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Costing the impact of interventions during pregnancy in the UK: a systematic review of economic evaluations

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ABSTRACT

Objective The aim of this review was to summarise the current evidence on the costing of resource use within UK maternity care, in order to facilitate the estimation of incremental resource and cost impacts potentially attributable to maternity care interventions.

Methods A systematic review of economic evaluations was conducted by searching Medline, the Health Management Information Consortium, the National Health Service (NHS) Economic Evaluations Database, CINAHL and National Institute for Health and Care Excellence (NICE) guidelines for economic evaluations within UK maternity care, published between January 2010 and August 2019 in the English language. Unit costs for healthcare activities provided to women within the antenatal, intrapartum and postnatal period were inflated to 2018–2019 prices. Assessment of study quality was performed using the Quality of Health Economic Analyses checklist.

Results Of 5084 titles or full texts screened, 37 papers were included in the final review (27 primary research articles, 7 review articles and 3 economic evaluations from NICE guidelines). Of the 27 primary research articles, 21 were scored as high quality, 3 as medium quality and 3 were low quality. Variation was noted in cost estimates for healthcare activities throughout the maternity care pathway: for midwife-led outpatient appointment, the range was £27.34–£146.25 (mean £81.78), emergency caesarean section, range was £1056.44–£4982.21 (mean £3508.93) and postnatal admission, range was £103.00–£870.10 per day (mean £469.55).

Conclusions Wide variation exists in costs applied to maternity healthcare activities, resulting in challenges in attributing cost to maternity activities. The level of variation in cost calculations is likely to reflect the uncertainty within the system and must be dealt with by conducting sensitivity analyses. Nationally agreed prices for granular unit costs are needed to standardise cost-effectiveness evaluations of new interventions within maternity care, to be used either for research purposes or decisions regarding national intervention uptake.

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Strengths and limitations of this study

► This systematic review is the first to compare published unit costs for the different healthcare activities that may be offered to women in the UK during antenatal, intrapartum and postnatal care.

► A comprehensive search was conducted in four databases; unit costs extracted from published research articles were compared with one another and with summary costs published as part of review articles (mostly national Health Technology Assessments) and guidelines.

► The search was limited to reports published since January 2010 (to ensure the data was contemporaneous) and studies conducted in the UK.

► Unit costs were extracted for common or presumed high-cost activities within the maternity pathway, where the frequency of use was expected to vary with implementation of new antenatal or intrapartum interventions; low-cost interventions, for which the frequency of use was not expected to vary, were not costed.

► Unit costs extracted from published reports of economic evaluations were inflated to 2018/2019 prices and stratified by quoted cost perspective to ensure comparability.

BACKGROUND

Healthcare economic evaluations are pertinent components of healthcare research and quality improvement, informing policymakers on the cost-effectiveness of new interventions and thereby assisting in decisions regarding their uptake. The UK National Institute for Health and Care Excellence (NICE) bases its recommendations on the implementation of new interventions according to both their clinical efficacy and cost-effectiveness.[1] The number of cost-effectiveness evaluations published annually in obstetrics and gynaecology has increased

since 2000, with the majority being conducted alongside a clinical trial.[2]

Internationally, maternity care is funded using different payment models, including itemised bills and payment using composite 'bundled' costs.[3–5] Bundled pricing describes a model where a single price is used to cover a full package of care for a specific indication. Bundled costs can be uplifted locally using factors that account for geographical variation in the cost of providing care and by the level of comorbidity or complexity of the woman and her pregnancy, but are not explicitly changed by differences in utilisation of maternity services.[4 6] Such models are often used because they are easier for hospitals to manage, allow flexibility within the pathway and are intended to encourage improvements in care including standardisation of evidence-based care.[3] Bundled payments were introduced by the Medicaid initiative (USA) to also reduce interventions that are not medically indicated and potentially harmful.[5] Bundled payment models are also used for non-maternity indications.[7]

While bundled costs represent the cost of a woman's care to a commissioner or insurer, to the hospital they only reflect the average cost of women who experience the same level of complexity in pregnancy. Bundled payments present difficulties in estimating small changes to the overall cost of a woman's maternity care as a result of a new intervention, because the cost of her care is estimated as a composite, which is often not affected by small changes in resource use (eg, additional antenatal appointments or ultrasound scans). This represents a significant limitation for using these tariffs in estimating costs within economic evaluations, which seek to identify the true clinical resource impact of initiatives aimed at improving quality of maternal and perinatal care, as distinct from potential financial impacts to commissioners or insurers.

The aim of this review was to summarise the current evidence on the costing of resource use within UK maternity care, in order to facilitate the estimation of incremental resource and cost impacts potentially attributable to maternity care interventions.

METHODS

This review was registered on PROSPERO during the data collection stage. The report has been written using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines; the checklist has been included in online supplemental file 1.

