overview of the assumptions made for each model and the resulting cost curves. A number of cross-cutting assumptions have been made to generate the models. These are set out below.

Where relevant, services have been segmented into sub-categories so as to build a full picture of the service line

- E.g. hip, knee and shoulder procedures in orthopaedics account for the majority of procedures

Different metrics have been used for different services to enable accurate cost bases, e.g. cost/birth for obstetrics, cost per attendance for A&E, cost per hour of theatre time for theatres

Costs has been approached as per the HFMA's Acute Health Clinical Costing Standards 2011/12

- This is the guidance issued to trusts and should enable comparisons with research-based findings

Service line costs per unit are fully loaded, including direct, indirect, overhead costs as per HFMA guidelines, and so as to enable comparison with tariff

- E.g. cost / birth includes allocated radiology costs and governance overheads

Support services are shared, with high fixed costs: costs per unit do not include service line specific costs

- E.g. theatres support multiple service lines: costs would include general (service line agnostic) but not orthopaedic-specific costs

Teaching / research costs are assumed to be fully reimbursed by SIFT / MADEL income and are not modelled specifically

- As per HFMA guidelines

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Obstetrics modelling – an overview

In the slides that follow, we set out the modelling work that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis. We have built two separate models of Obstetrics Units to represent the two different types of unit that exist (to illustrate the importance of identifying the key capability differences in terms of understanding inputs, costs and economies of scale): The models are (i) a Consultant Led Unit (CLU), and (ii) a Midwife Led Unit (MLU).

Inputs in both models are based on best practice clinical guidelines, which includes 168 consultant presence (no trust has currently achieved this) plus 1:1 midwife care in labour. In both models, we have assumed that all inputs are based on a single site. Whilst we recognise that some trusts share inputs across sites, we wanted to keep the modelling work as tractable as possible. However, we believe that only some of the required inputs could realistically be shared (without replication) between sites.

Other key assumptions include:

- the capacity of an Obstetrics unit (number of beds that can be accommodated) is fixed for the period of time under consideration (units of different sizes are therefore modelled); and
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Step 1: Determine appropriate comparator sets of units for obstetrics

Determine appropriate comparator set of units

- Midwife Led Units and Consultant Led Units modelled separately as different capabilities and input requirements
- Within MLUs: Case mix and location accounted for - adjusts curve rather than separate model
  - Case mix of Antenatal Care, Delivery and Postnatal Care
  - Salary bands for Inner London, Outer London, Fringe and other
- Within CLUs: Case mix and location accounted for – adjusts curve rather than separate model
  - Case mix of Antenatal Care, Delivery and Postnatal Care
  - Salary bands for Inner London, Outer London, Fringe and other

Driver	Impact on cost		Inclusion in model
Model of care • e.g. MLU vs. CLU	Impact on cost *e.g. CLU has higher staffing and equipment input requirements*	✓	Model MLU and CLU as separate units
Case mix within unit type • e.g. with or without complications & co morbidities	Impact on capacity *e.g. complex case mix increases length of stay; more capacity needed for same number of births*	✓	Input length of stay according to case mix (best practice for each level)
Location • E.g. Inner vs. Outer London	Impact on cost *e.g. uplift on salaries*	✓	Include salary bands for Inner London, Outer London, Fringe and Other
Turnaway rates • E.g. 0.01%, 0.1%, 1%	Impact on capacity *e.g. lower turnaway rates need more capacity for same number of births*	✗	Restrict turnaway rates between best practice parameters e.g. From 0.01% to 0.1%
Integrated support services • e.g. dedicated obstetrics HDU	Impact on costs *e.g. presence on HDU means higher cost of equipment*	✗	Only applicable to tertiary units. Critical care covered by separate tariff
Teaching/research costs	Impact on costs *e.g. can increase length of stay*	✗	Assumed to be fully reimbursed by SIFT/MADEL income as per HFMA guidelines

Step 2: Determine inputs and key assumptions for obstetrics

Determine inputs and key assumptions for Obstetrics Units

- The slides in the annexe set out the key inputs for a Consultant Led Unit
- Included are:
  - Staffing
  - Consumables
  - Medical equipment
  - Fixtures and fittings
  - Other building costs
  - Indirect and overhead costs (e.g. portering, catering, management)
  - Cost for use of support services
- The allocation method indicates whether the cost has been treated as fixed, semi-fixed or variable
- The assumptions indicate exactly how the costs have been calculated and attributed
- The average cost provides an annual figure for how much each input item would cost

Key assumptions for Obstetric Units

According to maternity pathway payments we model antenatal, delivery and postnatal care

- This includes community based care, inpatient and outpatient care, scans, screens and tests, births, post birth care for well and healthy babies and CNST payments
- This excludes critical care – covered under own tariff and neonatal/paediatric care – covered under own tariff

Costs are modelled according to best practice

- 168 hour consultant presence, 1:1 midwife care in labour
- Only co-located MLUs are modelled (standalone units are not best practice)
- Nursing staff are able to operate on flexible contracts (e.g. 0.5 WTE), Consultant medical staff operate on a WTE basis only

There is no vertical integration between clinical support services and obstetrics

- Obstetrics theatre is dedicated to obstetrics and not a support service, therefore it is within service line costs

Step 3: Identify fixed inputs for a Consultant Led Unit (CLU)

Fixed inputs – these inputs are fixed for a given size of unit (i.e. do not change with the volume of births)

- **Capacity** – Consultant led units are self contained so if the volume of births changes the size of the unit cannot be changed easily (beds in obstetrics are not interchangeable with beds elsewhere). This means that costs are established for specific sizes of unit.
  - A scale curve is modelled for the volume range each unit (calculated on delivery beds only) can accommodate within acceptable turn away ranges (0.01%-1%)
  - A unit is equipped for the maximum number of births they can accommodate
- **Fixed Minimum staffing** – O&G Consultant, O&G Specialist and Staff Grade doctors, Anaesthetist Consultant and Duty Anaesthetist. Minimum levels of staffing required for a 24/7 presence - could not run the unit without this presence
- **Fixtures and fittings for unit** – required to run the unit
- **Medical equipment and fixtures and fittings for outpatient unit, delivery suite, labour rooms and antenatal beds, theatres** – required to run the unit
- **Cleaning, property costs, management and administration** – required to run the unit

Semi fixed inputs – these inputs can be changed according to the number of births within a unit but some indivisibility

- **Staffing for delivery suite** - O&G Registrar, O&G SHO, O&G JHO, Midwife Consultant, Midwife, Registered Nurse, MSW, HCA. These inputs can be changed to reflect the number of births in a unit. Consultant staff can be changed to the nearest 1 WTE required, Nursing staff to the nearest 0.5 WTE.
- **Staffing for outpatient appointments** - O&G consultant, Midwife, Sonographer. Can be changed to reflect the number of births to within nearest 1 WTE Consultant staff and 0.5 for nurses.
- **Staffing for Obstetrics theatres** – O&G consultant, Anaesthetist, Scrub Nurse, Nurse (as above)

Variable inputs – can change fully according to number of births

- **Drugs and medicines**
- **CNST**
- **Catering, portering and laundry**
- **Pathology**
- **Cost of using ITU and HDU**

Step 4: The inputs that are fixed in a Consultant Led Unit

Our modelling indicates that semi-fixed costs are a reasonably significant feature of Consultant Led Units. We find that for a 8 bed Unit, semi-fixed costs make up 34% of total costs, increasing to 51% for a 16 bed unit and to 52% for a 21 bed unit. Fixed costs are also a significant feature with 34% of the costs of a 8 bed Unit being fixed, although as the size of the unit increases (which increases the volume of activity), it falls to 24% for a 16 bed unit and 23% for a 21 bed unit.

The staffing requirements mean that many of the fixed and semi-fixed costs are labour. In fact, for a 8 bed unit, staffing costs alone make up 66% of costs, falling to 62% for a 21 bed unit.

The presence of these fixed costs means that economies of scale are relatively significant. We find that the Minimum Efficient Scale for a CLU is at least 8,000 births per year (see next slide). Units with births of around 2,500 or below, are well below Minimum Efficient Scale and therefore have much higher costs per birth. This is certainly consistent with Royal College guidance which expresses specific concern for smaller units delivering fewer than 2,500 babies per annum.

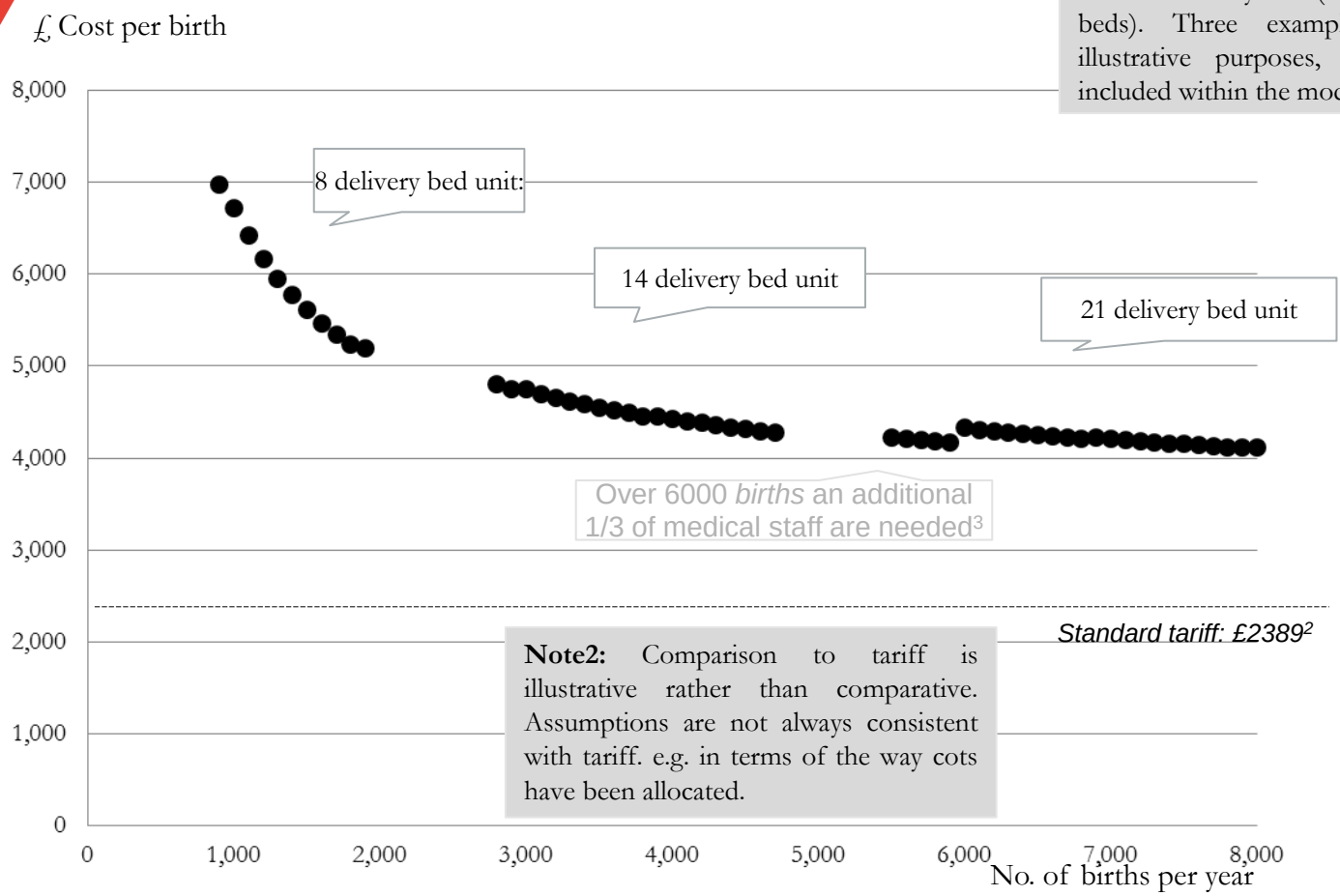
Nature of input	Proportion of costs (%) 8 bed unit	Proportion of costs (%) 16 bed unit	Proportion of costs (%) 21 bed unit
Fixed	34%	24%	23%
Semi-fixed	45%	51%	52%
Variable	21%	25%	25%

Type of input	Proportion of costs (%) 8 bed unit	Proportion of costs (%) 16 bed unit	Proportion of costs (%) 21 bed unit
Labour	66%	62%	62%
Non-labour	34%	38%	38%

Step 4: Consultant Led Obstetrics Unit cost curve: worked example

Create scale curve for Consultant Led Obstetrics Unit

Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, curves can be produced for units of any size (i.e. any number of beds). Three examples shown for illustrative purposes, but others are included within the modelling.



Note2: Comparison to tariff is illustrative rather than comparative. Assumptions are not always consistent with tariff. e.g. in terms of the way cots have been allocated.

1. HES 2. Pathway payments standard antenatal and postnatal care, birth without cc Source: For full list see costing model 3. Case study based

Step 3: Identify fixed inputs for a Midwife Led Unit (MLU)

Fixed inputs – these inputs are fixed for a given size of unit (i.e. do not change with the volume of births)

- **Capacity** – Midwife led units are self contained so if volume of births changed the size of the unit could not be changed easily (beds in obstetrics are not interchangeable with beds elsewhere). This means that costs are established for specific sizes of unit.
  - A scale curve is modelled for the volume range each unit (calculated on delivery beds only) can accommodate within acceptable turn away ranges (0.01%-1%)
  - A unit is equipped for the maximum number of births they can accommodate
- **Fixtures and fittings for unit** – required to run the unit
- **Medical equipment and fixtures and fittings for outpatient unit, delivery suite, labour rooms and antenatal beds** – required to run the unit
- **Cleaning, property costs, management and administration** – required to run the unit

Semi fixed inputs – these inputs can be changed according to the number of births within a unit but some indivisibility

- **Staffing for delivery suite** - Midwife Consultant, Midwife, Registered Nurse, MSW, HCA. These inputs can be changed to reflect the number of births in a unit. Consultant staff can be changed to the nearest 1 WTE required, Nursing staff to the nearest 0.5 WTE.
- **Staffing for outpatient appointments** - Midwife, Sonographer. Can be changed to reflect the number of births to within nearest 0.5 for nurses.

Variable inputs – can change fully according to number of births

- **Drugs and medicines**
- **CNST**
- **Catering, portering and laundry**

Step 4: The inputs that are fixed in a Midwife Led Unit

Our modelling indicates that fixed costs represent a smaller share of costs in Midwife Led Units than in Consultant Led Units. The reason for this is that a big part of the CLU fixed staffing (consultant, specialist and anaesthetists) is not needed. We find that for a 5 bed Unit, fixed costs make up 15% of total costs, falling to 14% for a 8 bed unit and 12 bed unit. Semi-fixed costs are the most significant feature in MLUs with 52% of the costs of a 5 bed Unit being semi-fixed. For larger units the percentage of semi-fixed costs is nearly the same.

The staffing requirement mean that many of the fixed and semi-fixed costs are labour. In fact, for a 5 bed unit, staffing costs alone make up 52% of costs, rising to 53% for a 12 bed unit.

The presence of these fixed costs means that economies of scale are present. We find that the Minimum Efficient Scale for a MLU is at least 3,500 births per year (see next slide). Units with births of around 1,000 or below, are well below Minimum Efficient Scale and therefore have much higher costs per birth. This is not consistent with anecdotal evidence that the recommended MLU size is 500-1000 births per annum.

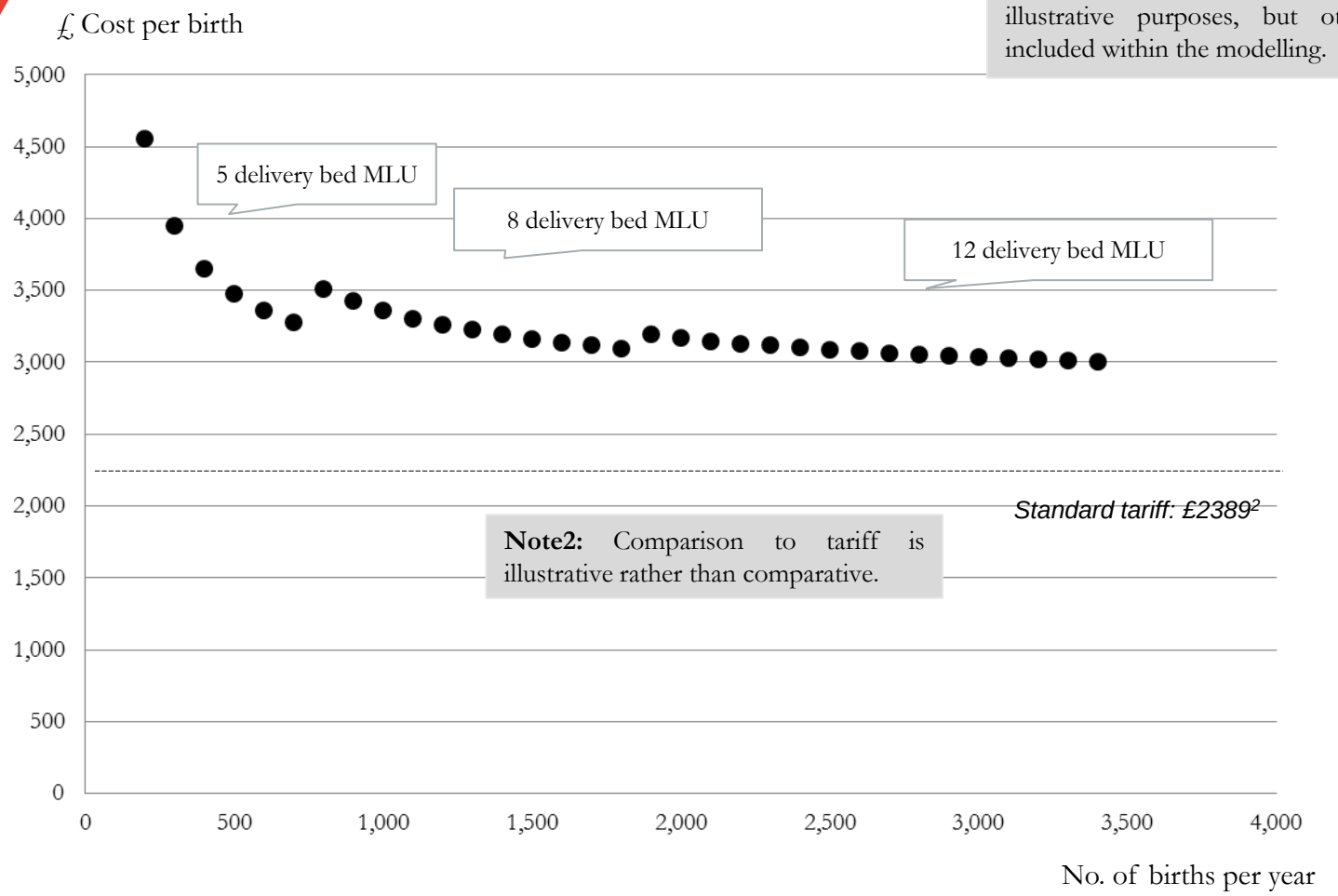
Nature of input	Proportion of costs (%) 5 bed unit	Proportion of costs (%) 8 bed unit	Proportion of costs (%) 12 bed unit
Fixed	15%	14%	14%
Semi-fixed	52%	53%	53%
Variable	34%	33%	34%

Type of input	Proportion of costs (%) 5 bed unit	Proportion of costs (%) 8 bed unit	Proportion of costs (%) 12 bed unit
Labour	52%	53%	53%
Non-labour	48%	47%	47%

Step 4: Midwife Led Obstetrics Unit cost curve: worked example

Create scale curve for Midwife Led Obstetrics Unit

Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, **c**urves can be produced for units of any size (i.e. any number of beds). Three examples shown for illustrative purposes, but others are included within the modelling.



1. HES 2. Pathway payments standard antenatal and postnatal care, birth without cc Source: For full list see costing model

Obstetrics - Key modelling assumptions and caveats

The modelling results presented in this report for Obstetrics are based on an extensive review of the literature about economies of scale and scope, interviews with the relevant Royal Colleges and National Clinical Directors as well as case study visits and data. Subject to data and timing constraints, they represent our best view as to the inputs required to run the two different types of Obstetrics departments. That said, the models were developed to aid the development of the framework set out in this report rather than as a core output in their own right. They should therefore be regarded with a degree of caution since their development has been based on guidance and advice about the core inputs for a service and data from a limited number of case studies, rather than specific data gathered across a broad range of trusts.

As with all modelling exercises of this nature, they make use of a range of assumptions and are therefore accompanied by a number of caveats. We outlined a number of key overarching assumptions earlier on pages 62-63. However, there are also a number of other more specific assumptions that have been made. These are outlined below:

- **Drugs and medicine, blood and consumables:** costs based on a sample of case study trusts so may not be representative of best practice
- **Capacity:** modelled on number of delivery beds - does not take into account any single rooms that could be used for delivery
- **Length of Stay:** based on national average and does not reflect CLU versus MLU
- **CNST:** an approximate cost from NHS Litigation - there is likely to be variation amongst trusts and it is expected that trusts with 168 hour consultant presence would have considerably reduced payments
- **Outpatient and Community Care**: no adjustments are made for the outsourcing of outpatient or community care
- **HDU:** dedicated HDU units have not been included
- **Theatre building depreciation**: not specific to an obstetrics theatre
- **Use of support services e.g. ITU and HDU**: not adjusted for case mix – it is at national levels from safer childbirth
- **Estates cost:** we have included the cost of renting the buildings to capture the full economic cost - this has been estimated using a report from the UK's valuation company which is not hospital-specific
- **Indirect and overhead costs:** current benchmarks for Indirect and Overhead costs are based on trusts in Scotland

- Executive Summary
- Introduction and context
- Approach to the work
- Framework
  - Economies of scale and scope in healthcare - technical overview
  - Timeframe and comparative context
  - Methodology for developing cost curves
  - Methodology for identifying scope implications
- Framework application: four alternative scenarios
- Illustrative implications from modeling work
  - Obstetrics
  - A&E
  - Orthopaedics
  - Support services
  - Scope implications
- Next steps and recommendations
- Annexes

A&E modelling – an overview

In the slides that follow, we set out the modelling work that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis. We have built two separate models of A&E to represent two of the different types of A&E departments that exist (to illustrate the importance of identifying the key capability differences in terms of understanding inputs, costs and economies of scale): The models are (i) a "Standard" Level 1 A&E, and (ii) a Level 1 A&E with trauma specialisation.