Search strategy

A systematic review was conducted in August 2019 of the Medline, Health Management Information Consortium, the National Health Service (NHS) Economic Evaluations Database, CINAHL database and National Institute for Health and Care Excellence (NICE) guidelines for economic evaluations of maternity care and the economic impact of research interventions. Search terms included free text and expanded synonyms for terms relevant to economic evaluations (eg, cost-effectiveness and price tariffs) and to pregnancy healthcare (eg, midwife, maternity and pregnancy). The full search strategy is included within online supplemental file 2. The search was limited to papers written in the English language (because the perspective was that of UK maternity care providers) and published since 2010 (to ensure the cost estimations were recent and more reliable when inflated to current prices).

For inclusion in the review, it was predetermined that papers must be full reports of primary research studies or systematic reviews (including those in NICE guidelines), where an economic evaluation of an antenatal or intrapartum intervention was performed and assessed within the UK context only. A UK context was chosen because it is well-established internationally that different countries vary in their approach to providing maternity care, the type of clinical resource inputs used to deliver specific types of clinical activity and in terms of the efficiency with which this is delivered. A review on the international economics of childbirth identified no accepted cost that was translatable across international settings[8] due to differences in national clinical practices, outcome definitions and healthcare funding mechanisms. It was also necessary that the papers reported unit costs for at least one of the maternity pathway activities listed in table 1.

Table 1	Key activities costed within the maternity pathway	
Antenatal activity	**Intrapartum activity**	**Postnatal/neonatal activity**
► Midwife-led antenatal appointment. ► Obstetrician-led antenatal appointment. ► Glucose tolerance test. ► Attendance to day assessment unit/triage. ► Antenatal inpatient admission. ► Sonography-led ultrasound scan. ► Consultant-led ultrasound scan.	► Induction of labour. ► Augmentation of labour. ► Epidural. ► Normal vaginal birth. ► Instrumental vaginal birth. ► Elective caesarean section. ► Emergency caesarean section. ► Repair third/fourth degree tear. ► Manual removal of placenta. ► Treatment of postpartum haemorrhage (500–1500 mL). ► Treatment of major obstetric haemorrhage (>1500 mL). ► Examination under anaesthesia for haemorrhage.	► Maternal stay in postnatal ward (with/without baby). ► Maternal stay in high-dependency unit. ► Maternal stay in intensive care unit.

This list contains common and presumed high-cost maternity activities for which the frequency of use may be affected by interventions introduced in research settings; that is, activities that were expected to impact upon cost estimates calculated in economic evaluations of maternity care. There were no specific exclusion criteria. The titles and abstracts were screened by the lead author (SR), and the remaining full texts were reviewed in full against the inclusion criteria by two authors (SR and LD).

Data extraction

Data were extracted from each paper by two authors (SR and LD) onto a prespecified study spreadsheet on the cost perspective taken by the study, year and methodology used for costing the resource use. Cost perspective refers to the level at which the costs are assessed; the most common examples are patients and families, a single healthcare provider, the health and/or social services and wider society.[9] Unit costs quoted for any of the key activities listed in table 1 were collected. Costs were inflated to the 2018/2019 financial year using the Department of Health's Pay & Price Series for financial years 2008/2009–2015/2016 and the NHS Improvement Economic Assumptions for years 2016/2017 to 2018/2019.[10 11]

Assessment of study quality

Assessment of study quality was performed using the Quality of Health Economic Analyses (QHES) checklist.[12] This was designed by health economists and validated by both clinicians and economists with the aim of providing a tool suitable to evaluate all common types of health economic analyses by reviewers of either profession. As per the case study in the original QHES paper, papers have been assessed as high (≥75/100 points), medium (50–74 points) or low (<50 points) quality.

Data analysis

For the cost of each activity within the maternity pathway, the range, mean, SD and relative difference between the minimum and maximum estimates were reported. The distribution of costs was represented graphically on a scatter plot, with data divided by cost source (national guideline, review article and primary research study).

Simulated low-risk and high-risk patients were agreed through consensus of the clinical coauthors with reference to risk stratification guidance produced by NICE, to demonstrate the difference in cost estimates for common exemplar clinical scenarios when applied across the whole maternity pathway.[13] The planned low-risk pregnant woman was 35 years old and multiparous, having had two previous vaginal births with no medical or obstetric complicating factors. She had an uncomplicated pregnancy and spontaneous vaginal birth, followed by a 6-hour postnatal discharge. The planned high-risk woman was 42 years old and nulliparous, having conceived with in vitro fertilisation. She develops pre-eclampsia in the 35th gestational week and is induced at 37 weeks' gestation.

She labours with an epidural but requires an emergency caesarean section for fetal distress.

Two post hoc sensitivity analyses were conducted to determine; (1) the extent to which removal of low-quality primary research papers reduced the variability in cost estimates and (2) whether the variation in cost estimates for each named activity was caused by the range of different cost perspectives used. For the first analysis, costs derived from published papers deemed to be of low quality were removed, and the effect on the mean and range costs per activity was described. For the second analysis, cost estimates for each activity included in the primary research articles were presented graphically, stratified by the perspective.

Patient and public involvement

A lay representative from Guy's and St Thomas' charity (AA) was involved in the early set-up of the DESIGN trial, the economic evaluation of which motivated this review. He is a coauthor of the DESiGN Trial Team group, who reviewed the final draft manuscript.

Ethical review

Ethical review is not required in the UK for systematic reviews.

RESULTS

Of 5081 papers identified in the electronic database search, 3 economic evaluations in relevant NICE guidelines and 10 publications identified from handsearching systematic reviews, 848 were duplicates and 4080 were excluded through screening of the titles and abstracts, leaving 140 full texts for screening. Following exclusion of papers that did not meet the inclusion criteria, 37 papers were included in the final review, including 27 primary research articles, 7 review articles and 3 economic evaluations from NICE guidelines. This is represented diagrammatically in figure 1.

The characteristics of the included studies are detailed in online supplemental file 3. Of the included primary research studies (n=27), four costed the healthcare activities from the perspective of the local hospital (ie, direct costs of procuring items and paying staff salaries at those hospitals), one costed from the perspective of the commissioner (ie, direct costs of paying the hospital for providing a service), two costed from the indirect societal perspective (ie, the wider costs to society, including work days lost; in one case this includes the NHS perspective) and the remaining studies (n=20) (including guidelines and review articles) costed from the NHS perspective only (ie, directly attributed, nationally agreed costs for procurement, staff salaries and so on).

In quality assessment of the 27 primary research articles, 21 were scored as high quality (≥75/100 points),[14–34] 3 as medium quality (50-74/100 points)[35–37] and 3 were scored as low quality (<50/100 points).[38–40] The detailed
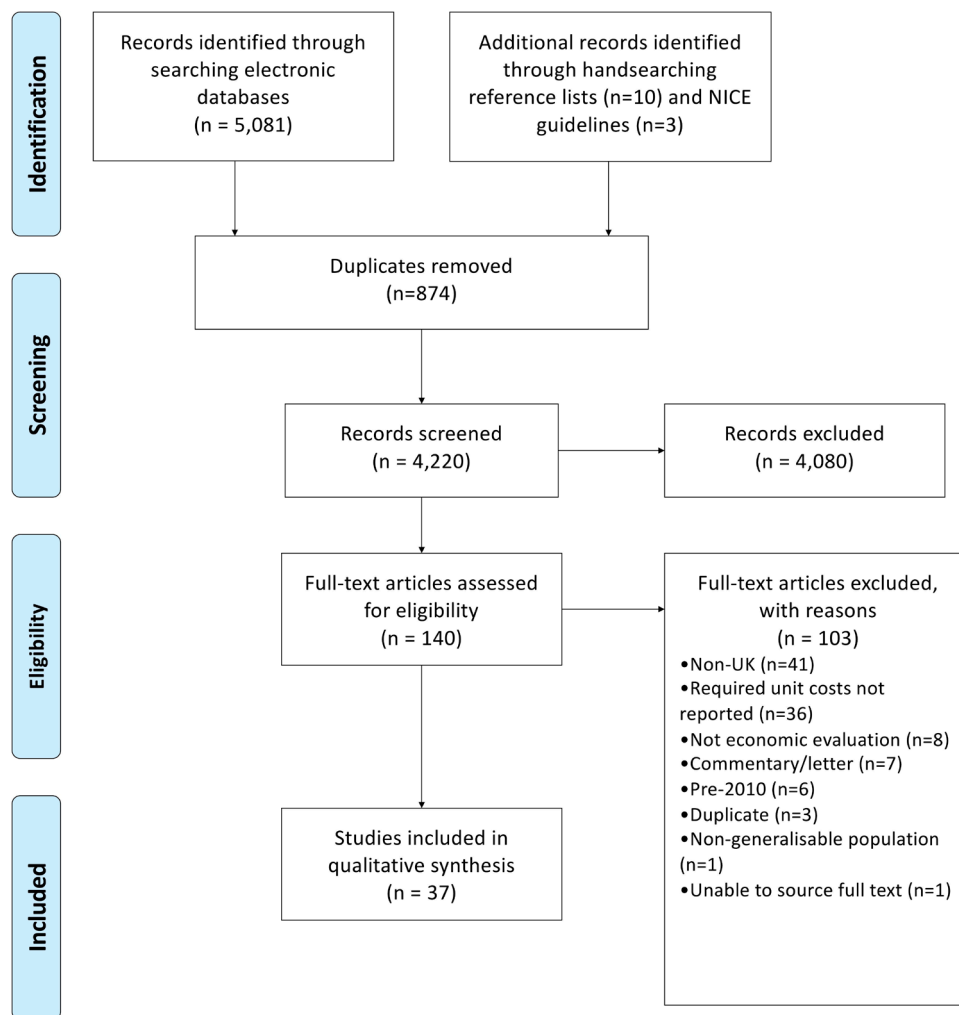
Figure 1 Study selection process. NICE, National Institute for Health and Care Excellence.