"Standard" Level 1 A&E

This model is meant to reflect a department with *full backup facilities on site*. By this we mean that it has:

- Specialist support from Paediatrics, Orthopaedics, General Surgery, General Medicine, Radiography and Radiology on site; and
- Co-located ITU support (Critical Care).

Level 1 A&E with additional trauma specialisation

- This model is meant to reflect a department with *full backup facilities on site (*as for the *"Standard" Level 1 A&E)*
- It also has an *additional specialisation,* in this case trauma. This additional specialisation means that the department also requires on site support from neurosurgery, spinal surgery, plastic surgery, vascular surgery, cardiothoracic surgery and anaesthetics as well as 168 hour support from trauma consultant and doctors.

Inputs in both models are based on best practice clinical guidelines, which includes 168 consultant presence in A&E plus 168 specialist support cover from the 4 key specialties, radiography and radiology. In both models, we have assumed that all inputs are based on a single site. Whilst we recognise that some trusts share inputs across sites, we wanted to keep the modelling work as tractable as possible. However, we believe that only some of the required inputs could realistically be shared (without replication) between sites. The main inputs for which this would be true would be support from Specialist Staff and some general hospital overheads.

Other key assumptions include:

- the capacity of an A&E unit (number of beds that can be accommodated) is fixed for the period of time under consideration (units of different sizes are therefore modelled);
- the split of emergency to non-emergency attendances to hospital is a reasonable proxy for the proportion of Specialist Staff time allocated to work on A&E (checked with case studies as far as possible); and
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Step 1: Determine appropriate comparator sets of units for A&E

Determine appropriate comparator set of units

- A&Es have differing capabilities. This is broadly classified in terms of the Level of the department*.
- Different levels of department would need to be modelled separately. However, within the classification of Level 1 departments, a further split has been made according to whether the A&E has additional specialisation (trauma, stroke, heart attack). For the purposes of modelling, only Level 1 departments have been modelled. These have been split into:
  - "Standard" Level 1 A&Es; and
  - Level 1 A&Es that accept trauma.

Driver	Impact on cost		Inclusion in model
Capabilities offered • e.g. ability to cope with trauma	Impact on inputs *e.g. Trauma units require additional staffing*		Model different levels of department separately (only Level 1 departments modelled) Split Level 1 departments according to additional specialisations (trauma, stroke, heart attack)
Case mix within unit type	Impact on capacity		No evidence to support case mix differentiation within type of unit.
Location • E.g. Inner vs. Outer London	Impact on cost *e.g. uplift on salaries*		Include salary bands for Inner London, Outer London, Fringe and Other
Turnaway rates • E.g. 0.01%, 0.1%, 1%	Impact on capacity *e.g. lower turnaway rates need more capacity for same number of attendances*		Restrict turnaway rates between best practice parameters
Teaching/research costs	Impact on costs *e.g. can increase length of stay*		Assumed to be fully reimbursed by SIFT/MADEL income as per HFMA guidelines
Integrated support services • e.g. dedicated diagnosis services	Impact on costs *e.g. presence of diagnosis equipment and personnel*		Key radiology equipment included within A&E in line with best practice

*We understand that the Levels denomination may be changing shortly.

Step 2: Determine inputs and key assumptions for "standard" Level 1 A&E

Determine inputs and key assumptions for "standard" Level 1 A&E

- The slides in the annexe set out the key inputs for a "standard" Level 1 A&E
- Included are:
  - A&E specific staff
  - AMU staff
  - Specialist support staff
  - A&E Beds
  - AMU Beds
  - Equipment
  - Consumables
  - Other building costs
  - Indirect and overhead costs (e.g. portering, catering, management)
  - Cost for use of support services
- The allocation method indicates whether the cost has been treated as fixed, semi-fixed or variable
- The assumptions indicate exactly how the costs have been calculated and attributed
- The average cost provides an annual figure for how much each input item would cost

Key assumptions for "standard" Level 1 A&E

Costs are modelled according to best practice

- 168 hour A&E consultant presence
- 168 hour Specialist support cover from 4 main specialties (Paediatrics, Orthopaedics, General Surgery and General Medicine). Assumed that ITU would be co-located but not included in costs as support service.
- 168 hour support from radiographers and radiologists
- Co-located AMU assessment unit included (6-12 hour average stays)
- Nursing staff are able to operate on flexible contracts (e.g. WTE), Consultant medical staff operate on a WTE basis only

There is no direct vertical integration between clinical support services and A&E

- Radiology for A&E is dedicated and not a support service, therefore it is within service line costs. This reflects best practice

Step 3: Identify fixed inputs for a "standard" Level 1 A&E

Fixed inputs – these inputs are fixed for a given size of unit (i.e. do not change with the number of attendances)

- **Capacity** – A&E units are self contained so if volume of attendances changed the size of the unit could not be changed easily (beds in A&E are not interchangeable with beds elsewhere). This means that costs are established for specific sizes of unit.
  - A scale curve is modelled for the volume range each unit (calculated on total A&E beds) can accommodate within an acceptable range
  - A unit is equipped for the maximum number of attendances they can accommodate
- **Fixed Minimum staffing** – A&E Consultant, Middle grade, Junior Grade - Minimum levels of staffing required for a 24/7 presence.- could not run the unit without this presence
- **Fixed Minimum Specialist staffing cover** – Paediatric consultant. Orthopaedics consultant, General Surgery Consultant, General Medicine Consultant and Middle grade specialist support for each of the aforementioned, plus Radiographers, Radiologist Consultant
- **Fixed Minimum Acute Medical Unit staffing** – Consultants, Middle grade, Junior grade
- **Fixtures and fittings for unit and Acute Medical Unit** – required to run the unit
- **Equipment** – One of each of Ultrasound, CT, MRI, Blood gas machine
- **Beds** – fixed for size of unit
- **A&E admin/reception staff** - minimum level
- **Cleaning, property costs, management and administration** – required to run the unit

Semi fixed inputs – inputs can be changed according to the number of attendances but some indivisibility

- **Other staffing** – staffing above minimum levels, Nurses, Clinical Support Workers. These inputs can be changed to reflect the number of attendances (in a non-linear way as advised by the College of Emergency Medicine). Consultant staff and nursing staff can be changed to the nearest 1 WTE required.
- **Equipment** – X-ray machines depend on attendances

Variable inputs – can change fully according to number of attendances

- **Drugs and medicines**
- **Medical supplies**
- **Catering, portering and laundry**
- **Pathology**

Step 4: The inputs that are fixed in a "Standard" Level 1 A&E

Our modelling work on a "Standard" Level 1 A&E has tried to capture those inputs that are required for an A&E with *full backup facilities on site*. By full backup facilities, we are referring to:

- Specialist support from Paediatrics, Orthopaedics, General Surgery, General Medicine, Radiography and Radiology; and
- Co-located AMU support (Acute Medical Unit).

Our modelling indicates that semi-fixed costs, which are mainly the specific costs of the A&E staff, are a significant feature of A&Es of this type, making up around 50% of total costs. Fixed costs are also a significant feature, with 37% of the costs of A&E units with 25 beds being fixed, decreasing to 28% for 200 beds. The most relevant fixed costs are the specialists that provide support to the A&E department.

The rostering and specialist cover requirements of a Standard A&E mean that most of the fixed and semi-fixed costs are labour. In fact, for a 25 bed unit, labour costs alone make up 81% of costs, falling to 65% for a 200 bed unit. For a 25 bed unit the fixed specialist support costs account for 30% of all costs.

The presence of fixed costs means that economies of scale are significant within A&E. We find that the Minimum Efficient Scale for an A&E is around 600,000 attendances per year (see next slide). We note that is beyond the size of the majority of A&E units in this country, although several providers (with multiple units) may reach this scale. We also note that the majority of the scale economies are exhausted by units with around 350,000 attendances. Units with attendances of around 100,000 or below, are well below Minimum Efficient Scale and therefore have much higher costs per attendance.

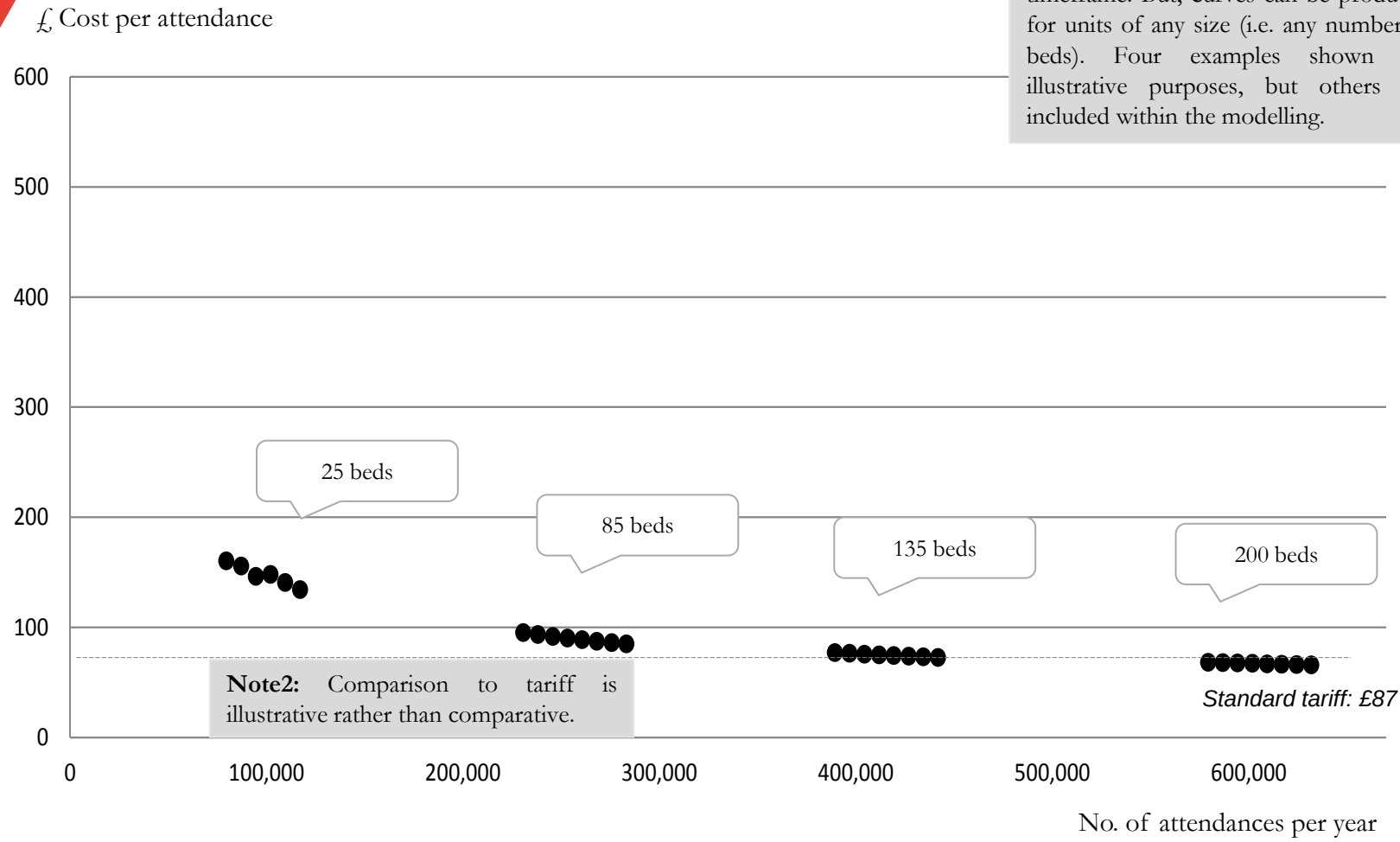
Nature of input	Proportion of costs (%)			
	25 beds	85 beds	135 beds	200 beds
Fixed	37%	32%	30%	28%
Semi-fixed	50%	53%	54%	54%
Variable	13%	16%	17%	18%

Type of input	Proportion of costs (%)			
	25 beds	85 beds	135 beds	200 beds
Labour	**81%**	**71%**	**68%**	**65%**
A&E specific	42%	47%	49%	50%
Specialist support	30%	19%	14%	11%
Acute Medicine	9%	6%	4%	3%
Non-labour	**19%**	**29%**	**32%**	**35%**

Step 4: "Standard" Level 1 A&E cost curve: worked example

Create scale curve for "Standard" level 1 A&E

Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, curves can be produced for units of any size (i.e. any number of beds). Four examples shown for illustrative purposes, but others are included within the modelling.



Notes: 1- Minor tariff is £59, standard tariff £87 and high tariff £117

Step 2: Determine inputs and key assumptions for Level 1 A&E with trauma capability

Appropriate comparator set

- See page 31 and 62

Determine inputs and key assumptions for Level 1 A&E with trauma capability

- The slides in the annexe set out the key inputs for a Level 1 A&E with trauma capability
- Included are:
  - Staffing
  - Consumables
  - Medical equipment
  - Fixtures and fittings
  - Other building costs
  - Indirect and overhead costs (e.g. portering, catering, management)
  - Cost for use of support services
- The allocation method indicates whether the cost has been treated as fixed, semi-fixed or variable
- The assumptions indicate exactly how the costs have been calculated and attributed
- The average cost provides an annual figure for how much each input item would cost

Key assumptions for Level 1 A&E with trauma capability

Costs are modelled according to best practice

- 168 hour A&E consultant presence
- 168 hour Specialist support cover from 4 main specialties (Paediatrics, Orthopaedics, General Surgery and General Medicine). Assumed that ITU would be co-located but not included in costs as support service. Plus 168 hour Specialist support cover from neurosurgery, spinal surgery, plastic surgery, vascular surgery, cardiothoracic surgery and anaesthetics
- 168 hour support from radiographers and radiologists
- 168 hour support cover from trauma consultant and doctors
- Co-located AMU included
- Nursing staff are able to operate on flexible contracts (e.g. WTE), Consultant medical staff operate on a WTE basis only

There is no direct vertical integration between clinical support services and A&E

- Radiology for A&E is dedicated and not a support service, therefore it is within service line costs

Step 3: Identify fixed inputs for a Level 1 A&E with trauma capability

Fixed inputs – these inputs are fixed for a given size of unit (i.e. do not change with the number of attendances)

- **Capacity** – A&E units are self contained so if volume of attendances changed the size of the unit could not be changed easily (beds in A&E are not interchangeable with beds elsewhere). This means that costs are established for specific sizes of unit.
  - A scale curve is modelled for the volume range each unit (calculated on total A&E beds) can accommodate within an acceptable range
  - A unit is equipped for the maximum number of attendances they can accommodate
- **Fixed Minimum staffing** – A&E Consultant, Middle grade, Junior grade - Minimum levels of staffing required for a 24/7 presence.- could not run the unit without this presence
- **Fixed Minimum Specialist staffing cover** – Paediatric consultant. Orthopaedics consultant, General Surgery Consultant, General Medicine Consultant, Neurosurgeon, Spinal Surgeon, Plastic Surgeon, Vascular Surgeon, Cardiothoracic Surgeon, Anaesthetist and Middle grade specialist support for each of the aforementioned, plus Radiographers, Radiologist Consultant, Trauma Consultant
- **Fixed Minimum Acute Medical Unit staffing** – Consultants, Middle grade, Junior grade
- **Fixtures and fittings for unit and Acute Medical Unit** – required to run the unit
- **Equipment** – One of each of Ultrasound, CT, MRI, 2 Blood gas machines, 2 Blood analysers
- **Beds** – fixed for size of unit
- **A&E admin/reception staff** - minimum level
- **Cleaning, property costs, management and administration** – required to run the unit

Semi fixed inputs – inputs can be changed according to number of attendances but some indivisibility

- **Other staffing** – staffing above minimum levels, Nurses, Clinical Support Workers, Trauma doctors. These inputs can be changed to reflect the number of attendances. Consultant staff and nursing staff can be changed to the nearest 1 WTE required
- **Equipment** – X ray machine

Variable inputs – can change fully according to number of attendances

- **Drugs and medicines**
- **Medical supplies**
- **Catering, portering and laundry**
- **Pathology**

Step 4: The inputs that are fixed in a Level 1 A&E with trauma capability

Our modelling work on a Level 1 A&E with trauma capability has tried to capture those inputs that are required for an A&E with *full backup facilities on site (as for the "Standard" Level 1 A&E)* as well as *an additional specialisation,* in this case trauma.

Our modelling indicates that fixed costs are a significant feature of A&Es of this type, making up 65% of total costs for an A&E unit with 25 beds. However, fixed costs fall sharply with size as the increase of semi-fixed and variable costs is higher than in "standard" level 1 A&E departments.

It is predominantly the additional specialist support required to support the trauma specialisation that cause the proportion of fixed costs to increase relative to a "Standard" Level 1 A&E for small units It is the increased need for A&E staff on a per patient basis and the increased cost of drugs and medical supplies relative to a "Standard" Level 1 A&E that make semi-fixed and variable costs significant for larger units.

The presence of these fixed costs means that economies of scale are particularly significant. However, the Minimum Efficient Scale for an A&E of this type is similar to a standard A&E at around 600,000 attendances per year (see next slide). The difference between the units is that, even at Minimum Efficient Scale level, the costs of a Level 1 A&E with trauma capability are around 50% higher than those of an A&E without the trauma specialisation.

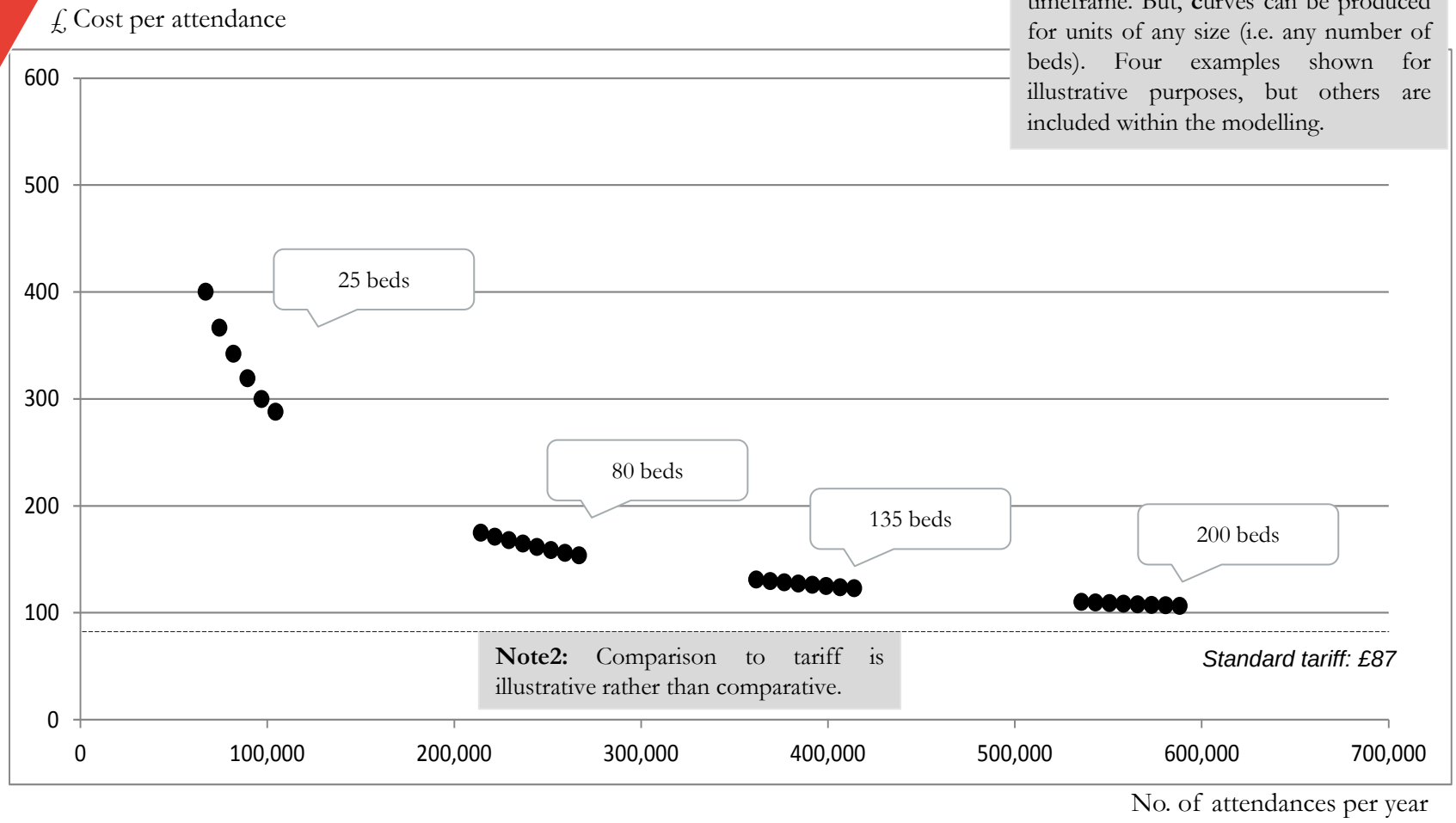
Nature of input	Proportion of costs (%)			
	25 beds	85 beds	135 beds	200 beds
Fixed	65%	47%	38%	31%
Semi-fixed	23%	35%	40%	45%
Variable	13%	19%	22%	29%

Type of input	Proportion of costs (%)			
	25 beds	85 beds	135 beds	200 beds
Labour	**65%**	**65%**	**64%**	**64%**
A&E specific	28%	38%	42%	46%
Specialist support	33%	24%	19%	16%
Acute Medicine	5%	3%	3%	2%
Non-labour	**35%**	**32%**	**36%**	**36%**

Step 4: Level 1 A&E with trauma capability cost curve: worked example

Create scale curve for Level 1 A&E with trauma capability

Note1: separate curves are produced for units of different sizes as capacity of unit (no. beds) is assumed to be fixed in timeframe. But, curves can be produced for units of any size (i.e. any number of beds). Four examples shown for illustrative purposes, but others are included within the modelling.