QHES evaluations are provided in online supplemental file 4.

Of the primary research articles (n=27), seven estimated activity costs using bottom-up methodologies (ie, individually microcosted each item, for example, drug costs, equipment costs and cost per staff-hour worked), 10 costed activities using national reference costs for NHS diagnosis or procedure codes and staff, 3 used other available literature to cost activities and the remaining 7 studies used a combination of costing methodologies.

The cost estimates from the NICE guidelines, review articles and primary research papers (inflated to 2018/2019 prices) are presented separately for activity items within antenatal, intrapartum and postnatal care within figure 2 and in more detailed and referenced format in online supplemental files 5–7, respectively.

With respect to antenatal care, estimates for 20 min long antenatal clinic appointments were provided for midwifery-led clinics (range £27.34–£146.25, mean £74.70, 5.3-fold difference)[29 34 36 41–43] or consultant obstetrician-led clinics (range £43.36–£312.29, mean £144.15, 7.2-fold difference).[22 25 29 34 36 41 42 44] There were only two cost estimates identified for glucose tolerance tests (range £13.03–£26.16, mean £21.80, 2.0-fold difference). A larger absolute unit cost range was found when estimating the cost for 1 day of an antenatal inpatient admission (range £298.47–£1115.87, mean £546.08, 3.7-fold difference).[14 15 18–21 25 28 34 36–38 44–46] Similarly, cost estimates for antenatal scans were variable for both general scans conducted by a sonographer (range £40.67–£139.85, mean £80.86, 3.4-fold difference)[29 30 35 36 42 43 45–49] and 'specialist' scans, usually conducted by a fetal medicine consultant (range £77.82–£143.65, mean £116.34, 1.8-fold difference).[25 29 38]

When estimating cost for intrapartum activities, there is wide variation, and the costs for each activity item are generally higher than they are for antenatal or postnatal care. For example, the estimated cost of induction of labour varies between £47.56 and £805.42 (mean £450.08, 16.9-fold difference).[17 19 20 22 28 41 43 47 49–51] In some papers, it was clear that this variation follows decisions to cost the induction with or without the cost of staffing and antenatal admission, but this is not always the case. The estimated cost of an emergency caesarean section varies from £1056.44–£4982.21 (mean £3508.93, 4.7-fold difference)[13 18–22 24 28–30 32 36 41 42 47 49–51]; this includes the staffing and bed space required for the intrapartum admission. There are lower estimates that cost the surgery only (£318.78–£1432.71, 4.5-fold difference).[15 17 33 43]
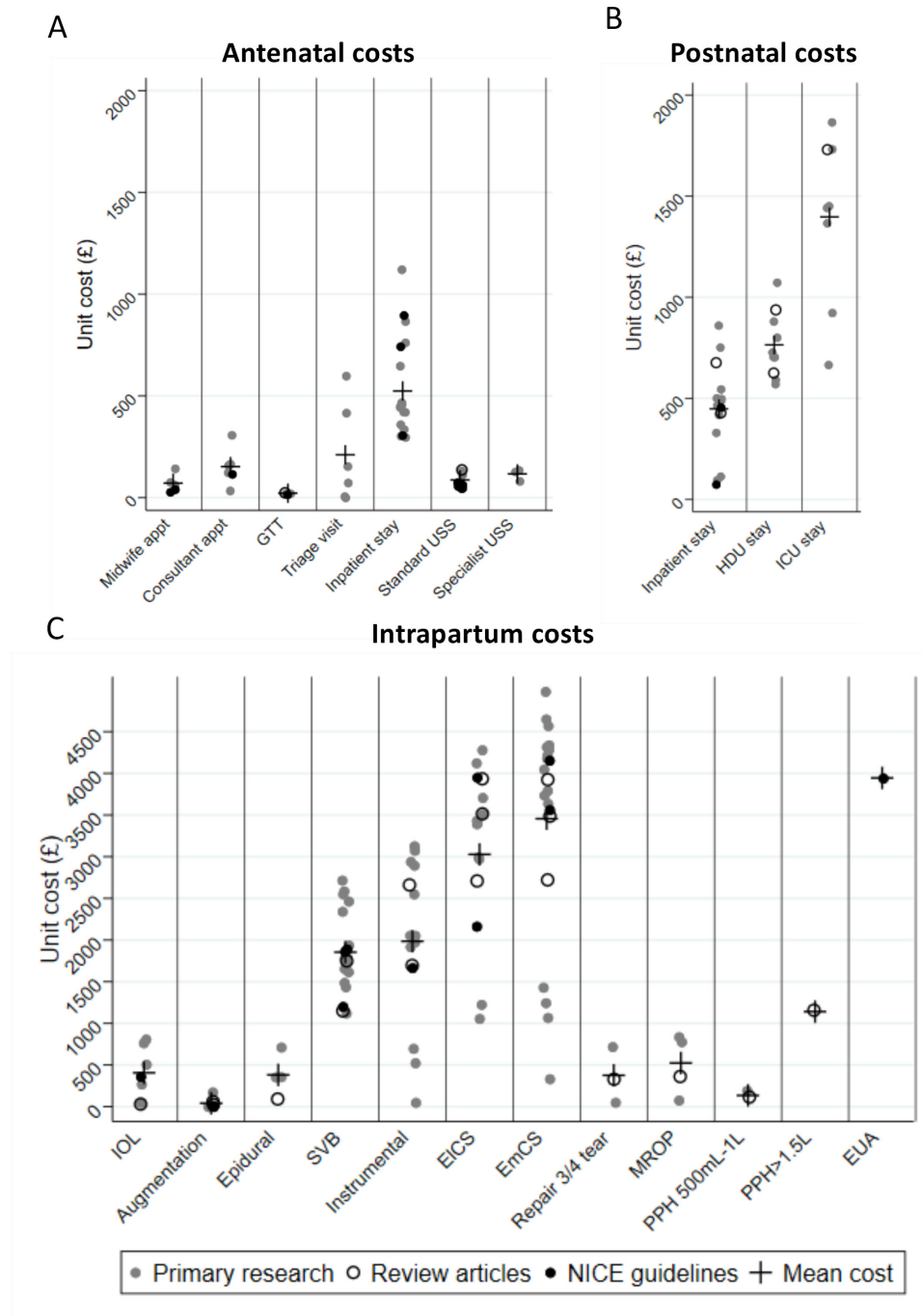
Figure 2 Variation in extracted unit costs for activities within the maternity care pathway. EICS, elective caesarean section; EmCS, emergency caesarean section; EUA, examination under anaesthesia; GTT, glucose tolerance test; HDU, high dependency unit; ICU, intensive care unit; IOL, induction of labour; MROP, manual removal of placenta; NICE, national institute for health and care excellence; PPH, postpartum haemorrhage; SVB, spontaneous vaginal birth; USS, ultrasound scan.

With regards to postnatal care, the inpatient postnatal stay for a healthy woman and baby on a postnatal ward varies between £103.00 and £870.10 per day (mean £469.55, 8.4-fold difference).[13–15 21 23 24 27 28 33 36 39 40 44 50 52]

Through application of cost estimates to the exemplar activities within the care pathway for a low-risk multiparous woman and high-risk nulliparous woman and applying the lowest and highest cost estimates, we have demonstrated the significant effects that these cost variations can have on the estimated cost of care provided to a single woman (tables 2 and 3).

Sensitivity analysis with exclusion of the three primary research papers that were assessed as low quality using the QHES instrument resulted in only two cost estimates being removed from the overall results. The mean cost per antenatal admission day changed from £524.11 (SD: £239.07) to £528.51 (SD: £248.24), and the mean cost per day on postnatal ward changed from £471.92 (SD:

Table 2 Estimating costs for a low-risk pregnant woman

Activity within care pathway*	Lowest cost estimate	Highest cost estimate
Antenatal booking appointment	£27.34[42]	£146.25[34]
Two sonography-led ultrasound scans	2× £42.24[46] £84.48	2× £139.85[48] £279.70
Five midwifery-led antenatal appointments	5× £27.34[42] £136.70	5× £146.25[34] £731.25
One attendance to maternity triage	£6.56[37]	£415.65[25]
Uncomplicated spontaneous vaginal birth	£1125.95[33]	£2572.02[21]
6-hour discharge	£0	£0
Total	£1381.03	£4144.87

*The exemplar lower risk pregnant woman was multiparous, aged 35 years, two previous vaginal births and no medical or obstetric complicating factors.

£211.26) to £469.55 (SD: 219.69). There were no changes to intrapartum costs.

Sensitivity analysis to determine the effect of including a range of cost perspectives on the variation identified between cost estimates for each activity was conducted graphically, and the results are presented in online supplemental file 8. The majority of costs are derived from economic evaluations that use the perspective of the health service. The figure demonstrates the extent to which variation still exists, even for costs derived from studies conducted from the perspective of the health service. There were too few data points to examine variation across studies conducted from other perspectives.