1. HES 2. Pathway payments standard antenatal and postnatal care, birth without cc Source: For full list see costing model

A&E - Key modelling assumptions and caveats

The modelling results presented in this report for A&E are based on an extensive review of the literature about economies of scale and scope, interviews with the relevant Royal Colleges and National Clinical Directors as well as case study visits and data. Subject to data and timing constraints, they represent our best view as to the inputs required to run the two different types of A&E departments. That said, the models were developed to aid the development of the framework set out in this report rather than as a core output in their own right. They should therefore be regarded with a degree of caution since their development has been based on guidance and advice about the core inputs for a service and data from a limited number of case studies, rather than specific data gathered across a broad range of trusts.

As with all modelling exercises of this nature, they make use of a range of assumptions and are therefore accompanied by a number of caveats. We outlined a number of key overarching assumptions earlier on pages 62 - 63. However, there are also a number of other more specific assumptions that have been made. These are outlined below:

- **Equipment:** prices of equipment have been obtained using web searches and have normally been converted from prices in US$. If anything, we expect that these are prices are lower than prices obtained by a standard NHS trust and so would lead us to underestimate the degree of economies of scale. The cost of equipment has been depreciated using a Weighted Average Cost of Capital (WACC) of 10%.
- **Drugs and medicines and medical supplies:** it has not been possible to specifically check the cost of drugs, medicines and medical supplies used by an A&E department. However, based on discussions with experts we believe they are in the right ballpark.
- **Estates cost:** we have included the cost of renting the buildings to capture the full economic cost. This has been estimated using a report from the UK's valuation company which is not hospital-specific.
- **Cost and usage of pathology:** the cost of pathology services for a standard A&E has been assumed based on advice from experts. We have based our estimates of usage on the first A&E investigations reported by HES.
- **Indirect and overhead costs:** Current benchmarks for Indirect and Overhead costs are based on trusts in Scotland.
- **Mental health**: we have not included the cost of mental health support to the A&E as this would usually be paid by the PCT.
- **Critical decision unit:** we have not included the cost of a critical decision unit, although we understand that there are likely to be more of these in the future.
- **Nurse practitioners:** our model is based on current best practice use of junior doctors. We understand that there is a move towards using more nurse practitioners instead of junior doctors. This is unlikely to significantly affect results as rates of pay are similar.
- **Highly qualified nurses**: our model is based on current best practice use of middle grade doctors. We understand that there is a move towards using more highly qualified nurses. This is unlikely to significantly affect results as rates of pay are similar.
- **Acute medical unit staffing:** our model is based on current best practice staffing in acute medical units. We understand that, in a drive to improve early care, the staffing of Acute medical units is likely to increase.

Elective orthopaedics modelling – an overview

In the slides that follow, we set out the modelling work for an elective orthopaedics ward that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis.

We have built a single model of an elective orthopaedic ward as our assumption is that all orthopaedic wards can be treated as capability equivalent.

Inputs to the model are based on best practice clinical guidelines. Other key assumptions include:

- orthopaedic units are not assumed to have any capacity constraints as modelled for A&E and obstetrics units – this is an assumption that beds are effectively generic and can be shared between services (i.e. are not fixed to a particular service line);
- the number of beds required for a given volume of patients can be derived using best practice length of stay and occupancy rate;
- prosthetic costs, which are an important element of consumable costs, are based on an average of arthroscopic, knee and hip prosthetics, unadjusted for case mix – these account for a high proportion of all procedures; and
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Step 1: Determine appropriate comparator sets for elective orthopaedics ward

Determine appropriate comparator set of units

- All orthopaedic units treated as equivalent in terms of capability
- Within orthopaedic units case mix and location accounted for - adjusts curve rather than separate model
  - Case mix adjusted according to average length of operation and average length of stay
  - Salary bands for Inner London, Outer London, Fringe and other

Driver	Impact on cost		Inclusion in model
Case mix within unit type • e.g. type & complexity of procedure	Impact on direct costs *e.g. cost of prosthetics* Impact on capacity *e.g. complex case mix increases length of stay; more capacity needed for same number of procedures*	✓	Input average length of operation and average length of stay
Location • e.g. Inner vs. Outer London	Impact on cost *e.g. uplift on salaries*	✓	Include salary bands for Inner London, Outer London, Fringe and Other
Integrated support services • e.g. dedicated physiotherapy	Impact on costs *e.g. dedicated physiotherapist can lead to higher costs*	✗	Excluded for comparability between units
Teaching/research costs	Impact on capacity *e.g. can increase length of stay* Impact on costs: *e.g. additional consultant time*	✗	Assumed to be fully reimbursed by SIFT/MADEL income as per HFMA guidelines
Integration with Trauma	Impact on costs *e.g. disrupt theatre lists*	✗	According to best practice should not be combined

Step 2: Determine inputs and key assumptions for elective orthopaedics ward

Determine inputs and key assumptions for elective orthopaedics ward

- The slides in the annexe set out the key inputs for an elective orthopaedics ward
- Included are:
  - Staffing
  - Consumables
  - Medical equipment
  - Fixtures and fittings
  - Other building costs
  - Indirect and overhead costs (e.g. portering, catering, management)
  - Cost for use of support services
- The allocation method indicates whether the cost has been treated as fixed, semi-fixed or variable
- The assumptions indicate exactly how the costs have been calculated and attributed
- The average cost provides an annual figure for how much each input item would cost

Key assumptions for elective orthopaedics ward

Orthopaedic wards managed as a single block of capacity within the hospital

- Key assumption is that beds can be shared between services (i.e. are not fixed to a particular service line)
- Costs established along a continuum of different sized units
- No. of beds is derived using best practice length of stay and occupancy rate

Costs are established for inpatient care only

Costs are modelled according to best practice

- Nursing staff are able to operate on flexible contracts (e.g. 0.5 WTE), Consultant medical staff operate on a WTE basis only

Step 3: Identify fixed inputs for an elective orthopaedics ward

Fixed inputs – these inputs are fixed for a given size of unit (i.e. do not change with the number of patients)

- **Ward medical equipment -** would be fixed for the unit
- **Orthopaedic specific theatre fittings** – would be fixed for the unit

Semi fixed inputs – these inputs can be changed according to the number of patients within a unit but some indivisibility

- **Staffing for ward** – Nursing staff, Consultant, Associate Specialist, Registrar, SHO. These inputs can be changed to reflect the number of patients in a unit. Consultant staff can be changed to the nearest 1 WTE required, Nursing staff to the nearest 0.5 WTE.
- **Staffing for theatre** – Consultant surgeon, Registrar
- **Fixtures and fittings** – would vary according to the number of beds dedicated to orthopaedics within the hospital
- **CNST** – fixed per WTE consultant on ward
- **Cleaning** – fixed for size of ward
- **Property** – fixed for size of ward
- **Administration** – fixed for size of ward

Variable inputs – can change fully according to the number of patients

- **Drugs and medicines**
- **Medical supplies**
- **Catering, portering and laundry**
- **Cost of using Pathology**
- **Cost of using Radiology**
- **Cost of using theatres**
- **Cost of using ITU and HDU**
- **Orthopaedic theatre consumables and kit**
- **Physiotherapy**

Step 4: The inputs that are fixed in an elective orthopaedics ward

Our modelling work on an elective orthopaedics ward indicates that fixed and semi-fixed costs are not significant features. It should be noted, that our assumption to treat all beds within a hospital as effectively interchangeable has a part to play in that conclusion.

We find that for a typical specialist orthopaedic hospital, fixed costs make up 2% of total costs and semi-fixed costs make up approximately 2% of costs, leaving 96% for variable costs.

The absence of significant fixed costs ,means that economies of scale are not particularly significant. There is no real Minimum Efficient Scale as costs decline very little between 2000 and 15,000 patients per year. The cost per patient of a typical specialist orthopaedic hospital (which would tend to have longer operation lengths and lengths of stay) is around £8000. A typical District General Hospital providing orthopaedic services (which would tend to have shorter operation lengths and lengths of stay) is around £6000.

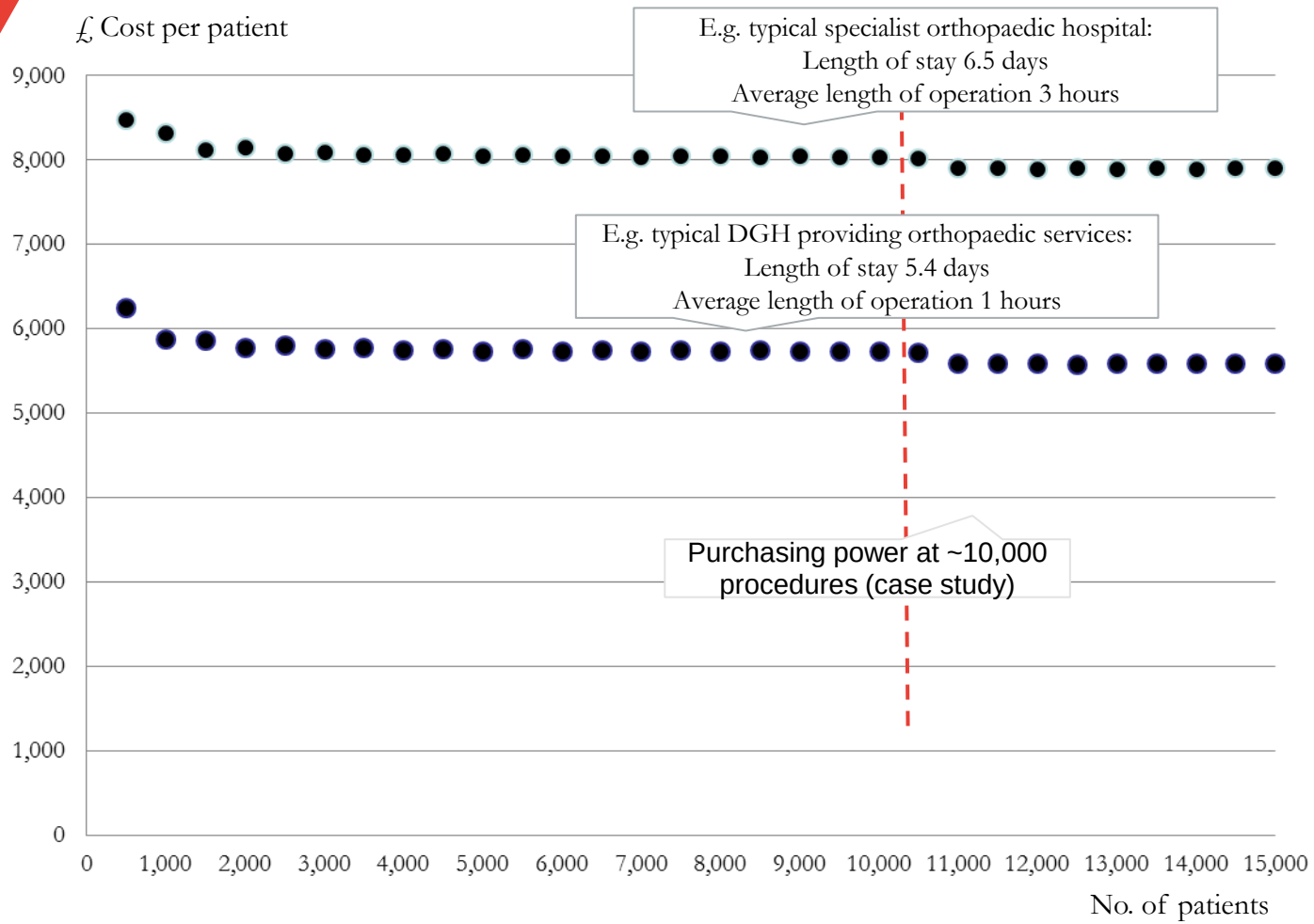
Nature of input	Proportion of costs (%)
Fixed	2%
Semi-fixed	2%
Variable	96%

Type of input	Proportion of costs (%)
Labour	13%
Non-labour	87%

Step 4: Elective orthopaedics ward cost curve: worked example

Note: single curve is produced for orthopaedics as capacity of unit (no. beds) is assumed to be variable in timeframe.

Create scale curve for elective orthopaedics ward



Orthopaedics tariff is wide ranging, encompassing the varying severity of a procedure and prosthetic components used. In this way, income for each trust will vary widely, depending on case mix. E.g. major hip procedure non-trauma category 2 with major cc, £8152, intermediate hip procedure for non trauma category 2, £3101, major knee procedures for non trauma category 2 without cc, £5198

Elective orthopaedics - Key modelling assumptions and caveats

The modelling results presented in this report for elective orthopaedics are based on an extensive review of the literature about economies of scale and scope, interviews with the relevant Royal Colleges and National Clinical Directors as well as case study visits and data. Subject to data and timing constraints, they represent our best view as to the inputs required to run an elective orthopaedics ward. That said, the model was developed to aid the development of the framework set out in this report rather than as a core output in its own right. It should therefore be regarded with a degree of caution since its development has been based on guidance and advice about the core inputs for a service and data from a limited number of case studies, rather than specific data gathered across a broad range of trusts.

As with all modelling exercises of this nature, they make use of a range of assumptions and are therefore accompanied by a number of caveats. We outlined a number of key overarching assumptions earlier on slide 62 - 63. However, there are also a number of other more specific assumptions that have been made. These are outlined below:

- **Fixtures and fittings:** costs are modelled on an obstetrics ward - as this is non clinical it is assumed to be transferable.
- **Purchasing power:** effect is estimated from one case study alone
- **Theatre building depreciation:** not specific to an orthopaedic theatre.
- **Dedicated physio:** we have excluded this from the modelling as it would tend to be paid for by the PCT.
- **CNST:** is an approximate cost from NHS litigation. There is likely to be variation amongst trusts and it is expected that trusts at best practice would have considerably reduced payments.
- **Indirect and overhead costs:** ccurrent benchmarks for Indirect and Overhead costs are based on trusts in Scotland.

- Executive Summary
- Introduction and context
- Approach to the work
- Framework
  - Economies of scale and scope in healthcare - technical overview
  - Timeframe and comparative context
  - Methodology for developing cost curves
  - Methodology for identifying scope implications
- Framework application: four alternative scenarios
- Illustrative implications from modeling work
  - Obstetrics
  - A&E
  - Orthopaedics
  - Support services
  - Scope implications
- Next steps and recommendations
- Annexes

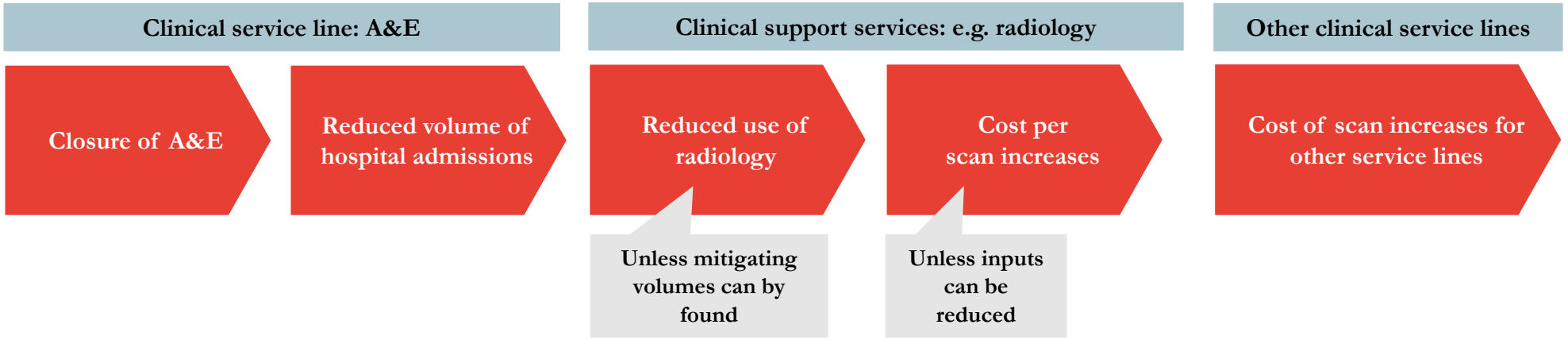
Support service modelling – a caveat

We have created models of three main clinical support services:

- Radiology
- Inpatient theatres
- Day surgery theatres

As discussed earlier, clinical support services are clear examples of inputs which are service line agnostic and can therefore be shared between service lines. The slides that follow will illustrate that these support services have a large number of fixed inputs, which means that the volume of patients that they see has clear implications for their average cost of use.

Since these inputs are service line agnostic it is best to think of them as having implications for economies of scope. As the link between the costs of co-located service lines is made via the support services rather than as a result of directly shared inputs, we have called these secondary scope economies (see diagram below).



The slides that follow provide results of our modelling for inpatient theatres, day surgery theatres and radiology.

Radiology modelling

In the slides that follow, we set out the modelling work for a radiology department that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis.

We have built a single model of a radiology department as our assumption is that all radiology departments can be treated as capability equivalent. However, we allow the user to select the case-mix of procedures in order to adapt results to specific circumstances.

The availability of data and guidance about radiology input requirements and costs has been rather more scarce that for other service lines. The results from this modelling work should therefore regarded with a fair degree of caution. Key assumptions that we have made include:

- radiology departments are not assumed to have any capacity constraints as modelled for A&E and obstetrics units;
- the number of pieces of radiology equipment varies according to the number of procedures (scans and X-rays) undertaken; and
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Our modelling work indicates that the only fixed cost is the PACS, an IT system that makes it possible to see the results of the procedures in the computers of the department. We find that semi-fixed costs make up 65% of total costs and variable costs make up approximately 35% of costs.

The presence of significant fixed costs means that economies of scale are significant. Minimum Efficient Scale appears to be above 200,000 procedures (scans, X-rays) per year. Departments that undertake fewer procedures could experience a cost per procedure of up to around twice the minimum efficient scale cost.

Nature of input	Proportion of costs (%)
Fixed	0.5%
Semi-fixed	65%
Variable	35%

Type of input	Proportion of costs (%)
Labour	54%
Non-labour	46%

Modelling caveats

Equipment: prices of equipment have been obtained using web searches and have normally been converted from prices in US$. If anything, we expect that these are prices are lower than prices obtained by a standard NHS trust and so would lead us to underestimate the degree of economies of scale. The cost of equipment has been depreciated using a Weighted Average Cost of Capital (WACC) of 10%.

Staff requirements: based on limited data.

Drugs and medicines and medical supplies: it has not been possible to specifically check the cost of drugs, medicines and medical supplies used by a radiology department. However, based on discussions with experts we believe they are in the right ballpark..

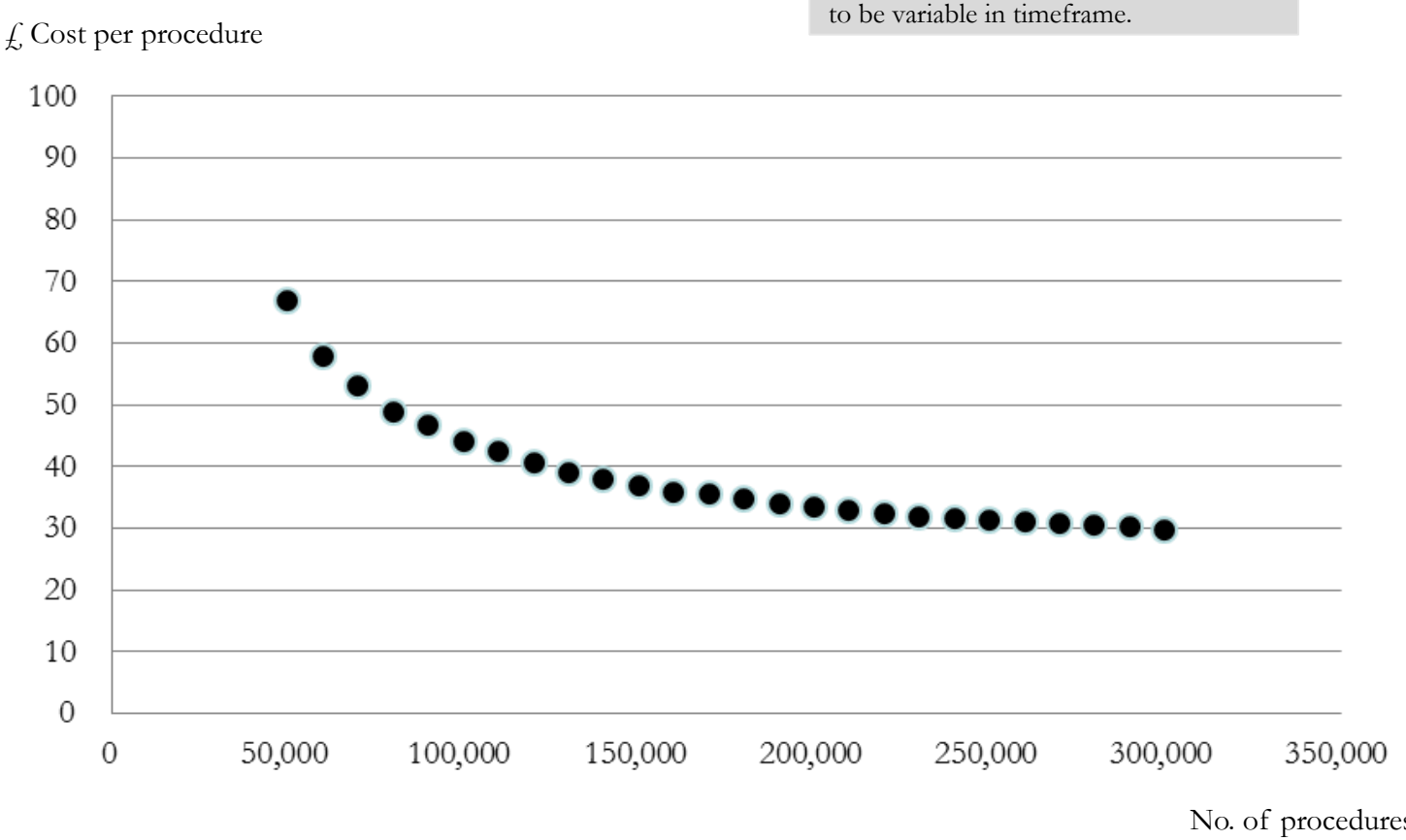
Estates cost: we have included the cost of renting the buildings to capture the full economic cost. This has been estimated using a report from the UK's valuation company which is not hospital-specific.

Indirect and overhead costs: Current benchmarks for Indirect and Overhead costs are based on trusts in Scotland.

Radiology cost curve: worked example

Create scale curve for radiology department

Note: single curve is produced for radiology as capacity of unit is assumed to be variable in timeframe.



Inpatient theatre modelling

In the slides that follow, we set out the modelling work for an inpatient theatre that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis.

We have built a single model of inpatient theatres as our assumption is that all theatres can be treated as capability equivalent. The availability of data and guidance about theatre input requirements and costs has been rather more scarce that for other service lines. The results from this modelling work should therefore be regarded with a fair degree of caution. Key assumptions that we have made include:

- the capacity of a theatre (number of hours of theatre that can be accommodated) is fixed (units with different numbers of theatres are therefore modelled);
- current best practice theatre hours (2 session, 5 days a week) is modelled;
- flexible staffing arrangements are assumed to be possible i.e. if theatre is only used for 4 days a week, staff are only employed for 4 days a week;
- pre-operative assessment and surgeon cost are attributed to the service line (as service line specific); and
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Our modelling work indicates that fixed costs are a significant feature of inpatient theatres. We find that for a given unit size, fixed costs make up 84% of total costs and semi-fixed costs make up approximately 4% of costs.

The presence of significant fixed costs means that economies of scale are significant. Minimum Efficient Scale appears to be achieved for a fully utilised 10 theatre unit. What is also particularly evident from our work is that the utilisation of theatre time is critical. A poorly utilised theatre could have a cost per hour significantly higher than a well utilised theatre.

Nature of input	Proportion of costs (%)
Fixed	84%
Semi-fixed	4%
Variable	12%

Type of input	Proportion of costs (%)
Labour	24%
Non-labour	76%

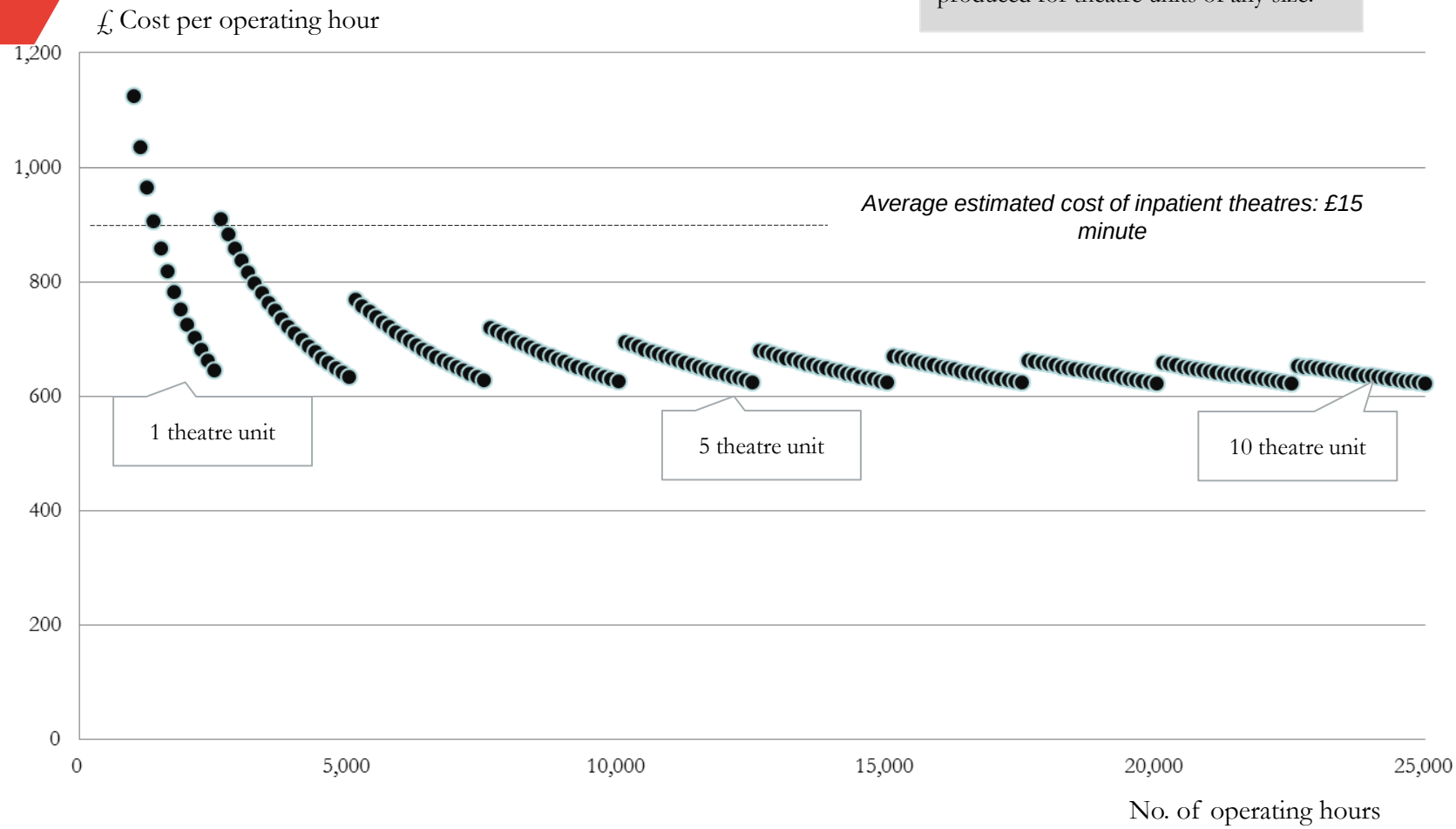
Modelling caveats

Administration costs: assumed to vary according to operating hours
Fixtures and fittings: costs are modelled on an obstetrics ward. As this is non clinical it is assumed to be transferable
Operating theatre equipment: assumptions based on DH Day surgery operational guide and the Audit Commission Operating Theatres guide.
Anaesthetic Disposables: from literature (Hearnden and Tennet, 2008)
General Consumable: from literature (Hearnden and Tennet, 2008)
Cost of Drugs and Medical Supplies: costing specific drugs to the service line and then using case study information for generic drugs
Recovery Staff: included in the cost of theatres - 1 Matron assumed per recovery room, with 1 recovery room serving two theatres. Recovery staff with a 1:1 ratio with patients. This is a potential overestimate.
Estates cost: we have included the cost of renting the buildings to capture the full economic cost. This has been estimated using a report from the UK's valuation company which is not hospital-specific.
Indirect and overhead costs: Current benchmarks for Indirect and Overhead costs are based on trusts in Scotland.

Inpatient theatre cost curve: worked example

Create scale curve for inpatient theatres

Note1: separate curves are produced for units with different numbers of theatres as the number of theatres is assumed to be fixed in timeframe. But, curves can be produced for theatre units of any size.



Day Surgery Unit modelling

In the slides that follow, we set out the modelling work for a day surgery unit that we have undertaken to develop and strengthen the framework described previously, as well as to test that the modelling approach to scale and scope can be implemented on a practical basis.

We have built a single model of a Day Surgery Unit as our assumption is that all Day Surgery Units can be treated as capability equivalent. The availability of data and guidance about Day Surgery input requirements and costs has been rather more scarce that for other service lines. The results from this modelling work should therefore regarded with a fair degree of caution. Key assumptions that we have made include:

- the capacity of a theatre (number of hours of theatre that can be accommodated) is fixed (units with different numbers of theatres are therefore modelled);
- current best practice theatre hours (1 session, 6 days a week) are modelled;
- flexible staffing arrangements are assumed to be possible i.e. if theatre is only used for 4 days a week, staff are only employed for 4 days a week;
- diseconomies of scale are not built into the model as we have no evidence to suggest if and when they might occur.

Our modelling work indicates that fixed costs are a very significant feature of day surgery theatres. We find that for a given unit size, fixed costs make up 73% of total costs and variable costs make up approximately the remaining 27% of costs.

What is also particularly evident from our work is that the utilisation of theatre time is critical. A poorly utilised theatre could have a cost per hour significantly higher than a well utilised theatre.

Nature of input	Proportion of costs (%)
Fixed	73%
Semi-fixed	0%
Variable	27%

Type of input	Proportion of costs (%)
Labour	28%
Non-labour	72%

Modelling caveats

Fixtures and fittings: costs are modelled on an obstetrics ward. As this is non clinical it is assumed to be transferable

Operating theatre equipment: assumptions based on DH Day surgery operational guide and the Audit Commission Operating Theatres guide.

Consumable: costs based on orthopaedic example

Recovery Staff: included in the cost of theatres - Recovery staff with a 1:1 ratio with patients..

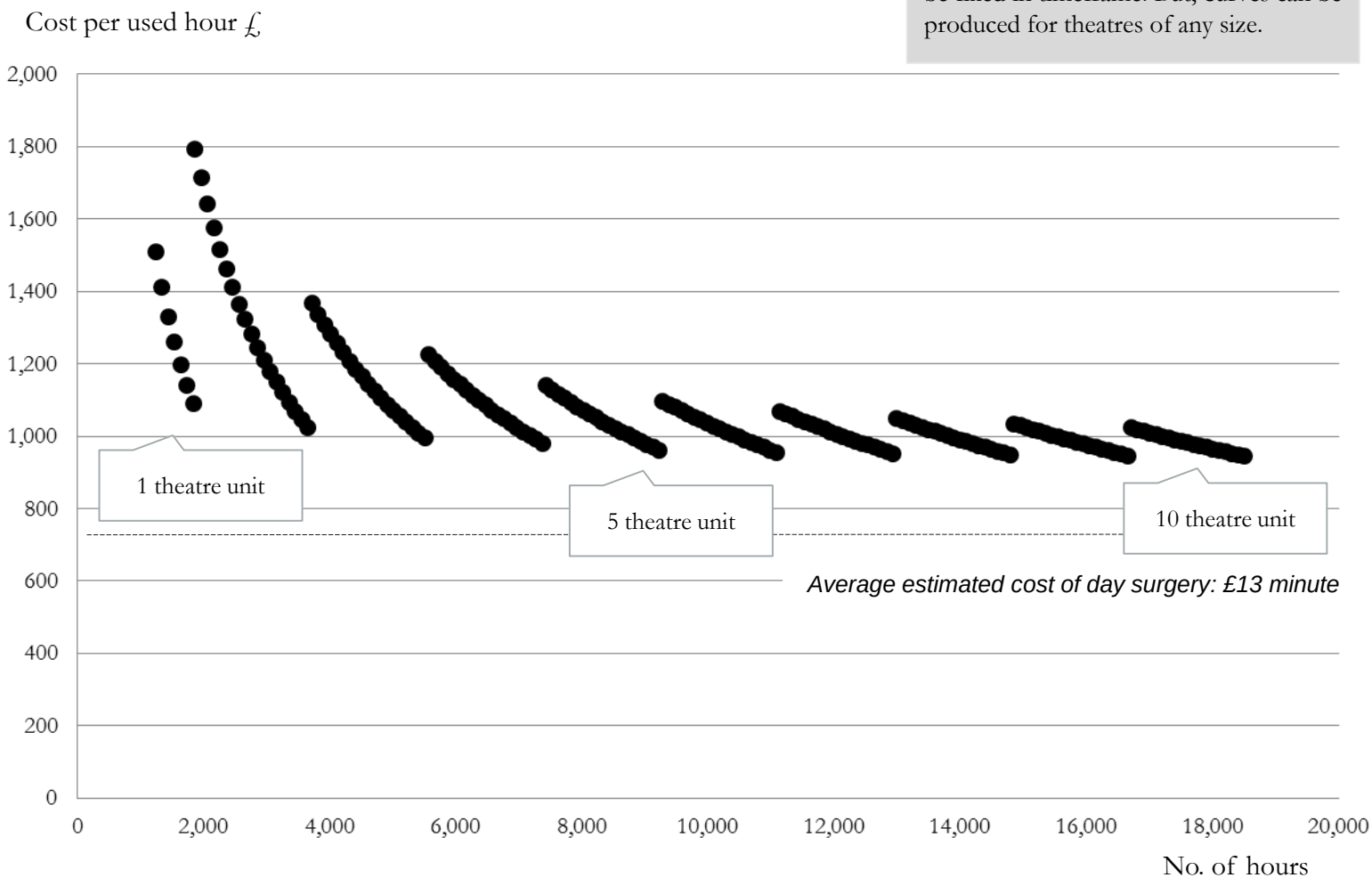
Estates cost: we have included the cost of renting the buildings to capture the full economic cost. This has been estimated using a report from the UK's valuation company which is not hospital-specific.

Indirect and overhead costs: Current benchmarks for Indirect and Overhead costs are based on trusts in Scotland.

Step 4: Day Surgery Unit cost curve: worked example

Create scale curve for day surgery unit

Note1: separate curves are produced for units with different numbers of theatres as the number of theatres is assumed to be fixed in timeframe. But, curves can be produced for theatres of any size.



Source: For full list see back up

Scope modelling – an overview

In the slides that follow, we set out the implications for our modelling work for understanding scope economies. As discussed earlier, the extent of economies of scope will differ between hospitals because the extent of spare capacity on potentially shared inputs will differ.

In this section, we present the implications from our modelling for three alternative scenarios:

- closing an Obstetrics Unit;
- closing a Standard Level 1 A&E; and
- closing an elective orthopaedics ward.

Whilst, conclusions around economies of scope will therefore be situation specific, it is possible to draw out some linkages and indications of what might be important from our modelling work. For example, it is possible to explore:

- whether the service lines we have modelled (A&E, obstetrics, orthopaedics) exhibit primary and secondary scope effects;
- the service lines which are linked to A&E, obstetrics and orthopaedics directly or via the support services; and
- the likely scale of the primary and secondary scope effects.

However, what cannot be done is to understand what might be the effect of economies of scope in any particular instance. This will depend on the extent to which shared inputs are genuinely fixed and the mapping of changes in demand for that input with its capacity constraints. This can only be investigated on a trust-by-trust basis.

Consider the effect of economies of scope in relation to closing an obstetrics unit

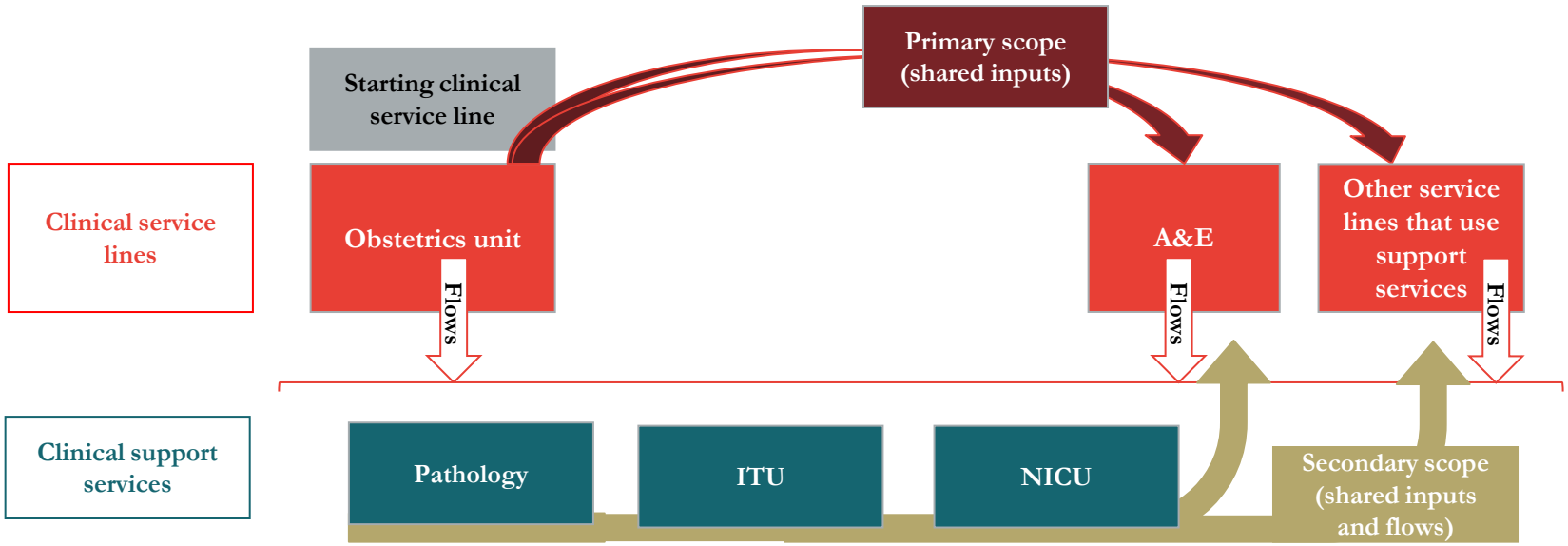
Step 1: Select unit for consideration

In terms of understanding the effect of economies of scope related to an obstetrics unit, we will consider the question of what would be the effect of removing a unit from a hospital. Starting point: Obstetrics Unit

Step 2: Identify the linked clinical service lines

Primary scope: O&G Consultants required to provide cover to A&E, Anaesthetists shared with other clinical service lines

Secondary scope: Obstetrics Units make use of ITU/HDU, NICU, pathology



Step 3: Genuinely fixed and shared

Primary: Very limited scope economies - Obstetrics Consultants provide very little cover to A&E so limited scope economy (also can be split between O&G so no scope economy there), Anaesthetists can be scaled (not genuinely shared) so little scope economy

Secondary: Some scope economies - Use of ITU, NICU and Pathology could have implications for other service lines – extent of the effect likely to be limited as small volume sent to ITU – cost impact will be captured by scale curve etc.

Obstetrics patient flows and scope implications

Not related to shared inputs but may indicate clinical reasons for co-location

To service lines

Destination	% of patients	Source
Gynaecology	4.0%	Dr Foster 2011: Modelled on sample foundation trust. DH. 2010-11. Maternity Statistics - Provider level analysis
Psychiatric Medicine	0.4%	Oates M 1994. Postnatal mental illness, organisation and function services - Total referral rate for pregnancy and childbirth related psychiatric problems.
Emergency Surgery	0.08%	Dr Foster 2011: Modelled on sample foundation trust - includes upper gastrointestinal surgery ,breast surgery, colorectal surgery and urology.
Acute Surgery	0.02%	Dr Foster 2011: Modelled on sample foundation trust
Elective surgery	0.0%	Dr Foster 2011: Modelled on sample foundation trust
Paediatrics	2.5%	Dr Foster 2011: Modelled on sample foundation trust

To support services

Destination	% of patients	Source
Pathology	100.0%	RCOG. 2007. Safer Childbirth
ITU	0.1%	RCOG. 2007. Safer Childbirth
HDU	1.0%	RCOG. 2007. Safer Childbirth
Theatres	n/a	Case studies: Conducted in obstetrics unit
NICU	11.0%	MSAG.Neonatal sub group. 2008. Review of neonatal services in Scotland. Verified by case study data
Radiology	n/a	Case studies: Conducted in obstetrics unit

Between obs units

Destination	% of patients	Source
Consultant led unit (from Midwife Led unit)	40.0%	RCOG. 2007. Safer Childbirth

Consider the effect of economies of scope in relation to closing a "standard" Level 1 A&E

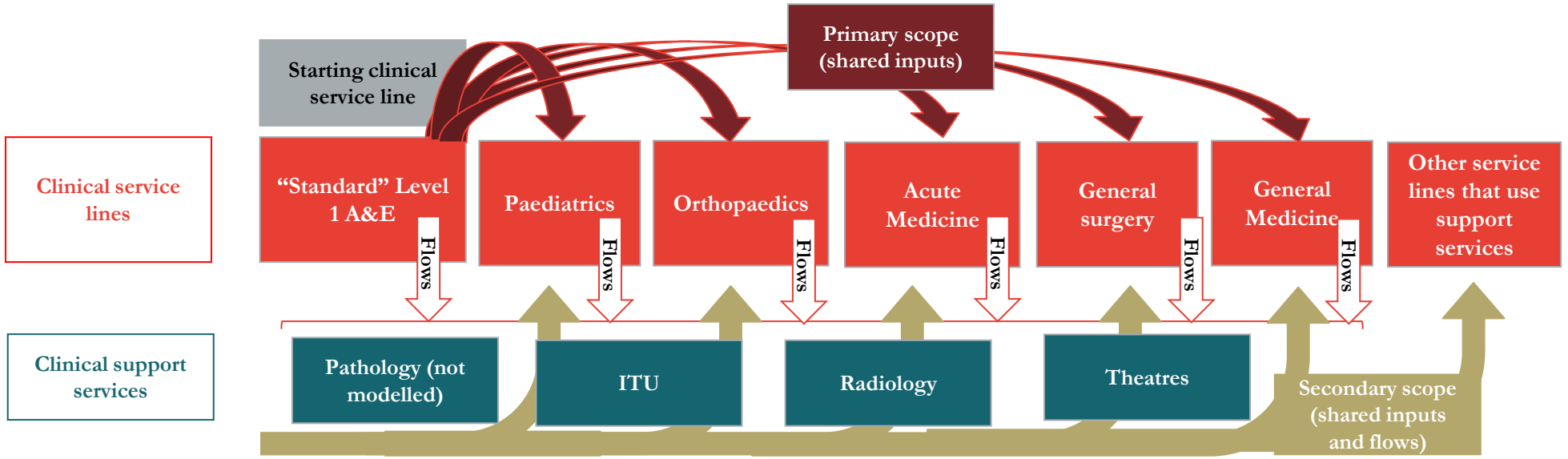
Step 1: Select unit for consideration

In terms of understanding the effect of economies of scope related to a "standard" level 1 A&E, we will consider the question of what would be the effect of removing it from a hospital. Starting point: A&E

Step 2: Identify the linked clinical service lines

Primary scope: Paediatrics, Orthopaedics, Acute Medicine, General Surgery and General Medicine

Secondary scope (direct): A&E makes use of some radiology and pathology (not modelled).
Secondary scope (indirect because without A&E emergency patients would not be admitted): A&E makes use of ITU, Theatres, Radiology, Pathology



Step 3: Genuinely fixed and shared

Primary: Some scope economies – shared inputs with a range of other service lines. Key question would be the extent to which these inputs are actually fixed. If only elective specialties remain, work on elective orthopaedics suggests inputs could be scaled down

Secondary: Scope economies - Use of Pathology, theatres could have implications for other service lines – but only to the extent that they cannot be scaled back to reflect non-emergency volume only. Clearly, there could be significant implications for ITU.