DISCUSSION
Summary of the key findings
The aim of this report was to overview the current evidence on the costing of resource use within maternity care to inform economic evaluations of maternity interventions. We have reviewed 7 economic evaluations with UK costs applied following a systematic literature review, 3 economic evaluations from UK NICE guidelines and 27 primary research articles that have attributed unit costs to activity within the antenatal, intrapartum and postnatal pathways, specific to the UK context. We have noted wide ranges in published cost estimates, including a 16.9-fold difference between the minimum and maximum cost estimates for induction of labour, despite limiting the search to studies within the last 10 years and inflating costs to 2018/2019 prices.

Table 3 Estimating costs for a higher risk pregnant woman

Activity within care pathway*	Lowest cost estimate	Highest cost estimate
Antenatal booking appointment	£27.34[42]	£146.25[34]
Two sonography-led ultrasound scans	2x £42.24[46] £84.48	2x £139.85[48] £279.70
Seven midwifery-led antenatal appointments	7x £27.34[42] £191.38	7x £146.25[34] £1023.75
Two consultant-led appointments	2x £43.36[22] £86.72	2x £312.29[25] £624.58
Three attendances to maternity triage with pre-eclampsia	3x £15.49[37] £46.47	3x £415.65[25] £1246.95
Two specialist growth scans	2x £77.82[38] £155.64	2x £127.55[25] £255.10
3-day antenatal admission	3x £298.47[19] £895.41	3x £1115.87[14] £3347.61
Induction of labour with 2-day antenatal admission	£361.77[43]	£805.42[19]
Epidural	£118.08[13]	£693.70[20]
Labour augmentation	£1.10[24]	£189.16[33]
Emergency caesarean section	£1056.44[30]	£4982.21[49]
3-day postnatal inpatient stay	3x £103.00[24] £309.00	3x £870.10[21] £2610.30
Total	£3333.83	£16204.73

*The exemplar higher risk pregnant woman was nulliparous, aged 42 years and conceived by in vitro fertilisation. Develops pre-eclampsia at 35 weeks.

For intrapartum costs in particular, the absolute difference between the minimum and maximum costs are greater, because these are usually higher cost interventions. This is likely to have more of an impact on the results of cost-effectiveness evaluations. Even where absolute cost differences are small because the activity itself is relatively inexpensive, for example, cost estimates for the glucose tolerance test (GTT), the relative difference shows that the maximum estimate is twice as high (or more) than the minimum estimate, although a low absolute difference is less likely to impact when estimating the financial impact of new interventions.

While the estimate ranges are tighter for the unit costs supplied in the seven review articles, with the overall estimate tending towards the middle of the range of the primary research articles, this may be accounted for by both the smaller number of studies and that these studies are often based on estimates from the national guidelines and primary research articles. Wide variation also exists within cost estimates supplied by some NICE guidelines, where the same activity (eg, emergency caesarean section) is priced differently by economic evaluations featured in different guidelines.[13 41 47 50]

Interpretation of study findings and comparison with existing literature

There are several potential explanations for some of this variation. Variation can reflect different methodology of cost calculation and differing definitions of each activity, for example, the average cost for an inpatient admission varies from cost per day/night to costs estimated for a time-defined (eg, 3 nights) admission (although only costs for a single night are presented in the results). Costs may also vary with changing geographical perspective and varying approaches to clinical practice resource use between localities; it is well established that costs are higher in Southern England, particularly inner-city London.[53] Methodological quality is another explanation for the variation found in this review, although the estimates changed little after exclusion of papers determined to be of low methodological quality. Poorly applied methods and incomplete reporting make the results of economic evaluations less reliable, less comparable on a consistent like-with-like basis and difficult to interpret. It also introduces additional uncertainty when seeking to transfer evidence on costs to other study contexts.

Implications of this systematic review

In this paper, we have shown how variation in reported costs can introduce uncertainty into estimates of the overall cost of pregnancy management at different levels of pregnancy risk. This is likely to have important implications where 'bottom-up' costing methodologies are required to support the evaluation of interventions that are expected to change the type and volume of clinical activity that patients are exposed to along the pregnancy care pathway. This will be further magnified in cases where an intervention impacts on comparatively expensive areas

of clinical activity, for example, antenatal admissions, method of birth and infant admission to neonatal units.

This review was originally motivated by an economic evaluation of the complex antenatal intervention (Growth Assessment Protocol)[54] studied within the DEtection of the Small for GestatioNal age Fetus (DESiGN) trial.[55] DESiGN is a cluster-randomised controlled trial, the primary aim of which is to report on the clinical effectiveness of the GAP programme; secondary outcomes include a process and economic evaluation. GAP aims to improve the rate of antenatal detection of small for gestational age fetuses.[54] Estimating the financial impact of introducing an intervention into the antenatal pathway was expected to be challenging because of the bundled nature of national reference costs in England.[4] Our hypothesis specified that the intervention was expected to increase antenatal activities such as clinic appointments or scans and intrapartum activities such as induction of labour. While these changes were expected to incur cost to the hospital, this would not be reflected in the bundled price charged to the commissioner. Itemised costs were therefore required.