Consider the effect of economies of scope in relation to closing an elective orthopaedics ward

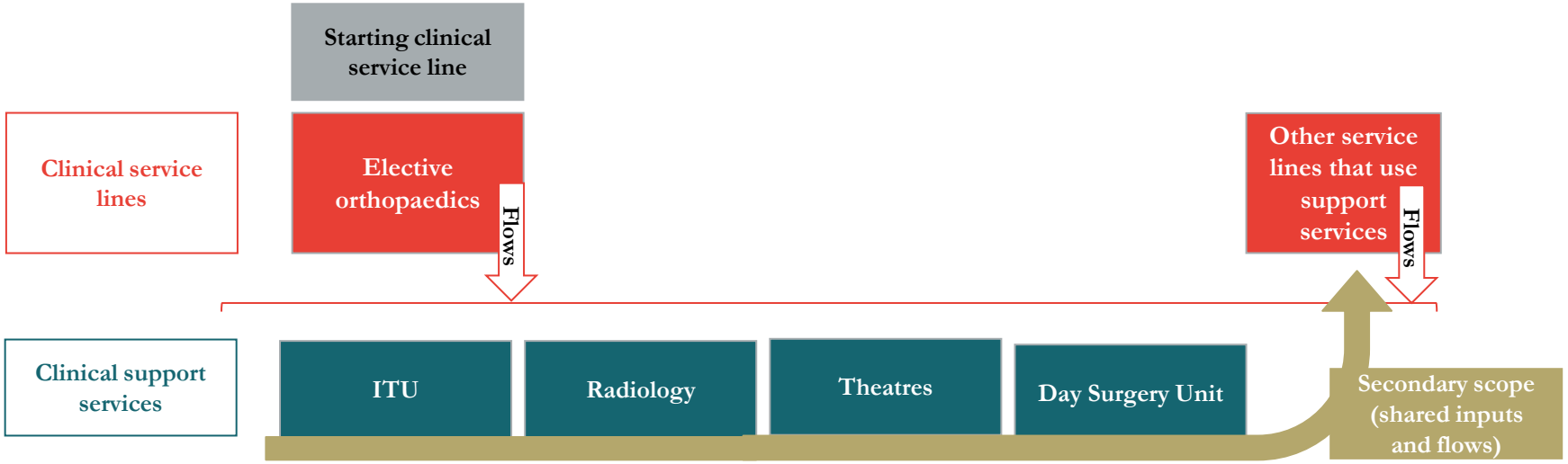
Step 1: Select unit for consideration

In terms of understanding the effect of economies of scope related to an elective orthopaedics unit, we will consider the question of what would be the effect of removing the unit from a hospital. Starting point: elective orthopaedics

Step 2: Identify the linked clinical service lines

Primary scope: None.

Secondary scope: Elective orthopaedic ward make use of Radiology, Day Surgery Unit, Theatres, ITU/HDU, pathology (not currently modelled), outpatients (not modelled), physiotherapy (not modelled), occupational therapy (not modelled)



Step 3: Genuinely fixed and shared

Primary: No scope economies

Secondary: Potentially large scope economies - Use of Radiology, Day Surgery Unit, Theatres, ITU/HDU, Pathology, etc. could have implications for other service lines that also use these service lines within the hospital. Significant volumes of patients flow from elective orthopaedics, but depends on the extent to which support service inputs can be scaled back or the extent to which spare capacity can be filled from other service lines.

Elective orthopaedic patient flows and scope implications

Not related to shared inputs but may indicate clinical reasons for co-location

To service lines

Destination	% of patients	Source
Geriatrics	35%	35% of total hip replacement FCE are for age group 75 (HES online)

To support services

Destination	% of patients	Source
Radiology	100%	1 MRI and 2 x ray per patient (NHS Choices)
Day Surgery Unit	75%	75% of elective surgery should be performed as day cases (DH. The NHS Plan. A Plan for Investment. A Plan for Reform. 2000)
Theatres	25%	25% of elective surgery will remain in inpatient theatres (DH. The NHS Plan. A Plan for Investment. A Plan for Reform. 2000)
ITU	2%	2% of surgical patients require specialist critical care support (Royal College of Surgeons, Separating emergency & elective care)
Pathology	100%	1 x blood/ urine and swab work per patient
Outpatients	100%	Pre assessment and follow up OP services with surgeon. Physio for 100%
Physiotherapy	n/a	1/2 physiotherapy per bed day (NHS Choices)
Occupational therapy	n/a	Out of scope

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Next steps and implications for Monitor's areas of work

- Undertaking this work has highlighted a number of issues that were beyond the scope of this project to explore in detail. Further research could be undertaken in any of these areas:
  - link between minimum efficient scale and clinical guidance about minimum volumes required for acceptable clinical standards, and more generally between scale, scope, cost and clinical quality
  - link between current tariff levels and structures and the cost structures that arise from an analysis of economies of scale and scope;
  - relationship between what is considered best practice in the organisation of healthcare services (and how quickly that can change) and economies of scale and scope;
  - impact of multi-site operation versus single-site operation on the nature and extent of economies of scale and scope; and
  - role of teaching and research in how we consider economies of scale and scope.
- There are also **two cross-cutting recommendations** that emerge from this work. The **first** is whether Monitor should aim to develop a generic set of scale curves and analysis of economies of scope for certain services where it is likely to be repeatedly faced with similar questions (e.g. A&E, obstetrics). We would recommend that Monitor give serious consideration to doing so despite the fact that it may have to generate bespoke curves for some cases (particularly those involving trusts in distress or failure). The main reasons for this recommendation are that generating some pre-prepared curves and analysis:
  - will serve to embed important knowledge within Monitor and allow future analysis – which may have to be done quickly and under pressure – to be done much better than would otherwise be the case;
  - provides an initial screening tool that is useful in a large number of cases (e.g. pricing and local modifications issues, complaints and competition concerns, early stages of distress) and may allow Monitor to make some initial decisions (including whether it is worth investing time to generate a more bespoke curve) quickly;
  - allows Monitor to clearly signal to the sector where it thinks these issues may be important and where they are much less likely to be important which could have benefits for how the sector then engages with each of the elements of the regulatory framework; and
  - allows Monitor to undertake preliminary quantitative modelling on issues such as pricing and service reconfiguration to understand the magnitudes of various issues it will be considering.
- A related, but **second**, cross-cutting issue relates to the use of the analysis in this report and subsequent curves to develop clear guidance about when economies of scale and scope are material and should be important in decisions about competition, pricing, assessment and compliance.
- The rest of this section provides initial thoughts about specific areas of this work that might be taken up by each of Monitor's workstreams.

Implications and issues for pricing

- The main report provided two specific illustration of the implications for **setting prices**:
  - whether prices should be set at minimum efficient scale where economies of scale or scope are detected; and
  - whether pricing structures should reflect the nature of economies of scale or scope (e.g. through two part tariffs*)
- The main issue for pricing in each of these contexts is the extent to which there is clear evidence of economies of scale or scope. If there is then each of these two issues can be considered. It will be necessary for the pricing workstream to reach a view – based on the evidence here and likely further research – about where economies of scale and scope are sufficiently large that they should be taken into account. Such considerations of **materiality** would require a larger evidence base than presented here.
- The thinking developed here also provides a clear starting point for assessing the need for **local modifications.** Given the onus on providers and commissioners to provide the justification for requests for local modifications, there is a question of whether Monitor would make available:
  - some or all of this framework available to provide clear guidance about the issues and how to develop them; and
  - a set of example cost curves in key services that providers and commissioners could use rather than needing to generate their own (possibly without using appropriate comparators, timeframes etc.).
- If Monitor confirms the existence of significant economies of scope in some areas of care that may form the basis for **categorising providers into different types to allow fair comparisons** for many pricing purposes (e.g. benchmarking, setting efficiency expectations, local modifications). The categories would fall out of the analysis of economies of scope because trusts that provide all the relevant services would have different cost structures to those that only provide some, who would be different again to those who provide none. To the extent that taking advantage of such economies was beyond the control of the trust, fair comparisons would require looking only at trusts that are similar in the services where economies of scope have been shown to exist.

* A two part tariff is a pricing technique where the price for a product has two components – a lump sum fee and a variable or per patient fee.

Implications for competition

- Monitor has a formal role **advising during Phase 1 merger investigations**. The competition investigations (across Phases 1 and 2) are likely to consider three distinct issues in relation to economies of scale and scope:
  - Whether they exist in particular services to a material degree
  - Whether the merger is necessary in order to achieve any economies of scale and scope that do exist
  - Whether the public will benefit should the merger achieve the claimed economies of scale and scope
- Phase 1 investigations are likely to focus on the first and second of these issues. Building on this work could allow Monitor to have a package of evidence about the nature of economies of scale and scope that would be available to the Phase 1 investigating authority (e.g. the Office of Fair Trading). This would provide Monitor's expert view about the conditions under which economies of scale or scope are likely to be a relevant consideration in a merger context to inform the first and second issues.
- Monitor may receive **complaints about procurement processes** and particularly about how services are bundled for procurement. Providers able to supply only one part of a bundled service may complain they have been unfairly excluded. In such cases, Monitor's role is likely to be limited to whether commissioners can reasonably justify their process. Having a clear approach to thinking about the nature of economies of scale or scope in those contexts might help to inform Monitor about whether commissioners did make reasonable decisions in this particular dimension. In particular, whether the evidence used by commissioners was sufficient to justify the decision that they took.
- The practical application of competition is likely to be affected by whether some services are regarded as 'natural monopolies'. We use the term loosely here to refer to services that because of their cost structure or local geographic characteristics might not have competitors. Developing the thinking and analysis on economies of scale and scope, would allow Monitor to develop **an initial view of which bundles of services are "acceptable"** even though they might limit competition (i.e. because they reflect genuine economies of scope and so good value for money) and which are not. Having a preliminary internal answer to the question of which local monopolies may be acceptable provides a powerful way for Monitor to decide whether local health markets are functioning efficiently and whether entry is happening as would be expected.

Implications for continuity of service

- As it currently stands, we understand there are demand-side and supply-side considerations in relation to continuity of service. The demand-side considerations relate to the availability of alternative providers within suitable proximity to meet relevant healthcare needs should a particular trust or service fail. The issue of economies of scale and scope is the supply-side counterpart to this issue. In particular, it allows Monitor (and, if applicable, the pre-failure team and special administrator) to understand better the cost implications of existing and future service configurations.
- **Developing the framework further** could provide a powerful tool for Monitor (or those working on behalf of Monitor) when they go into a trust (either in distress, pre-failure or failure) and examine the reasons for the problems and impact of possible solutions. In particular, the framework provides the step-by-step guide to consider the nature and extent of economies of scale and scope.
- **Developing a preliminary view of areas of healthcare in the NHS likely to be subject to economies of scale and scope** would act as an initial diagnosis. When faced with a trust in distress, it would provide Monitor with a quick check-list to decide whether scale or scope issues merit further detailed investigation as potentially important causes of the problems. The two key issues on which to reach agreement in order to carry this forward are the relevant comparator and relevant timeframe. Both of those are discussed in detail in the main report.
- Going one step further and **developing initial ("benchmark") agreed cost curves** for those services would allow a quick assessment of the extent of any likely cost or revenue issues for a trust that is not at minimum efficient scale (given the relevant tariff), and what solutions might be required if the service(s) are to be reconfigured rather than closed.
- Many of the issues above are also related to Monitor's on-going functions around **Foundation Trust compliance**. The steps above would also allow a better understanding of actual and potential financial difficulties of Foundation Trusts.
- Finally, commissioners will play a central role in this area – including their role defining commissioner requested services. Another iteration of the framework and thinking in this report would allow this to be developed into **guidance and support documents for commissioners**.

Implications for integrated care

- Economies of scale and scope affect the relationship between service design and cost. Since the delivery of integrated care will often involve changing the way in which services are delivered it may be useful to consider whether there are implications for cost and access created by economies of scale and scope. In any particular area of care for which more integrated service delivery is being developed, economies of scale and scope will need to be considered. The framework set out earlier in this report provides the approach for deciding whether they do exist. Where they do, there may be additional implications.
- First, **aspects of integrated care are closely linked to the continuity of service regime**. For example, it may be possible for commissioners to designate fewer services if it is possible to create effective networks of providers, allowing some flexibility in service configuration to meet commissioned health outcomes. Where integrated care does not involve merger, the risk to healthcare provision in the case of the failure of one provider may be reduced. A more detailed understanding of economies of scale and scope in key areas (and particularly which joint fixed costs need to be owned by a particular provider and/or on one site) would allow Monitor to assist commissioners in considering how integration may relate to their designation decisions.
- Secondly, **where economies of scale and scope mean there are few providers of a service in a region it may be important to ensure that the development of integrated pathways is not prevented or made unduly costly**. For example, if one provider operates a service and others are trying to develop integrated pathways involving some or all of this service, the monopoly provider may lack incentives to cooperate. Illustratively, this could be an obstacle to developing integrated pathways, such as stroke (including full rehabilitation and support) or the delivery of comprehensive peri-natal pathways (including maternity, ante-natal and post-natal support from Health Visitors and other specialties). It may be useful to investigate potential mitigations (e.g. through regulating pricing) that can minimise any undue cost.
- Finally, the work here might **help the NHS Commissioning Board and Commissioners more widely (should Monitor make it available) in their decisions around how to procure specialist hub and spoke networks for some services**. It would inform decisions about which pathway elements to bundle together, where and how to promote better inter-provider working relationships (e.g. through pricing or contracting incentives) and the cost implications of those decisions.

Implications for Monitor's on-going role with Foundation Trusts

- Monitor has on-going duties around assessment and compliance of Foundation Trusts. The framework and initial case studies provided here can help Monitor in that role as well.
- In the areas of FT assessment, the thinking developed in this report:
  - provides a new lens through which to look at the 3 year financial models provided by trusts and particularly if further analysis provides clear evidence of economies of scale and scope in some areas it will allow Monitor to examine the impact of changes to tariffs and services in those areas; and
  - allows Monitor in its assessment function to look at the impact of proposed mergers that are used to support FT applications.
- The framework also provides a range of support and thinking for Monitor's compliance regime:
  - a basis for differentiation between FTs (e.g. where economies of scale and scope are significant) in order to provide one source of evidence about the financial stability of the sector; and
  - a basis for distinguishing where financial difficulties arise from issues of scale and scope or from other issues (e.g. inefficiency, management difficulties) and the subsequent potential solutions to financial difficulties.

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Literature review: executive summary

We have conducted a high level literature review; this does not attempt to provide a definitive answer

We found no clear message on economies of scale or scope

- Difficulties around design of studies e.g. case mix
- High degree of circularity as many documents cite similar documents rather than primary sources
- Mainly based on high level outcomes (e.g. mortality), quality of care and training rather than costs
- Often at a "whole hospital level" rather than examining specific service lines and linkages between them,

Most literature around economies of scale is mainly at a hospital level, e.g.

- Optimal size for acute hospitals is 200-400 beds – which would suggest that many NHS hospitals are too small or large[1] but studies subject to caveats set out above
- Economies of scale shown to exist in hospitals < 200 beds. If output doubled unit cost would increase by ~95% for clinical functions and 65-85% for non clinical functions
- Above a certain size unit costs shown to either increase or remain constant, but unclear what bed size is referred to by 'large' and 'small' hospitals
    - evidence attributes this to the increased complexity of running a large hospital or case mix in large hospitals

Less primary research available at service line or procedure level

- Scale suggested in CABG; hip surgery; clinical support functions

No consistent evidence that large units produce better outcomes although some positive links for specialties e.g. surgery, cardiovascular and paediatrics

Literature around scope of hospital services is dominated by clinical/expert view of what services need to be connected to deliver safe care, little economic evidence on the impact of such decisions on costs

1. 149 hospitals are <200 beds, 26% are between 200-400 beds, 38% are larger than 400 beds

Literature review: detail (i)

Hospital Types	• **Marini and Miraldo (2009):** Economies of scale exist in NHS hospitals. Results imply that increasing all of hospital outputs by 1% induce a total variable cost increase between 0.66%-0.85% in FTs and between 0.77% and 0.82% for non FTs. However if inpatient activities doubled for both FTs and non FTs would experience diseconomies of scale • **Wang et al (2006):** Diseconomies of scale existed in very large hospitals (principal referral, specialist paediatric, ungrouped acute, major metropolitan and non metropolitan) whereas scale economies existed in very small hospitals (DGHs) • **Aletras (1999)**: Constant returns to scale prevail in Greek public hospitals • **Kristensen T (2008):** Scale economies for medium size hospitals & decreasing economies of scale for largest sub groups • **Dranove (1998)** Economies exist in most smaller hospitals ~200 bed, not at larger size (+280 beds)
Specialties	• **Emergency orthopaedics:** Centralisation makes some economies of theatre time use but less impact on wards (Bowers 2001) • **Intensive care:** Modest scale economies: a 7-bed unit is predicted to have average costs that are 96% those of a 6-bed unit (Jacobs, 2004) • **Cochlear implants:** Economies of scale & scope exist up to 9 children & 20 adults per year in a centre (Barton, 2004) • **Non clinical functions:** Exist in all non revenue producing cost centres but larger in those which rely on internal staff and cannot be easily outsourced. Substantial scale economies in "hotel" functions such as laundry, cafeteria and housekeeping. (Dranove 1998) • **Outpatients** No data on optimum size for an outpatient department or at what level economies/diseconomies of scale operate (Centre for Healthcare Evaluation2010) • **Cardiovascular:** Scale economies for CABG, PTCA (Huckman, 2006) • **Pneumonia:** Scale economies but limited to low volumes. No difference between medium & high (Lin, 2007) • **Stroke:** Scale economies – potential cost savings if all patients were treated by high volume physicians estimated to be ~41% of low volume costs (Lin, 2007) • **Diagnostics (pathology & imaging) and Therapeutic Services (physical medicine & rehabilitation)**: Doubling of production means average costs would reduce by 6-11% (Goncalves and Barros, 2009) • **Elective hip:** Small economies of scale (OHE, 2012) • **Trauma:** Large economies of scale (OHE, 2012) • **Orthopaedic**: For elective orthopaedic surgery specialist hospitals are on average £500 higher than tariff. Teaching and acute hospitals roughly break even. Small hospitals make a profit on every procedure. This is proved to be due to case mix in specialist hospitals (Jones 2008)

Literature review: detail (ii)

Quality

Clinical reviews argue for greater concentration of secondary services

- **London Stroke Strategy, Healthcare for London and London Cardiovascular:** all argue for centralisation
- **Royal College of Obstetricians and Gynaecologists:** express concern for units smaller than 2500 births per year

Studies show positive links between volume and quality for specialised units

- **Tilford (2000):** Paediatrics intensive care
- **Huckman (2006**): CABG and PTCA
- **Luft (1979):** A small group of surgeons performing more complicated surgeries can mean fewer complications
- **Dowrie and Garvell (1997) and Fulop (2002):** Higher quality medical training
- **Sowden et al. (1997):** Increased effectiveness of higher volume activity of specialised units in certain clinical specialities

Counter studies show that consolidations decrease or have no effect on quality of care

- **Bond and Weissman (1997)**: Patient choice is restricted
- **Ho and Hamilton (2000):** Increased probability of patient readmission by 1.7%
- **Magel (1999) and Kassirer (1996)**: Physicians tend to lose income, jobs and autonomy, which may undermine the physician/patient relationship
- **Cuellar and Gertier (2003):** Found that in the U.S., following mergers, hospital market power increased, while the efficiency of delivery did not. Hospitals gained higher prices but did not translate them into higher quality of inpatient care or provision of more common goods.

Literature review: detail (iii)

Scope

- **Goudie and Goddard (2011):** Set of 'core' services required to be collocated (from a clinical point of view) where emergency care is provided: Acute medicine, critical care/intensive care, diagnostic imaging, general surgery, laboratory services (i.e. pathology), orthopaedics and paediatrics
- **Academy of Medical Royal Colleges (2007):** finds that high volume, low cost elements contribute to maintaining more expensive services e.g. ophthalmology or dermatology as are net contributors to hospital budget
- **Kittlesen and Magnusson (2002):** Norwegian study of scope economies in hospital sector found strong economies for surgical and medical services, intermediate for inpatient and outpatient production while elective and emergency care cases only have weak economies of scope which may not be statistically significant
- **Wang (2006):** Found economies of scope in both large and small hospitals
- **Marini and Miraldo (2009):** FTs experience global diseconomies of scope. Non FTs experience economies of scope

Obstetrics

Some evidence of economies of scale

- Larger units have lower reference costs (2020 delivery)
- Attempts to reduce costs e.g. by LOS are not successful since it is size rather than average LOS which determines the cost base (Jones 2011)

Units below a certain size struggle to meet quality requirements

- There is specific concern for smaller units delivering fewer than 2500 women per annum (RCOG)
- Unpublished evidence from a number of SHAs indicates that smaller maternity units struggle to meet clinical guidelines for number of hours of dedicated consultant presence on obstetrics wards each week

However indicators in the Healthcare Commission's 2007 Maternity Services Review, larger maternity units tend to have slightly lower quality of care

Literature review: detail (iv)

Orthopaedics

Little evidence of economies of scale in orthopaedic services above a certain critical mass, and increasing size and scope can increase costs associated with complexity and coordination

- For elective overnight work medium and small hospitals make, on average a profit for every procedure (thereby deemed to be efficient) while teaching and large scale acute hospitals will roughly break even (i.e. perceived average efficiency.) However costs at specialist orthopaedic hospitals is on average over £500 per procedure higher than the tariff. This gap is due to complexity which is not encapsulated within the clinical information currently used in the tariff
- 44% of activity at specialist orthopaedic hospitals cost less than equivalent teaching and large acute hospitals. A further 36% cost up to 50% more and the remaining 20% cost more than £500 more than the equivalent at a teaching or large hospital (Jones 2008)

Royal College of Surgeons argues for a physical separation of services, facilities and rotas works best between emergency and elective care. Separate unit on same site is preferable to a completely separate location

- Separating emergency and elective services can prevent the admission of emergency patients (both medical and surgical) from disrupting planned activity and vice versa, thus minimising patient inconvenience and maximising productivity for the trust

There is evidence of links between increasing volume and increasing quality

- Although more closely linked to clinician volume than institution volume (NHS Wales 2010)
- Knee replacement. Higher hospital volume associated with lower risk of complications (Benjamin 1995)
- Since 1 Jan 2007 a minimum provider volume of 50 total knee replacements per year per hospital has been mandatory in Germany (Schrader and Ewerbeck), 2007

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Criteria for selecting *services* to be tested in case studies

	Criteria	Proposed services
Relevance	**Service lines should include those most likely to come under scrutiny**	➢ Obstetrics; A&E/acute
Impact	**Service lines should include those with significant linkages to other services lines**	➢ A&E/acute (includes geriatrics)
	Service lines should include those with significant linkages to key support services ● For example, a high volume surgical specialty utilising significant theatre capacity	➢ Orthopaedics
	Service lines should represent those with: ● The potential for flexible capacity utilisation across wards ● Distinct needs where capacity cannot easily be shared	➢ Orthopaedics; A&E / acute ➢ Obstetrics
Approach considerations	**Service lines should be represented in the majority of trusts**	➢ All
Other considerations	**Service lines should be both elective and non-elective**	➢ Orthopaedics; A&E / acute
	Service lines should utilise the relevant support services ● E.g. theatres; radiology; ITU/NICU/PICU; ... ● Pathology has been excluded given outsourcing potential	➢ All

Principles for selecting *trusts* for case studies

Geography

Trusts should represent key geographical locations likely to be encountered by Monitor

- Urban with more than one provider, e.g. London, Birmingham
- Urban with single provider, e.g. Hull
- Rural

Types of trust

The majority of selected trusts should be representative of a 'typical' trust

- Multi-specialty organisations
- No significant exceptional circumstances or interests

Trusts should include those representing different organisational models

- Sites: single and multi-site
- Staffing: flexible staff utilisation and fixed or 'traditional'

Trusts should reflect different case mixes

- Affluent and deprived local populations
- Teaching and non-teaching trusts

Regulatory considerations

Trusts with major quality, financial or other difficulties should be excluded

- As determined by Monitor

Annexes

- Literature review
- Case study selection
- Supporting evidence for models
  - Consultant Led Obstetrics
  - Midwife Led Obstetrics
  - “Standard” Level 1 A&E
  - Level 1 A&E with trauma
  - Orthopaedics
  - Radiology
  - Inpatient Theatre
  - Day Surgery Theatre
- Glossary

Supporting evidence for models

The slides that follow provide an overview of how each of the qualitative models has been constructed.

For each model, they provide:

- a full list of inputs for the unit being considered;
- the key assumptions made; and
- the key caveats.

Annexes

- Literature review
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Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Consultant Led Unit (CLU)) (i/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Central Delivery Suite	Staffing	**O&G consultant**	Fixed	12 WTE consultants are needed for 168 hour presence with break times covered. This assumes consultants work 7.5 clinical care sessions in the delivery ward in a 10p.a. contract (The Future Workforce in Obstetrics and Gynaecology) After 6000 births per year an additional 1/3 of staff are needed on the labour ward (Case study) To cover maternal and fetal medicine, antenatal clinics, theatre or outpatient clinics additional p.as are needed. (The Future Workforce in Obstetricians and Gynaecology) Salary 74,504-100,446	87,475	individual salary
			O&G associate specialist and staff grade	Fixed	1 specialist trainee for units below 2500 births, 2 for units 2500-4000 births, 3 for units over 4000 births (Safer Childbirth) After 6000 births per year an additional 1/3 of staff are needed on the labour ward (Case study)Salary: 36807-70126 (NHS Careers)	48,944	individual salary
			Anaesthetist consultant	Fixed	24/7 coverage by dedicated anaesthetist (Safer Childbirth) This equates to 12 WTE (The Future Workforce in Obstetrics and Gynaecology) After 6000 births per year an additional 1/3 of staff are needed on the labour ward (Case study) Salary 74,504-100,446 (NHS Careers)	87,475	individual salary
			Duty Anaesthetist	Fixed	1 specialist trainee for units below 2500 births, 2 for units 2500-4000 births, 3 for units over 4000 births (Safer Childbirth) After 6000 births per year an additional 1/3 of staff are needed on the labour ward (Case study) Salary: 36807-70126 (NHS Careers)	48,944	individual salary
			O&G registrar	Semi-Fixed	Mean FTE-birth ratio: 324.73 (National Nursing Research Unit) Salary: 30,992-46,708 (NHS Careers)	38,850	individual salary
			O&G SHO	Semi-Fixed	Mean FTE-birth ratio:1,776.92 (National Nursing Research Unit) F2 Salary: 27,798 (NHS Careers)	33,252	individual salary
			O&G JHO	Semi-Fixed	Mean FTE-birth ratio:1901.18 (National Nursing Research Unit) F1 Salary: 22,412 (NHS Careers)	23,112	individual salary
			Midwife consultant	Semi-Fixed	1 WTE consultant midwife per 900 women based on 60% of women remaining at low risk and under midwifery care (Safer Childbirth) Salary: Band 8a-8c (NHS Careers) Use band 8c (Case study)	60,400	individual salary
			Midwife	Semi-Fixed	The minimum midwife to woman ratio is 1:28 for safe level of service to ensure the capacity to achieve 1:1 care in labour (BR+ evaluation data) The recommended total care ratios indicate the maximum number of women that a midwife can provide antenatal, intrapartum and postnatal care for within the service. It does not take into account midwives in other roles such as practice development or audit and risk management (Safer Childbirth) Salary: Band 6 (Hospital Midwife)-Band 7 (Midwife higher level/team leader) (NHS Careers)	32,391	individual salary
			Registered nurse	Semi-Fixed	Mean FTE-birth ratio: 257.60 (National Nursing Research Unit) Salary: Band 5 (NHS Careers)	24,188	individual salary
			MSW	Semi-Fixed	MSW to Midwife ratio is 1-6 for more complex case mix (Safer Childbirth) Salary: Band 5 (NHS Careers)	24,188	individual salary
			HCA	Semi-Fixed	Mean FTE-birth ratio: 144.21 (National Nursing Research Unit) Salary: Band 2-3 (NHS Careers)	16,350	individual salary

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Consultant Led Unit (CLU)) (ii/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Central Delivery Suite	Consumables	**Drugs and medicine**	Variable	Cost per birth £43 (Case study benchmarking 2011-12)	43	Per birth
			Blood Costs	Variable	Cost per birth £24 (Case study benchmarking 2011-12)	24	Per birth
			Consumables	Variable	Cost per birth £53 (Case study benchmarking 2011-12)	53	Per birth
		Medical Equipment	**Medical equipment for delivery suite**	Fixed	Cost to equip 14 bedded unit 115900: 8279 per bed. This includes foetal heart monitors (6300), blood pressure cuffs (46), wall mounted fans (70), blood pressure monitors (1250), portable ultrasound scanner (25000), infant resuscitate (9800) etc(Whipps Cross Big Push Appeal Fundraising documents). No difference in equipment between delivery bed and antenatal/ postnatal beds to maximise flexibility of bed allocations (BCG assumption) Depreciation rate as footnoted	1,656	Per bed
			Medical equipment for antenatal beds	Fixed	Cost to equip 14 bedded unit 115900: 8279 per bed. This includes foetal heart monitors (6300), blood pressure cuffs (46), wall mounted fans (70), blood pressure monitors (1250), portable ultrasound scanner (25000), infant resuscitate (9800) etc(Whipps Cross Big Push Appeal Fundraising documents). No difference in equipment between delivery bed and antenatal/ postnatal beds to maximise flexibility of bed allocations (BCG assumption) Depreciation rate as footnoted	1,656	Per bed
		Fixtures and fittings	**Fixtures and fittings for labour rooms**	Fixed	Cost of furniture and fittings for delivery suite: 9200. Current size 9 (CLU) and 5 (MLU) beds. Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
			Fixtures and fittings for antenatal beds	Fixed	Cost of furniture and fittings for delivery suite: 9200. Current size 9 (CLU) and 5 (MLU) beds. Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
			Fixtures and fittings for other areas	Fixed	Cost of furniture and fittings for birth partners rooms 1400, discharge lounge 4400, staff area 2800, reception 1463 (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	1,006	Per unit
		Other	**CNST**	Variable	Contribution to clinical negligence scheme for trusts. Approximate cost per birth in 2012/13 £850 (NHS Litigation Authority)	850	Per birth

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Consultant Led Unit (CLU)) (iii/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Obstetrics Theatres	Staffing	O&G Consultant	Fixed	To cover maternal and fetal medicine, antenatal clinics, theatre or outpatient clinics additional p.as are needed. (The Future Workforce in Obstetrics and Gynaecology) 1 list = 1 p.a. Salary 74,504-100,446 (NHS Careers)Combine outpatient and elective lists and round up to WTE consultant - see outpatient consultant line (BCG assumption)	87,475	individual salary
			Anaesthetist	Fixed	There should be a separate consultant anaesthetist for each formal elective caesarean list (Safer Childbirth) 1 list = 1 p.a. Salary 74,504-100,446 (NHS Careers) Round uip to closest full consultant (BCG assumption)	87,475	individual salary
			Scrub nurse	Semi-Fixed	1 scrub nurse per theatre session. (Case study) Salary: Band 5 (NHS Careers) Assume flexible working so cost per hour	12	individual salary
			Nurse	Semi-Fixed	1 nurse per theatre session. (Case study) Salary: Band 5 (NHS Careers) Assume flexible working so cost per hour	10	individual salary
		Equipment	Obstetrics theatre medical equipment	Fixed	Median replacement rates for theatre equipment are between 7500 and 45000 (Audit Commission: Operating Theatres) Use mid point for obstetrics theatre (BCG assumption) . Assume volume threshold is the same as theatre (BCG assumption)	26,250	unit per year depreciated
		Other building costs	Theatre building depreciation	Fixed	Cost to build and equip theatre is £0.8m (Audit Commission: Operating Theatres) 1 theatre per 4000 births (Safer Childbirth) Assume volume threshold is the same as theatre (BCG assumption) Depreciation rate as footnoted	40,000	unit per year depreciated
Obstetrics Unit	Indirect and Overhead	Indirect and Overheads	Catering, Portering & Laundry	Variable	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	139	Per patient consumer week
			Cleaning	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	33	Per square metre
			Property	Fixed	Includes maintenance, rent & rates and utiliities. Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	11,500	Per 100 square metres
			Management and administration	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	92	Per £1000 gross expenditure
Support Services	Direct	Support Services	Pathology	Variable	Cost per birth (DH audit of aute maternity services)	54	Per 1 birth
			ITU	Variable	Cost per bed day (Bennett and Bion) Mean length of stay is 7 days (Richa, Karim and Yazbeck: obstetric admissions to the intensive care unit 2008)	9,800	Per 1000 births
			HDU	Variable	Cost per bed day (Bennett and Bion) Mean length of stay is2.5 days (Rajagopal, Naz, Gibson, Roberts and Davidson. Review of utilisation of obstetric hdu care beds in newly designed labour unit)	1,093	Per 100 births

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Other assumptions - Obstetrics

	Assumption		Source
Length of stay	CLU on delivery suite	0.6	HES. Maternity – Provider Level analysis. 2010-11
	CLU total time in hospital	2.2	HES. Maternity – Provider Level analysis. 2010-11
	MLU on delivery suite	0.6	HES. Maternity – Provider Level analysis. 2010-11
	MLU total time in hospital	2.2	HES. Maternity – Provider Level analysis. 2010-11
Bed calculation	Ratio of antenatal/postnatal beds to delivery beds	3.95	Dr Foster Hospital Guide – Average of ~40 CLUs
Elective Lists	Length of caesarean section (minutes)	37.50	Overview NHS Evidence – Estimate 30-45 minutes
	Utilisation rate of theatres	85%	Case study guidance
	% elective c/s	10%	HES. Maternity – Provider Level analysis. 2010-11. National average
	Number of c/s per theatre list	4	Calculation
Staffing	Threshold for increased fixed staffing levels (no. of births)	6,000	Case study guidance
	Increase in fixed staffing	130%	Case study guidance
Antenatal appointments	Standard	7	NICE Guidance Antenatal Care
	Intermediate	10	NICE Guidance Antenatal Care
	Intensive	12	NICE Guidance Antenatal Care: Every 2 weeks from 16 weeks
	Average time for an antenatal appointment (minutes)	15	Case study guidance
	Assume antenatal care is led by obstetrician for intermediate and intensive patients and by midwives for the standard patients		
Antenatal scans	Standard	2	NICE Guidance Antenatal Care
	Intermediate	7	Estimate: Average of standard and intensive
	Intensive	12	NICE Guidance Multiple Births: Every 2 weeks from 16 weeks
	Average time for a scan (minutes)	30	Case study guidance
Postnatal appointments	Standard	3	Case study guidance
	Intermediate	3	Case study guidance
	Intensive	3	Case study guidance
	Average time for a postnatal appointment (minutes)	15	Case study guidance
	Assume postnatal care is led by obstetrician for intermediate and intensive patients and by midwives for the standard patients		

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Annexes

- Literature review
- Case study selection
- Supporting evidence for models
  - Consultant Led Obstetrics
  - Midwife Led Obstetrics
  - “Standard” Level 1 A&E
  - Level 1 A&E with trauma
  - Orthopaedics
  - Radiology
  - Inpatient Theatre
  - Day Surgery Theatre
- Glossary

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Midwife Led Unit (MLU)) (i/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Central Delivery Suite	Staffing	O&G consultant	Fixed	Not applicable for an MLU	n/a	n/a
			O&G associate specialist and staff	Fixed	Not applicable for an MLU	n/a	n/a
			Anaesthetist consultant	Fixed	Not applicable for an MLU	n/a	n/a
			Duty Anaesthetist	Fixed	Not applicable for an MLU	n/a	n/a
			O&G registrar	Fixed	Not applicable for an MLU	n/a	n/a
			O&G SHO	Fixed	Not applicable for an MLU	n/a	n/a
			O&G JHO	Fixed	Not applicable for an MLU	n/a	n/a
			Midwife consultant	Semi-Fixed	1 WTE consultant midwife per 900 women based on 60% of women remaining at low risk and under midwifery care (Safer Childbirth) Salary: Band 8a-8c (NHS Careers) Use band 8c (Case study)	60,400	individual salary
			Midwife	Semi-Fixed	The minimum midwife to woman ratio is 1:28 for safe level of service to ensure the capacity to achieve 1:1 care in labour (BR+ evaluation data) The recommended total care ratios indicate the maximum number of women that a midwife can provide antenatal, intrapartum and postnatal care for within the service. It does not take into account midwives in other roles such as practice development or audit and risk management (Safer Childbirth) Salary: Band 6 (Hospital Midwife)-Band 7 (Midwife higher level/team leader) (NHS Careers)	32,391	individual salary
			Registered nurse	Semi-Fixed	Mean FTE-birth ratio: 257.60 (National Nursing Research Unit) Salary: Band 5 (NHS Careers)	24,188	individual salary
			MSW	Semi-Fixed	MSW to Midwife ratio is 1-6 for more complex case mix (Safer Childbirth) Salary: Band 5 (NHS Careers)	24,188	individual salary
			HCA	Semi-Fixed	Mean FTE-birth ratio: 144.21 (National Nursing Research Unit) Salary: Band 2-3 (NHS Careers)	16,350	individual salary
Obstetrics Unit	Direct: Central Delivery Suite	Consumables	Drugs and medicine	Variable	Cost per birth £43 (Case study benchmarking 2011-12)	43	Per birth
			Blood Costs	Variable	Cost per birth £24 (Case study benchmarking 2011-12)	24	Per birth
			Consumables	Variable	Cost per birth £53 (Case study benchmarking 2011-12)	53	Per birth
		Medical Equipment	Medical equipment for delivery suite	Fixed	Cost to equip 14 bedded unit 115900: 8279 per bed. This includes foetal heart monitors (6300), blood pressure cuffs (46), wall mounted fans (70), blood pressure monitors (1250), portable ultrasound scanner (25000), infant resuscitate (9800) etc(Whipps Cross Big Push Appeal Fundraising documents). No difference in equipment between delivery bed and antenatal/ postnatal beds to maximise flexibility of bed allocations (BCG assumption) Depreciation rate as footnoted	1,656	Per bed
			Medical equipment for antenatal beds	Fixed	Cost to equip 14 bedded unit 115900: 8279 per bed. This includes foetal heart monitors (6300), blood pressure cuffs (46), wall mounted fans (70), blood pressure monitors (1250), portable ultrasound scanner (25000), infant resuscitate (9800) etc(Whipps Cross Big Push Appeal Fundraising documents). No difference in equipment between delivery bed and antenatal/ postnatal beds to maximise flexibility of bed allocations (BCG assumption) Depreciation rate as footnoted	1,656	Per bed

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Midwife Led Unit (MLU)) (ii/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Central Delivery Suite	Fixtures and fittings	Fixtures and fittings for labour rooms	Fixed	Cost of furniture and fittings for delivery suite: 9200. Current size 9 (CLU) and 5 (MLU) beds. Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
			Fixtures and fittings for antenatal beds	Fixed	Cost of furniture and fittings for delivery suite: 9200. Current size 9 (CLU) and 5 (MLU) beds. Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
			Fixtures and fittings for other areas	Fixed	Cost of furniture and fittings for birth partners rooms 1400, discharge lounge 4400, staff area 2800, reception 1463 (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	1,006	Per unit
		Other	CNST	Fixed	Contribution to clinical negligence scheme for trusts. Approximate cost per birth in 2012/13 £850 (NHS Litigation Authority)	850	Per birth
Obstetrics Unit	Direct: Outpaitent Unit	Staffing	O&G Consultant	Fixed	Not applicable for an MLU	87,475	individual salary
			Midwife	Fixed	Midwifes in outpatient unit are included in the 1:28 ratio on delivery ward (case study)		
			Sonographer	Fixed	Sonographer covers all patient scans. Salary: Band 5 (NHS Careers)	12	Per appointment
		Medical equipment	Medical equipment outpatient unit	Fixed	Cost of medical equipment in standard antenatal unit 38,900 (Whipps Cross Big Push Appeal Fundraising Documents) Split between MLU and CLU by no. of beds Depreciation rate as footnoted	7,780	unit per year depreciated
		Fixtures and fittings	Fixtures and fittings outpatient unit	Fixed	Cost of fixtures and fittings 6900 (Whipps Cross Big Push Appeal Fundraising Documents) Split between MLU and CLU by no. of beds. Depreciation rate as footnoted	690	unit per year depreciated

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Midwife Led Unit (MLU)) (iii/iii)

Cost description							
Cost Centre	Category		Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Obstetrics Unit	Direct: Obstetrics Theatres	Staffing	O&G Consultant	Fixed	Not applicable for an MLU	87,475	individual salary
			Anaesthetist	Fixed	Not applicable for an MLU	87,475	individual salary
			Scrub nurse	Semi-Fixed	Not applicable for an MLU	12	individual salary
			Nurse	Semi-Fixed	Not applicable for an MLU	10	individual salary
		Equipment	Obstetrics theatre medical equipment	Fixed	Not applicable for an MLU	26,250	unit per year depreciated
		Other building costs	Theatre building depreciation	Fixed	Not applicable for an MLU	40,000	unit per year depreciated
Obstetrics Unit	Indirect and Overhead	Indirect and Overheads	Catering, Portering & Laundry	Variable	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	139	Per patient consumer week
			Cleaning	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	33	Per square metre
			Property	Fixed	Includes maintenance, rent & rates and utiliities. Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	11,500	Per 100 square metres
			Management and administration	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	92	Per £1000 gross expenditure
Support Services	Direct	Support Services	Pathology	Variable	Not applicable for an MLU	54	Per 1 birth
			ITU	Variable	Not applicable for an MLU	9,800	Per 1000 births
			HDU	Variable	Not applicable for an MLU	1,093	Per 100 births

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Other assumptions - Obstetrics

	Assumption		Source
Length of stay	CLU on delivery suite	0.6	HES. Maternity – Provider Level analysis. 2010-11
	CLU total time in hospital	2.2	HES. Maternity – Provider Level analysis. 2010-11
	MLU on delivery suite	0.6	HES. Maternity – Provider Level analysis. 2010-11
	MLU total time in hospital	2.2	HES. Maternity – Provider Level analysis. 2010-11
Bed calculation	Ratio of antenatal/postnatal beds to delivery beds	3.95	Dr Foster Hospital Guide – Average of ~40 CLUs
Elective Lists	Length of caesarean section (minutes)	37.50	Overview NHS Evidence – Estimate 30-45 minutes
	Utilisation rate of theatres	85%	Case study guidance
	% elective c/s	10%	HES. Maternity – Provider Level analysis. 2010-11. National average
	Number of c/s per theatre list	4	Calculation
Staffing	Threshold for increased fixed staffing levels (no. of births)	6,000	Case study guidance
	Increase in fixed staffing	130%	Case study guidance
Antenatal appointments	Standard	7	NICE Guidance Antenatal Care
	Intermediate	10	NICE Guidance Antenatal Care
	Intensive	12	NICE Guidance Antenatal Care: Every 2 weeks from 16 weeks
	Average time for an antenatal appointment (minutes)	15	Case study guidance
	Assume antenatal care is led by obstetrician for intermediate and intensive patients and by midwives for the standard patients		
Antenatal scans	Standard	2	NICE Guidance Antenatal Care
	Intermediate	7	Estimate: Average of standard and intensive
	Intensive	12	NICE Guidance Multiple Births: Every 2 weeks from 16 weeks
	Average time for a scan (minutes)	30	Case study guidance
Postnatal appointments	Standard	3	Case study guidance
	Intermediate	3	Case study guidance
	Intensive	3	Case study guidance
	Average time for a postnatal appointment (minutes)	15	Case study guidance
	Assume postnatal care is led by obstetrician for intermediate and intensive patients and by midwives for the standard patients		

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Annexes

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Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a "standard" Level 1 A&E (i/iii)