As a result of the findings of this review, we have planned for sensitivity analyses to play a central role in the cost-effectiveness analysis of the DESiGN trial so that uncertainty in the magnitude of costs linked to key resource use items on cost-effectiveness conclusions can be fully examined and reported. We recommend for other trial-lists to do the same when conducting economic evaluations in settings where widely agreed itemised costs are not available.

The variation in quoted costs suggests uncertainty around methods to calculate costs. While the included studies have mostly been appraised as having medium or high reporting quality (according to the QHES checklist), it was not always explicit how costs were calculated and exactly what was included in each estimate, for example, length of appointment, salary of healthcare professional used and inclusion of indirect costs. Guidelines on what should be included when calculating the cost of common activities, including how to account for variable staff salaries and indirect costs and recommendations on the appropriate cost perspective to choose (and report) and how to translate costs geographically, would be invaluable in achieving lower variation in published estimates.

An alternative strategy would be publication of a list of nationally agreed itemised costs for use in the economic evaluation of interventions, with guidance on which costs within a range of estimates are more likely to be applicable to specific circumstances. This would facilitate greater consistency in the application of cost data across different evaluations. Such a list was previously available in England (online supplemental file 9) but has since been replaced by a national bundled tariff.[56]

Strengths and limitations

The strength of this study is in the extensive literature search of four relevant databases and the wide, clinically

generalisable (within UK maternity care) inclusion criteria. Unit costs extracted from published research articles were compared with one another and with summary costs published as part of national Health Technology Assessments and guidelines. Unit costs extracted from published reports of economic evaluations were inflated to 2018/2019 prices and stratified by quoted cost perspective to ensure comparability.

Due to the lack of comparability in international health systems and maternity reimbursement policies, it was not appropriate to extend the search outside of economic evaluations conducted within the UK. While the specific cost findings are only generalisable to UK maternity care, the overall findings regarding the challenges of estimating the financial impact of interventions using bundled prices, and the risk of cost variation where nationally agreed costs are not available, are relevant to maternity care providers internationally and potentially also to other medical specialities where bundled costs are commonplace.

CONCLUSIONS

Through this systematic review of economic evaluations within maternity care, we have described variation in costs applied to maternity care activities, even after controlling for study reporting quality and cost perspective. We have outlined the challenges in attributing cost to maternity activities, due to non-standardised activity descriptions and provision of composite 'bundled' cost estimates.

Overall, the level of variation in cost calculations is likely to reflect the uncertainty within the system and must be dealt with by conducting sensitivity analyses of economic evaluations. The development of nationally agreed unit costs for key areas of clinical activity within the pregnancy care pathway would serve to standardise cost-effectiveness evaluations of new interventions within maternity care to be used either for research purposes or national decisions regarding intervention uptake.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	6
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	6
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	6
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Supplementary material
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	7-8
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	8
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	8
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	8

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Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	8
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	9 and Fig 1
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Supplementary material
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	9
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-10 and Figure 2
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Figure 2
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	13-15
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	15
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14-15
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	16

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Example Search Strategy

Database: Medline
((exp PREGNANCY/ OR exp "PREGNANT WOMEN"/ OR exp "HOSPITALS, MATERNITY"/ OR exp "PRENATAL CARE"/ OR exp "MATERNAL HEALTH SERVICES"/ OR exp "BIRTHING CENTERS"/ OR exp PARTURITION/ OR exp PREGNANCY/ OR exp "HOME CHILDBIRTH"/ OR exp "NATURAL CHILDBIRTH"/ OR exp "TERM BIRTH"/ OR exp "PERINATAL CARE"/ OR exp "POSTNATAL CARE"/ OR (pregnan* OR matern* OR antenat* OR prenat* OR intrapartum OR postnat* OR birth OR obstetric* OR midwi*).ti) AND (exp "COSTS AND COST ANALYSIS"/ OR exp "COST-BENEFIT ANALYSIS"/ OR (health economic*).ti OR (economic evaluation).ti OR (cost effectiv*).ti OR (cost benefi*).ti)) [DT 2010-2018] [Languages English]