Cost description				Cost type				
Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% cost assigned to A&E
"Standard" Level 1 A&E department	Direct A&E	Equipment	X-ray machine	Semi-fixed	7,500 procedures per equipment and year - based on http://www.audit-commission.gov.uk/SiteCollectionDocuments/AuditCommissionReports/NationalStudies/Radiology_Full.pdf, p.15. We use data for upper quartile. 29% of attendances need x-ray - from HES. £89,000 per machine - from www.absolutemed.com	unit per year depreciated	18,281	100%
			Ultrasound	Fixed	1 per A&E dept - COEM. £27,000 per machine - from www.absolutemed.com	unit per year depreciated	7,123	100%
			Computed Tomography	Fixed	1 per A&E dept - COEM. £89,000 per machine - from www.absolutemed.com	unit per year depreciated	18,281	100%
			MRI equipment	Fixed with economies of scope	A&E department uses the one in the radioloy department - Assumption. £190,000 per machine - from www.absolutemed.com	unit per year depreciated	39,027	10%
			Blood gas machine	Fixed	1 per A&E dept - Assumption. £5,500 per machine - from www.blockscientificstore.com	unit per year depreciated	1,130	100%
		Specialist staffing	Specialist support - paediatrics consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	25%
			Specialist support - orthopaedics consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. Assume 50% of cost corresponds to A&E- from case studies	individual salary	109,321	50%
			Specialist support - general surgery consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	13%
			Specialist support - general medicine consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	31%
			Specialist support - middle grade doctors or equivalent	Fixed with economies of scope	One middle grade doctor always present for each of the specialties above always present - from case studies. 1 in 8 rota, from COEM, Emergency Medicine Operational Handbook, Dec 2011. This requires 8 doctors per specialty with 60% of costs allocated to A&E - assumption	individual salary	76,295	60%
			Specialist support - radiographers	Fixed	24/7 cover - from case studies. This requires 18 radiographers (assumption). Salary: band 6 - from NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=190. Assume 1/6 of cost to A&E - based on case studies	individual salary	33,942	17%
			Specialist support - radiologist consultant	Fixed with economies of scope	24/7 cover, can be remote through PACS - from case studies. Assume this requires 20 consultants. Assume 1/6 of cost to A&E - based on case studies	individual salary	109,321	17%
		Beds	Resuscitation beds	Fixed	0.2 resuscitation beds per 5,000 attendances - assumption based on case studies. £7,500 per resuscitation bed - assumption	unit per year depreciated	1,541	100%
			Major trolley cubicles / Monitored beds	Fixed	0.75 major trolley cubicles/monitored beds per 5,000 attendances - assumption based on case studies. £5,000 per monitoring bed - from www.absolutemed.com	unit per year depreciated	1,027	100%
			Minor trolley cubicles	Fixed	0.35 minor trolley cubicles per 5,000 attendances -assumption based on case studies. £2,000 per trolley cubicle - assumption	unit per year depreciated	411	100%

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a "standard" Level 1 A&E (ii/iii)

Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% cost assigned to A&E
Standard Level 1 A&E department	Direct A&E	Staffing	Consultants	Semi-fixed	Non-linear relationship from COEM, Emergency Medicine Operational Handbook, Dec 2011 - CEM recommends 16/7 cover for all EDs with a minimum of 10 consultants required to provide this, 12 if attendances > 80,000 and 16 if attendances > 100,000	individual salary	109,321	100%
			Middle grade doctors or equivalent	Semi-fixed	Non-linear relationship based on COEM, Emergency Medicine Operational Handbook, Dec 2011 - 1 in 8 rota. Minimum of 8 consultants required to provide this, 10 if attendances > 80,000 and 14 if attendances > 100,000	individual salary	76,295	100%
			Junior grade doctors or equivalent	Semi-fixed	Non-linear relationship based on COEM, Emergency Medicine Operational Handbook, Dec 2011 - 1 in 6 rota. Minimum of 6 consultants required to provide this, 8 if attendances > 80,000 and 12 if attendances > 100,000	individual salary	43,268	100%
			Nurses	Semi-fixed	Two options: semivariable cost (1 per 1500 attendances - Based on Dr. Matthew Cooke, A&E The present state) or fixed cost (always one nurse for each resuscitation bed, one nurse for every two major beds and one nurse for every four minor beds - based on Royal College of Nursing:,"Guidance on safe nurse staffing levels in the UK". Assume one in six rota.) Average salary: band 5 - Assumption based on NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	individual salary	27,816	100%
			Clinical support workers	Semi-fixed	1 per 2000 attendances - Assumption. Salary: band 2 - source: NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	individual salary	18,727	100%
		Consumables	Drugs and medicines	Variable	£2 per attendance - Case study	per attendance	2	100%
			Medical supplies	Variable	£2.5 per attendance - Case study	per attendance	2.5	100%
			Administration of A&E department	Fixed	10 staff (recepton + PA/medical secretary)- from case studies, salary: band 3 - assumption based on http://www.nhscareers.nhs.uk/details/Default.aspx?Id=541	individual salary	20,801	100%
	Direct Acute Medical Unit	Equipment	Acute Medical Unit - ultrasound for central line insertion	Fixed	1 per A&E dept -from The College of Emergency Medicine, Emergency Medicine Operational Handbook, Dec 2011. Cost : £19,000 - from http://iv-therapy.net/node/526	unit per year depreciated	5,012	80%
			Acute Medical Unit - ventilation support	Fixed	1 per A&E dept -from The College of Emergency Medicine, Emergency Medicine Operational Handbook, Dec 2011. Cost : £10,000 - from http://www.nextag.com/medical-ventilator/stores-html	unit per year depreciated	2,054	80%
		Beds	Acute Medical Unit - resuscitation beds	Fixed	20% of beds are resuscitation beds - assumption. £7,500 per monitoring bed - assumption	unit per year depreciated	1,541	80%
			Acute Medical Unit - monitored beds	Fixed	80% of beds are monitoring beds - £5,000 per monitored bed - from www.absolutemed.com	unit per year depreciated	1,027	80%
		Staffing	Acute Medical Unit - consultants	Semi-fixed	25 patients per consultant. Minimum of 3 consultants - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	109,321	80%
			Acute Medical Unit - middle grade doctors	Semi-fixed	20 patients per doctor. Minimum of 8 doctors - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	76,295	80%
			Acute Medical Unit -junior doctors	Semi-fixed	20 patients per doctor. Minimum of 10 doctors - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	43,268	80%
			Acute Medical Unit -nurses	Semi-fixed	1 Whole Time Equivalent (WTE) nurses per bed - based on Royal College of Nursing, Guidance on safe nurse staffing levels in the UK	individual salary	27,816	80%
		Consumables	Acute Medical Unit - drugs and medicines	Variable	£2 per attendance - Assumption	per attendance	2	80%
			Acute Medical Unit - medical supplies	Variable	£2.5 per attendance - Assumption	per attendance	2.5	80%

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a "standard" Level 1 A&E (iii/iii)

Cost Centre	Category	Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% cost assigned to A&E
Standard Level 1 A&E department	Indirect and overhead	Catering, Portering & Laundry	Variable	£138.25 per patient consumer week £ - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Costs/Overhead.asp. On average, 1 hour per attendance is relevant for this cost - assumption	per patient consumer week	138	100%
		Cleaning	Fixed	£33 per sq m - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Costs/Overhead.asp	per square meter	33	100%
		Property (maintenance, energy expenditure)	Fixed	£13 per sq m - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Costs/Overhead.asp	per square meter	13	100%
		Property (rent)	Fixed	Cost per sq m depends on location -> from Valuation Office Agency, http://www.voa.gov.uk/dvs/_downloads/pmr_2011.pdf	per square meter	115	100%
		General administration of hospital	Variable	£92 per £1000 gross expenditure- from http://www.isdscotland.org	per £1000 gross expenditure	92	100%
Pathology	Direct	Pathology	Variable	£2 per attendance - Case study	per attendance	2	100%

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Other model assumptions - A&E

Assumption			Source
Ratio of beds to attendances	Standard A&E department		
	Resuscitation beds	0.2 per 5,000 attendances	Case studies
	Major trolley cubicles/monitored beds	0.75 per 5,000 attendances	Case studies
	Minor trolley cubicles	0.35 per 5,000 attendances	Case studies
	A&E department with acute trauma capabilities		
	Resuscitation beds	0.3 per 5,000 attendances	Case studies
	Major trolley cubicles/monitored beds	0.9 per 5,000 attendances	Case studies
	Minor trolley cubicles	0.3 per 5,000 attendances	Case studies
Cost of capital	WACC	10%	Assumption
Cost sharing with radiology department	% of MRI costs allocated to A&E	10%	Case studies
	% of radiologists salaries allocated to A&E	17%	Case studies
	% of radiographers salaries allocated to A&E	17%	Case studies
Cost sharing with other departments	Paediatrics consultant	25%	Based on activity split between A&E and department in HES 2010-2011
	Orthopaedics consultant	50%	Case studies
	General surgery consultant	13%	Based on activity split between A&E and department in HES 2010-2011
	General medicine consultant	31%	Based on activity split between A&E and department in HES 2010-2011
	Trauma consultants - for A&E with acute trauma departments o	50%	Case studies
	Surgeon consultants: neurosurgeons, spinal surgeons, plastic su	17%	Case studies
	Middle grade doctors for all specialties	60%	Case studies

Annexes

- Literature review
- Case study selection
- Supporting evidence for models
  - Consultant Led Obstetrics
  - Midwife Led Obstetrics
  - “Standard” Level 1 A&E
  - Level 1 A&E with trauma
  - Orthopaedics
  - Radiology
  - Inpatient Theatre
  - Day Surgery Theatre
- Glossary

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Level 1 A&E with trauma capability (i/iv)

Cost description				Cost type				
Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% of cost assigned to A&E
A&E with trauma capabilities	Direct A&E	Equipment	X-ray machine	Semi-fixed	7,500 procedures per equipment and year - based on http://www.audit-commission.gov.uk/SiteCollectionDocuments/AuditCommissionReports/NationalStudies/Radiology_Full.pdf, p.15. We use data for upper quartile. Assume 35% of attendances need x-ray. £89,000 per machine - from www.absolutemed.com	unit per year depreciated	18,281	100%
			Ultrasound	Fixed	1 per A&E dept - COEM. £27,000 per machine - from www.absolutemed.com	unit per year depreciated	7,123	100%
			Computed Tomography	Fixed	1 per A&E dept - COEM. £89,000 per machine - from www.absolutemed.com	unit per year depreciated	18,281	100%
			MRI equipment	Fixed with economies of scope	A&E department uses the one in the radioloy department - Assumption. £190,000 per machine - from www.absolutemed.com	unit per year depreciated	39,027	10%
			Blood gas machine	Fixed	2 per A&E dept - Assumption. £5,500 per machine - from www.blockscientificstore.com	unit per year depreciated	1,130	100%
			Blood analyser	Fixed	2 per A&E dept - Assumption. £6,500 per machine - from www.blockscientificstore.com	unit per year depreciated	1,335	100%
		Specialist support	Specialist support - paediatric consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	25%
			Specialist support - orthopaedics consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. Assume 50% of cost corresponds to A&E-from case studies	individual salary	109,321	50%
			Specialist support - general surgery consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	13%
			Specialist support - general medicine consultant	Fixed with economies of scope	24/7 cover, assume these implies 20 consultants - based on case studies. % of cost assigned to A&E based on emergency and outpatient activity levels from HES online.	individual salary	109,321	31%
			Specialist support - middle grade doctors or equivalent	Fixed with economies of scope	One middle grade doctor always present for each of the specialties above always present - from case studies. 1 in 8 rota, from COEM, Emergency Medicine Operational Handbook, Dec 2011. This requires 8 doctors per specialty with 60% of costs allocated to A&E	individual salary	76,295	60%
			Specialist support - radiographers	Fixed with economies of scope	24/7 cover, 3 rooms with one radiographer each - from case studies. This requires 18*3 =54 radiographers (assumption). Salary: band 6 - from NHS careers. 1/6 of cost to A&E - based on case studies	individual salary	33,942	17%
			Specialist support - radiolgist consultant	Fixed with economies of scope	24/7 cover, assume this requires 20 consultants 1/6 of cost to A&E - based on case studies	individual salary	109,321	17%
			Specialist support trauma consultant	Fixed with economies of scope	24/7 cover, this requires 20 consultants - from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 50% of cost to A&E - based on case studies	individual salary	109,321	50%

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Level 1 A&E with trauma capability (ii/iv)

Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% of cost assigned to A&E
A&E with trauma capabilities	Direct A&E	Specialist support	Specialist support trauma doctors	Fixed with economies of scope	One middle grade doctor always present for each of the specialties above always present - from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 1 in 8 rota, from COEM, Emergency Medicine Operational Handbook, Dec 2011. This requires 8 doctors per specialty with 60% of costs allocated to A&E	individual salary	43,268	60%
			Specialist support- surgeon consultants: neurosurgeons, spinal surgeons, plastic surgeons, vasular surgeons,cardiothoracic surgeons	Fixed with economies of scope	24/7 cover, this requires 20 consultants per specialty- from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 1/6 of cost to A&E - based on case studies	individual salary	109,321	17%
			Specialist support- surgeon midlle grade doctors: neurosurgeons, spinal surgeons, plastic surgeons, vascular surgeons,cardiothoraic surgeons	Fixed with economies of scope	One middle grade doctor always present for each of the specialties above always present - from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 1 in 8 rota, from COEM, Emergency Medicine Operational Handbook, Dec 2011. This requires 8 doctors per specialty with 60% of costs allocated to A&E	individual salary	43,268	60%
			Specialist support - anaesthesists consultant	Fixed with economies of scope	24/7 cover, this requires 20 consultants - from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 50 of cost to A&E - based on case studies	individual salary	109,321	17%
			Specialist support - anaesthesists middle grade dotors	Fixed with economies of scope	One middle grade doctor always present for each of the specialties above always present - from "Major trauma service specification" (http://www.excellence.eastmidlands.nhs.uk/welcome/improving-care/emergency-urgent-care/major-trauma/major-trauma-related-documents/) and case studies. 1 in 8 rota, from COEM, Emergency Medicine Operational Handbook, Dec 2011. This requires 8 doctors per specialty with 60% of costs allocated to A&E	individual salary	43,268	60%
		Beds	Resuscitation beds	Fixed	0.3 resuscitation beds per 5,000 attendances - from case studies. £7,500 per resusctiation bed - assumption	unit per year depreciated	1,541	100%
			Major trolley cubicles / Monitored beds	Fixed	0.9 major trolley cubicles/monitored beds per 5,000 attendances - from case studies. £5,000 per monitored bed - from www.absolutemed.com	unit per year depreciated	1,027	100%
			Minor trolley cubicles	Fixed	0.2 minor trolley cubicles per 5,000 attendances - from case studies. £2,000 per trolley cubicle - assumption	unit per year depreciated	411	100%

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Level 1 A&E with trauma capability (iii/iv)

Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% of cost assigned to A&E
A&E with trauma capabilities	Direct A&E	Staffing	Consultants	Semi-fixed	Assume 24/7 cover by consultant, this requires 24 consultants - from case studies	individual salary	109,321	100%
			Middle grade doctors	Semi-fixed	Non-linear relationship based on COEM, Emergency Medicine Operational Handbook, Dec 2011 - 1 in 8 rota. Minimum of 8 consultants required to provide this, 10 if attendances > 80,000 and 14 if attendances > 100,000	individual salary	76,295	100%
			Junior grade doctors	Semi-fixed	Non-linear relationship based on COEM.Minimum of 6 doctors required to provide this, 8 if attendances >= 80,000 and 12 if attendances >= 100,000 Assumed to be StR1.	individual salary	43,268	100%
			Nurses	Semi-fixed	Two options: semivariable cost (1 per 1000 attendances - Based on Dr. Matthew Cooke, A&E The present state) or fixed cost (always one nurse for each resuscitation bed, one nurse for every two major beds and one nurse for every four minor beds - based on Royal College of Nursing:,"Guidance on safe nurse staffing levels in the UK". Assume one in six rota.) Average salary: band 5 - Assumption based on NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	individual salary	27,816	100%
			Clinical support workers	Semi-fixed	1 per 1,300 attendances - Assumption. Salary: band 2 - source: NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	individual salary	18,727	100%
		Consumables	Drugs and medicines	Variable	£5 per attendance - Assumption	per attendance	5	100%
			Medical supplies	Variable	£6 per attendance - Assumption	per attendance	6	100%
			Administration of A&E department	Fixed	10 staff (recepton + PA/medical secretary)- from case studies, salary: band 3 - assumption based on http://www.nhscareers.nhs.uk/details/Default.aspx?Id=541	individual salary	20,801	100%
	Direct Acute Medical Unit	Equipment	Acute Medical Unit - ultrasound for central line insertion	Fixed	1 per A&E dept -from The College of Emergency Medicine, Emergency Medicine Operational Handbook, Dec 2011. Cost : £19,000 - from http://iv-therapy.net/node/526	unit per year depreciated	5,012	80%
			Acute Medical Unit - ventilation support	Fixed	1 per A&E dept -from The College of Emergency Medicine, Emergency Medicine Operational Handbook, Dec 2011. Cost : £10,000 - from http://www.nextag.com/medical-ventilator/stores-html	unit per year depreciated	2,054	80%
		Beds	Acute Medical Unit - resuscitation beds	Fixed	20% of beds are resuscitation beds - assumption. £7,500 per monitoring bed - assumption	unit per year depreciated	1,541	80%
			Acute Medical Unit - monitored beds	Fixed	80% of beds are monitoring beds - £5,000 per monitored bed - from www.absolutemed.com	unit per year depreciated	1,027	80%
		Staffing	Acute Medical Unit - consultants	Semi-fixed	25 patients per consultant. Minimum of 3 consultants - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	109,321	80%
			Acute Medical Unit - middle grade doctors	Semi-fixed	20 patients per doctor. Minimum of 8 doctors - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	76,295	80%
			Acute Medical Unit -junior doctors	Semi-fixed	20 patients per doctor. Minimum of 10 doctors - from Royal College of Physicians, Acute Medical Care, Oct 2007	individual salary	43,268	80%
			Acute Medical Unit -nurses	Semi-fixed	1 Whole Time Equivalent (WTE) nurses per bed - based on Royal College of Nursing, Guidance on safe nurse staffing levels in the UK	individual salary	27,816	80%
		Consumables	Acute Medical Unit - drugs and medicines	Variable	£5 per attendance - Assumption	per attendance	5	80%
			Acute Medical Unit - medical supplies	Variable	£6 per attendance - Assumption	per attendance	6	80%

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Level 1 A&E with trauma capability (iv/iv)

Cost Centre	Category		Item	Cost input type	Assumptions	Cost unit	Annual cost per Unit	% of cost assigned to A&E
A&E with trauma capabilities	Indirect and overhead	Indirect and overhead	Catering, Portering & Laundry	Variable	£138.25 per patient consumer week £ - from http://www.isdscotland.org. On average, 2 hours per attendance is relevant for this cost - assumption	per patient consumer week	138	100%
			Cleaning	Fixed	£33 per sq m - from http://www.isdscotland.org	per square meter	33	100%
			Property (maintenance, energy expenditure)	Fixed	£13 per sq m - from http://www.isdscotland.org	per square meter	13	100%
			Property (rent)	Fixed	Cost per sq m depends on location -> from Valuation Office Agency, http://www.voa.gov.uk/dvs/_downloads/pmr_2011.pdf	per square meter	115	100%
			General administration of hospital	Fixed	£92 per £1000 gross expenditure- from http://www.isdscotland.org	per £1000 gross expenditure	92	100%
Pathology	Direct		Pathology	Variable	£6 per attendance - Assumption	per attendance	6	100%

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Other model assumptions - A&E

Assumption			Source
Ratio of beds to attendances	Standard A&E department		
	Resuscitation beds	0.2 per 5,000 attendances	Case studies
	Major trolley cubicles/monitored beds	0.75 per 5,000 attendances	Case studies
	Minor trolley cubicles	0.35 per 5,000 attendances	Case studies
	A&E department with acute trauma capabilities		
	Resuscitation beds	0.3 per 5,000 attendances	Case studies
	Major trolley cubicles/monitored beds	0.9 per 5,000 attendances	Case studies
	Minor trolley cubicles	0.3 per 5,000 attendances	Case studies
Cost of capital	WACC	10%	Assumption
Cost sharing with radiology department	% of MRI costs allocated to A&E	10%	Case studies
	% of radiologists salaries allocated to A&E	17%	Case studies
	% of radiographers salaries allocated to A&E	17%	Case studies
Cost sharing with other departments	Paediatrics consultant	25%	Based on activity split between A&E and department in HES 2010-2011
	Orthopaedics consultant	50%	Case studies
	General surgery consultant	13%	Based on activity split between A&E and department in HES 2010-2011
	General medicine consultant	31%	Based on activity split between A&E and department in HES 2010-2011
	Trauma consultants - for A&E with acute trauma departments o	50%	Case studies
	Surgeon consultants: neurosurgeons, spinal surgeons, plastic su	17%	Case studies
	Middle grade doctors for all specialties	60%	Case studies

Annexes

- Literature review
- Case study selection
- Supporting evidence for models
  - Consultant Led Obstetrics
  - Midwife Led Obstetrics
  - “Standard” Level 1 A&E
  - Level 1 A&E with trauma
  - Orthopaedics
  - Radiology
  - Inpatient Theatre
  - Day Surgery Theatre
- Glossary

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for an elective orthopaedics ward (i/ii)

Cost description						
Cost Centre	Category	Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Orthopaedics	Direct	**Nursing staff (all)**	Semi-Fixed	Nursing costs in general surgery wards vary from £72 to £148 a bed per day (Audit Commission. Making the most of NHS frontline staff) Use average (BCG assumption)	113	Fixed: per bed
		Consultant	Semi-Fixed	Ward rounds account for 1-2p.as per week for consultants. 1 p.a is 4 hours (BOA. Advisory Book on Consultant Trauma and Orthopaedics) Given 15 minutes per patient 1 ward round can cover 16 beds. (BCG assumption) Consultant salary 74504-100446 (NHS Careers)	87475	Per bed
		Associate Specialist	Semi-Fixed	Ratio of consultants to SASs: 1428:468 (Modern Surgical Workforce)	59728	Per bed
		Registrar	Semi-Fixed	Ratio of consultants to SpRs: 1428:680 (Modern Surgical Workforce)	38850	Per bed
		SHO	Semi-Fixed	Ratio of consultants to SHOs: 1428:975 (Modern Surgical Workforce	33252	Per bed
		Drugs and medicine	Variable	Cost of drugs (excluding anaesthetic) is £3.00 (Hearndon) Assume same costs as theatre per bed day (BCG assumption)	3	Per bed day
		Medical supplies	Variable	Cost of medical supplies in theatre: 35.54 (Hearndon) Assume same costs as theatre bed day	36	Per bed day
		Blood Products	Variable	Cost per procedure £24 (Case study benchmarking 2011-12)	24	Per procedure
		Medical equipment on ward	Fixed	Annual theatre replacement costs range from 7500-45000 a year (Audit Commission) Use low estimate for ward medical equipment	7500	Per unit
		Fixtures and fittings for orthopaedic ward	Fixed	Use Whipps Cross example as proxy for non clinical equipment: Cost of furniture and fittings for delivery suite: 9200. Current size 14 beds Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
	Indirect and Overhead	**CNST**	Fixed	Approximate cost is 18150 per WTE (NHS Litigation authority)	18150	Per WTE consultant on ward
		Catering, Portering & Laundry	Variable	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	139	Cost per patient consumer week £
		Cleaning	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	33	Cost per sq m £
		Property (maintenance, rent & rates, energy expenditure)	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	11500	Cost per 100 m squared £
		Administration	Fixed	Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	92	Cost per £1000 gross expenditure £

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for an elective orthopaedics ward (ii/ii)

Cost description						
Cost Centre	Category	Item	Cost input type	Assumptions	Cost per Item (unit in next column)	Cost Unit
Support Services		**Pathology**	Variable	Cost per person £54 (DH Audit of Acute Services 2006 - Hinchinbrook hospital)	54	Per patient
		Radiology	Variable	MRI price range in hospitals 1750-2200 (Web searches)	1975	Per patient
	Theatres	**General**	Fixed	Includes theatre running costs, nurse, anaesthetist consumables (Hearndon)	802	Per hour of operation
		Orthopaedic specific theatre fittings	Fixed	Annual replacement rate for theatre equipment ranges between 7500-45000 (Audit Commission 2003). Assume orthopaedic equipment high cost to account for Laminar Flow (BCG assumption)	45000	Per unit
		Consultant surgeon	Semi-Fixed	Included in WTE calculated on ward	0	Per hour of operation
		Registrar	Semi-Fixed	Included in WTE calculated on ward	0	Per hour of operation
		Orthopaedic consumables and kit	Variable	See calculation assumptions for cost of implants	1327	Per patient
		Physiotherapy	Variable	Physiotherapist: Band 5-6.(NHS Careers) Estimate 1/2 hour per bed day (BCG assumption)	14	Per hour of therapist time

Notes: Life span theatre: 20 years, life span clinical equipment: 5 years, life span non clinical equipment: 10 years

Other model assumptions – elective orthopaedics ward

Assumption			Source
Length of stay data points	Hip replacement LOS	4.3	HES - Average of Median length of stay for total hip replacement using cement, not using cement and other
	Knee replacement LOS	5.4	HES - Average of Median length of stay for total knee replacement using cement, not using cement and other
	Shoulder arthroscopy LOS	1.0	NHS Choices
	Trauma and Orthopaedics national average LOS	5.4	HES - Mean length of stay for trauma and orthopaedics in England
	Royal National Orthopaedic Hospital average LOS	6.5	HES - Mean length of stay for whole hospital - trauma and orthopaedics only
Length of operation data points	Shoulder arthroscopy operation length	0.6	NHS Choices between 30 and 40 minutes
	Hip replacement operation length	1.3	NHS Choices average length of operation 60-90 minutes
	Knee replacement operation length	2.0	NHS Choices between 1 and 3 hours
Purchasing power	Purchasing power reduction	0.9	Expert interview
	Threshold for purchasing power cost reduction of prosthetics	~11,000	Expert interview
Theatre calculations	Maximum no. of hours of theatre time a year	2,520	Estimate based on 10 hours for 6 days a week on 42 weeks a year (case study)
Implant costs	Average cost of knee implant	1,613	Benchmarking of Scottish Trusts - Audit Scotland Orthopaedic Services Review
	Cost of hip replacement	1,345	Benchmarking of Scottish Trusts - Audit Scotland Orthopaedic Services Review
	Cost of arthroscopic consumables	1,022	Hearnden and Tennent SWLEOC example

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  - Day Surgery Theatre
- Glossary

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a radiology department (i/ii)

Cost description						
Cost Centre	**Category**	**Item**	**Cost input type**	**Assumptions**	**Cost per Item (unit in next column)**	**Cost Unit**
Radiology	**Direct**	X-ray machine	Semi-variable	7500 procedures per equipment and year Assumption based on http://www.audit-commission.gov.uk/SiteCollectionDocuments/AuditCommissionReports/NationalStudies/Radiology_Full.pdf, p.15. We use data for upper quartile. £89,000 per machine - from www.absolutemed.com	18,281	unit per year depreciated
		Ultrasound	Semi-variable	7000 procedures per equipment and year - based on same doc as x-ray machine. £27,000 per machine - from www.absolutemed.com	7,123	unit per year depreciated
		Computed Tomography	Semi-variable	6900 procedures per equipment and year Assumption based on based on same doc as x-ray machine. £89,000 per machine - from www.absolutemed.com	18,281	unit per year depreciated
		MRI equipment	Semi-variable	4200 procedures per equipment and year Assumption based on based on same doc as x-ray machine. £190,000 per machine - from www.absolutemed.com	39,027	unit per year depreciated
		Radionuclide equipment	Semi-variable	2000 procedures per equipment and year Assumption based on based on same doc as x-ray machine. £222,500 per machine - from	45,703	unit per year depreciated
		Fluoroscopy equipment	Semi-variable	3500 procedures per equipment and year Assumption based on based on same doc as x-ray machine. £190,000 per machine - from	39,027	unit per year depreciated
		PACS	Fixed	1 per A&E dept. Unit cost: £1,112,510 - from http://books.google.co.uk/books?id=Pjjkyae_55oC&pg=PA559&lpg=PA559&dq=pacs+cost&source=bl&ots=vhGWWlvHMP&sig=rlItEs_MC37jKD1C5SHon9gCQPM&hl=en&sa=X&ei=rcFoT_3ZJOO80QW3_cSLCQ&ved=0CI8BEOgBMAk#v=onepage&q=pacs%20cost&f=false	29,680	unit per year depreciated
		Consultants	Semi-variable	Non-linear relationship from minimum rotas (you need at least 20 consultants for 24/7 coverage- from case studies) and using ratio of consultants/procedures at Royal United Hospital Bath to calculate additional consultants if needed- http://www.ruh.nhs.uk/patients/services/clinical_depts/radiology/index.asp	111,187	individual salary
		Radiographers	Semi-variable	Non-linear relationship from minimum rotas (you need at least 18 radiographers for 24/7 cover - from case study) and using ratio of radiographers/procedures at Royal United Hospital Bath to calculate additional radiographers if needed - http://www.ruh.nhs.uk/patients/services/clinical_depts/radiology/index.asp. Salary band of radiographer- 6 - from http://www.nhscareers.nhs.uk/details/Default.aspx?Id=190	35,509	individual salary
		Nurses	Semi-variable	Non-linear relationship from staff at Royal United Hospital Bath (minimum of 4 nurses and then use ratio of staff/procedures) http://www.ruh.nhs.uk/patients/services/clinical_depts/radiology/index.asp. Average salary: band 5 - Assumption based on NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	29,025	individual salary
		Clinical support workers	Semi-variable	Non-linear relationship from staff at Royal United Hospital Bath (minimum of 4 clinical support workers and then use ratio of staff/procedures) http://www.ruh.nhs.uk/patients/services/clinical_depts/radiology/index.asp. Salary: band 2 - source: NHS careers, http://www.nhscareers.nhs.uk/details/Default.aspx?Id=4	19,349	individual salary
		Drugs and medicines	Variable	£160 per radiounclied procedure- from http://www.labx.com/article.cfm?articleId=2261	160	per procedure
		Medical supplies	Variable	£5 - Assumption	15	per procedure

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a radiology department (ii/ii)

Cost description						
Cost Centre	**Category**	**Item**	**Cost input type**	**Assumptions**	**Cost per Item (unit in next column)**	**Cost Unit**
Radiology	**Indirect and overhead**	Catering, Portering & Laundry	Variable	£138.25 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality	138	per patient consumer week
		Cleaning	Fixed	£33 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Cos	33	per square metre
		Property (maintenance, energy expenditure)	Fixed	£13 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Cos	13	per square metre
		Property (rent)	Fixed	Cost depends on location -> from Valuation Office Agency, http://www.voa.gov.uk/dvs/_	250	per square metre
		Administration	Variable	£93 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Cos	93	per £1000 gross expenditure

Other model assumptions - Radiology

Assumption			Source
Distribution of procedures	Standard x-ray	57%	HES. A&E data 2010-2011
	Ultrasound	22%	HES. A&E data 2010-2011
	Computed tomography	10%	HES. A&E data 2010-2011
	MRI	5%	HES. A&E data 2010-2011
	Radionuclide	3%	HES. A&E data 2010-2011
	Fluoroscopy	4%	HES. A&E data 2010-2011
Number of procedures per piece of equipment and year	The source shows data by trust - we use the upper quartile		
	Standard x-ray	7,500	Audit Commission, Review of national findings - Radiology
	Ultrasound	7,000	Audit Commission, Review of national findings - Radiology
	Computed Tomography	6,900	Audit Commission, Review of national findings - Radiology
	MRI equipment	4,200	Audit Commission, Review of national findings - Radiology
	Radionuclide equipment	2,000	Audit Commission, Review of national findings - Radiology
	Fluoroscopy equipment	3,500	Audit Commission, Review of national findings - Radiology
Cost of capital	WACC	10%	Assumption
Cost sharing with A&E department	% of MRI costs allocated to radiology department	90%	Case studies
	% of radiologists salaries allocated to radiology department	83%	Case studies
	% of radiographers salaries allocated to radiology department	83%	Case studies

Annexes

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Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for an inpatient theatre (i/ii)

Cost description						
Cost Centre	**Category**	**Item**	**Cost input type**	**Assumptions**	**Cost per Item (unit in next column)**	**Cost Unit**
Operating Theatres	**Direct**	Administration of theatre units	Fixed	Assuming that theatre division of a hospital has own administrative staff. Assume staff rotas are somewhat less than A&E as theatres do not run 24/7. Assume instead 3 staff members for theatres. Assume as in A&E. 4 staff- from case study, salary: band 3 - assumption based on http://www.nhscareers.nhs.uk/details/Default.aspx?Id=541. Annual average cost	£21,423	individual salary
		Pre-operative assessment	Fixed	Each patient must under go a pre-operative assessment. However, such an assessment will form part of each specific procedure and be undertaken by the consultant within that speciality. This line-item is thus excluded from theatre costs on the grounds of being procedure specific. Excluded: can occur in primary care (DH. Day surgery operational guide) / assumption for day surgery	£0	per patient
		Fixtures and Fittings	Semi-fixed	Assume each theatre must have it's own fixtures and fittings. However, there is some sharing of fixtures across theatres-for example air supply. Thus, assume this line-item is semi-fixed with some sharing and variability between theatre lines. Use obstetrics example as proxy: Cost of furniture and fittings for delivery suite: 9200. Current size 9 (CLU) and 5 (MLU) beds.	£107	per theatre
		Operating theatre equipment	Fixed	Theatre equipment should be equivalent as to day surgery, so that the full range of appropriate surgery can be performed as a day case (DH Day surgery operational guide) Median replacement rates for theatre equipment are between 7500 and 45000 (Audit Commission Operating Theatres) Use mid point (assumption) Applies to fans, beds, light fittings Median equipment replacement rate	£5,250	per theatre
		Anaesthetic Disposables	Semi-variable	Cost of anaesthetic consumables: 114 (SWLEOC example, Hearndon, Cost of shoulder athroscopy) per operation. 5 hours per day per theatre session. 2 theatre sessions per day, equals 2 hours per operation. Estimate based on number of operations	£114	per operation
		General Consumables	Fixed	Cost of general consumables (gown etc) 35.54 (SWLEDOC example, Hearndon, Cost of shoulder athroscopy) Assuming this is per member of operating staff team per operation. 4 members of staff in a theatre for an operation is 35.54*4=£142.16. Need to account for number of operations per day, assuming 2 hours per operation. Estimate based on number of operations.	£142	Per operating staff member
		Drugs and medicines	Variable	Costing anaesthetic drugs to theatres. Costing procedure specific drugs to the service line. Case study assumption. Cost per theatre	£2,000	Per theatre

Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for an inpatient theatre (ii/ii)

Cost description						
Cost Centre	**Category**	**Item**	**Cost input type**	**Assumptions**	**Cost per Item (unit in next column)**	**Cost Unit**
Operating Theatres	**Direct**	Surgeon	Fixed	costed to the ward speciality	£0	procedure specific
		Anaesthetist	Fixed	BCG: Consultant salaray 74504-100446 basic (NHS Careers) to make hourly/52.14/37.5 (NHS Agenda for Change)	£85,415	individual salary
		Nurse or Operating Department Practitioner	Fixed	Usually 4 members of staff in a theatre during a procedure, case study assumption. Let this band represent the nurses/operating theatre practitioner/assistant theatre practitioner/circulating staff member. BCG: 3 per theatre (BADS. 2003. Skill mix and nursing establishment for day surgery) Theatre Nurse, Theatre specialist nurse: Band 5-6 (NHS Careers) To make hourly rate /52.14 and then /37.5 (NHS Agenda for Change Pay)	£27,048	individual salary
		Matron	Semi-fixed	One Matron is usually applied per recovery room ward. As recovery rooms are added, it is not necessary to add more Matrons, but if a recovery room is closed, it is more likely that a Matron will not be let go. With that, Matrons are semi-fixed, at the lower bound of theatre numbers-can increase, but not decrease lower than the number of theatres that first existed. Assume 1 recovery room for two theatres, but minimum 1 recovery room	£42,674	individual salary
		Recovery staff	Variable	In theatre staff Need 1:1 coverage in recovery (Acute hospital portfolio review: day surgery) Assume cost same as Nurse/ODP (BCG assumption). Assuming 5 staff per day per recovery room with 5 surgeries per day. Cost is annual cost of recovery staff for one theatre.	£135,241	individual salary
	Indirect and overhead	Catering, Portering & Laundry	Variable	Although this is only applicable for service lines, there will be portering and laundry for the recovery rooms. £138.25 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Costs/Overhead.asp. Assume this is 7 days a week and calculate the cost per patient hour. Only one patient can be in a theatre at any given point.	£138	per patient consumer week
		Cleaning	Fixed	£33 - from http://www.isdscotland.org/Health-Topics/Finance/Costbook/Speciality-Costs/Overhead.asp Including recovery room size, assuming 20m squared per bed, with 5 beds in a recovery room. Standards for Intensive Care Units, The Intensive Care Society, 1997	£33	per square metre
		Property (maintenance, rent & rates, energy expenditure)	Fixed	£13 - from http://www.isdscotland.org Including recovery room size, assuming 20m squared per bed, with 5 beds in a recovery room. Standards for Intensive Care Units, The Intensive Care Society, 1997	£18	per square metre
		Property (rent, should include pre-operative room and recovery room)	Fixed	Cost per sq m depends on location -> from Valuation Office Agency, http://www.voa.gov.uk/dvs/_downloads/pmr_2011.pdf Including recovery room size, assuming 20m squared per bed, with 5 beds in a recovery room. Standards for Intensive Care Units, The Intensive Care Society, 1997	£250	per square metre
		General administration of hospital	Fixed	£92 per £1000 gross expenditure- from http://www.isdscotland.org	92	per square metre

Other model assumptions – Inpatient Theatres

Assumption			Source
Operating Hours	Theatre Sessions per day	2	Audit Commission, Review of National Findings-Operating Theatres
	Theatre Sessions per week	10	Assuming inpatient theatres operate 5 days a week, Case Study
	Theatre Sessions per year	500	Assuming inpatient theatres operate 50 weeks year, Case Study
	Hours per year and per theatre	2500	5 hours in a given theatre session
	Operations per theatre per day	2	Case Study
Life of Theatre	Life span theatre	20	Assumption
	Life span theatre equipment	5	Assumption
	Life span ward equipment	5	Assumption
	Life span non-clinical equipment	10	Assumption
Cost of capital	WACC	10%	Assumption
Recovery Rooms	Ratio of recovery beds to theatres	5 to 1	Assumption
	Number of recovery beds	5	1 per patient per day, Assumption

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Inputs, key assumptions and annual costs for what a best practice NHS Trust could achieve within 2-3 years for a Day Surgery Theatre

Cost description						
Cost Centre	**Category**	**Item**	**Cost input type**	**Assumptions**	**Cost per Item (unit in next column)**	**Cost Unit**
Day Surgery	Direct	**Other pre operative assessment**	Fixed	Included in nursing staff	-	Per patient
		Nursing staff	Fixed	1 WTE in post per staffed bed, trolley or reclining chair in general day surgery units with their own theatre (Acute hosptial portfolio review) Nurse salary band 5 (NHS Careers)	26,889	Per bed
		Fixtures and fittings	Semi-Fixed	Use Whipps Cross example as proxy for non clinical equipment: Cost of furniture and fittings for on obstetrics unit is 9200 for 14 beds. Therefore 657 per bed. (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	66	Per bed
		General consumables	Fixed	Cost of general consumables (gown etc): 35.54 (SWLEOC example, Hearndon, Cost of shoulder athroscopy)	36	Per patient
		Anaesthetic disposables	Semi-variable	Cost of anaesthetic consumables: 114 (SWLEOC example, Hearndon, Cost of shoulder athroscopy)	114	Per patient
		Operating theatre equipment	Fixed	Theatre equipment should always be equivalent to inpatient theatres so that the full range of appropriate surgery can be poerformed as a day case (DH Day surgery operational guide) Median replacement rates for theatre equipment are between 7500 and 45000 (Audit Commission Operating Theatres) Use mid point (BCG assumption) Depreciation rate as footnoted	5250	Per theatre
		Operating theatre running cost	Fixed	Theatres should always be equivalent to inpatient theatres so that the full range of appropriate surgery can be performed as a day case (DH Day surgery operational guide) Cost of running the facility if no operations took place and no staff were paid is £3708000 for year 2005-2006. This includes capital repayment costs, contracts for sterile supplies and any non clinical equipment. Accounting for weekends and bank holidays the facility was open for 253 days servicing four theatres for 8h/day (Hearndon; SWEOC example)	927000	Per op hour
		Nurse/ODP	Fixed	3 per theatre (BADS. 2003. Skill mix and nursing establishment for day surgery) Theatre Nurse, Theatre specialist nurse: Band 5-6. (NHS Careers) To make hourly rate /52.14 and then /37.5 (NHS Agenda for Change Pay Scales 2011-12)	41	Per op hour
		Anaesthetist	Fixed	Consultant salary 74504-100446 basic (NHS Careers) To make hourly /52.14/37.5 (NHS Agenda for Change)	45	Per op hour
		Recovery	Fixed	Need 1:1 coverage in recovery (Acute hospital portfolio review: day surgery) Assume cost same as Nurse/ODP (BCG assumption)	14	Per patient
		Reception	Semi-fixed	Medical secretary: Band 3-4 (NHS Careers) Assume opening hours coverage only: 1WTE(BCG assumption)	10	Per unit
		Administration	Semi-fixed	Day case administration should be carried out by day surgery unit rather than central admissions unit (DH. Day surgery operational guide) Assumption that administration will increase per no. of theatres. Assume working hour coverage (BCG assumption) Medical Secretary: Band 3-4 (NHS Careers)	10	Per theatre
		Reception fixtures and fittings		Use proxy of Whipps Cross for non clinical equipment: Cost of furniture and fittings for general reception and staffareas: 8600 (Whipps Cross Big Push Appeal Fundraising documents) Depreciation rate as footnoted	860	Per unit
	Indirect and Overhead	**Cleaning**		Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	33	Per sq m £
		Property (maintenance, rent & rates, energy expenditure)		Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	1779	Per 100 m squared £
		Administration		Benchmark of ~40 acute hospitals in Scotland. Took 25th percentile (ISD)	92	Per £1000 gross expenditure £

Note: useful life of theatre: 20 years, clinical equipment 5 years, non clinical equipment 10 years

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Glossary of Terms

A&E: Accident and Emergency department

Capability of Trusts: ability of trusts to manage patient numbers and case mix of patients

Case mix: mix of patients attended to by a hospital or service line, based on type of need

Comparator: a trust or management practice against which we judge what it is possible to achieve

CLU: Consultant Led Obstetrics Unit

CNST: Clinical Negligence Scheme for Trusts – insurance payments made against claims of clinical negligence

Elective: medical procedures that do not constitute a medical emergency and thus can be scheduled in advance

HCA: Hospital Care Assistant

HDU: High Dependency Unit

HES: Hospital Episode Statistics – centrally collected data on volumes of procedures undertaken by trusts

HFMA guidelines: Healthcare Financial Management Association, Acute Health, Clinical Costing Standards, 2011/12, Shaping Healthcare Finance

JHO: Junior House Officer

ITU/ICU: Intensive Treatment/Care Unit

MADEL: Medical and Dental Education Levy. Allocation and spending provided by the Department of Health as a cost subsidy to compensate hospitals for the excess costs incurred due to the additional workload results from the presence of students. This payment supports the cost of junior doctors' salaries.

Market Forces Factor: a trust-specific adjustment made to tariff in order to recognise local costs that are beyond a trusts' control (e.g. higher local labour or capital costs).

MES: Minimum Efficient scale

MLU: Midwife Led Obstetrics Unit

NICU: Neonatal intensive care unit

Non-elective: medical procedures that may constitute a medical emergency and cannot be scheduled in advance

O&G: Obstetrics and gynaecology

Patient agnostic: indifferent between patient, irrespective of patient need or type

PLICS: Patient level information and costing system, Department of Health recommend use by the NHS, defined by the ability to measure resources consumed by individual patients

Semi fixed costs: costs that change with a step change in volumes, it is a matter of judgment about what is semi fixed and what is fixed. In this work we look over a 2-3 year period and judge semi fixed costs to be those that can change within that timeframe but require significant changes in volumes to be worthwhile.

SHO: Senior House Officer

SIFT: Service Increment for Teaching. Allocation and spending provided by the Department of Health as a cost subsidy to compensate hospitals for the excess costs incurred due to the additional workload results from the presence of students. This payment supports the additional costs incurred by NHS organisation in providing clinical placements for medical undergraduates in England, but it is not a payment for teaching.

WTE: whole time equivalent

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BRUSSELS | COLOGNE | LONDON | MADRID

Frontier Economics Ltd, 71 High Holborn, London, WC1V 6DA
Tel. +44 (0)20 7031 7000 Fax. +44 (0)20 7031 7001 www.frontier-economics.com