Supplementary material 3 - Characteristics of included studies

	Article	Perspective	Original cost year	Methodology
Economic evaluations for National guidelines	NICE - Hypertension in Pregnancy [1]	National Health Service	2010	Used NHS reference costs and costs published as parts of other trials.
	NICE - Intrapartum Care [2]	National Health Service	2014	Uses the bottom-up costing calculations from a primary research study (Schroeder E, 2012) and revised the cost calculations by consensus with an expert committee.
	NICE - Diabetes in Pregnancy [3]	National Health Service	2015	Used a combination of NHS reference costs and a bottom-up costing exercise
Review articles	Mistry, H (2013) [4]	National Health Service	2009-10	Health Technology Assessment Uses NHS costs and costs from a literature review of primary research studies.
	Deshpande, SN (2013) [5]	National Health Service	2011	Weighted averages from NHS reference costs.
	Thomas, CM (2013) [6]	National Health Service	2011	NHS reference costs applied to a cost-effectiveness model derived through published data sources on resource use.
	O'Donnell, A (2016) [7]	National Health Service	2012-13	Health Technology Assessment uses NHS reference costs and calculations from the Personal Social Services Research Unit.
	Alfirevic, Z (2016) [8]	National Health Service	2012-13	Health Technology Assessment using a de novo decision model and NHS reference/manufacturer costs inputs
	Farrar, D (2016) [9]	National Health Service	2013-14	Review article for Health Technology Assessment. Uses cost from NHS reference costs, NICE guidelines and the Personal Social Services Research Unit.
	Gallos, I (2019) [10]	National Health Service	2016	Health Technology Assessment using NHS reference costs and drug costs from the British National Formulary
Primary research studies	Petrou, S (2011) [11]	National Health Service	2008	Primary bottom-up methodology
	Eddama, O (2010) [12]	Hospital	2008	Bottom-up costing exercise
	Jit, M (2010) [13]	National Health Service	2008	NHS reference costs applied to a decision tree model developed through consultation of national hospital admission data
	Round, JA (2011) [14]	National Health Service	2009	Bottom-up methodology

Schroeder, E (2012) [15]	Hospital	2009-10	Costing exercise involved interviews with staff to describe resource use, costs from hospital finance departments and reference lists
Essex, HN (2015) [16]	National Health Service	2009-10	NHS reference costs applied to resource use determined through a randomised controlled trial.
Coomarasamy, A (2016) [17]	National Health Service	2011-12	Health Technology Assessment. Uses NHS reference costs to attribute cost estimates to calculated resource use from a randomised controlled trial.
Carolan-Rees, G (2015) [18]	National Health Service	2011-12	Applied NHS reference costs to resource use.
Lain, SJ (2017) [19]	National Health Service	2012	NHS reference costs applied to resource use in a randomised controlled trial.
Parisaei, M (2016) [20]	Central London Hospital	2012	Bottom-up methodology
Ussher, M (2015) [21]	National Health Service	2012-13	National Reference costs applied to resource use in a randomised controlled trial
Walker, KF (2017) [22]	National Health Service and personal social services	2012-13	Cost-utility analysis of a randomised controlled trial using National reference and manufacturer costs
van der Nelson, H (2017)[23]	National Health Service	2012-13	Costs taken from NHS Reference costs and the British National Formulary
Bick, D (2017) [24]	National Health Service	2013-14	Health Technology Assessment of a randomised controlled trial cost-effectiveness study using National reference costs and those from other primary research studies
Campbell, HE (2018) [25]	Societal Perspective	2013-14	Assessed the prevalence in a UK cohort and applied costs assessed from secondary sources.
Duckworth, S (2016) [26]	Commissioner	2013-14	Decision analytic model developed using data from an observational cohort study and National reference costs were applied
Orlovic, M (2017) [27]	National Health Service	2013-14	Applied NHS reference costs to resource use derived from a population study using national Hospital Episode Statistics data
Vatish, M (2016) [28]	National Health Service	2013-14	Applied NHS reference costs to an economic model derived from an observational cohort study.

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Bowers, J (2016) [29]	National Health Service	2014	Used data from the Scottish Nursing and Midwifery Workload and Workforce planning project to develop a financial model
Luni, Y (2017) [30]	South West England Hospital	2014-15	Bottom-up costing exercise
Khan, KS (2018) [31]	National Health Service	2014-15	Bottom-up costing attached to data on resource use.
Waugh, J (2017) [32]	National Health Service	2014-15	Cost-effectiveness analysis conducted by NHS reference and manufacturer costs to estimated resource use taken from the NICE hypertension guideline.
Jones, M (2019)[33]	National Health Service	2014-15	Costs derived from NHS reference costs and the expert opinion of an NHS midwife.
Jacklin, PB (2017) [34]	National Health Service	2015	Applied costs taken from published UK sources to UK and Australian cohorts
Xydopoulos, G (2019)[35]	National Health Service	2015	Cost inputs derived from a series of costing templates based on NICE guidelines and NHS practice reports as well as other relevant scientific literature. NHS hospital tariffs could not be extrapolated to these costs.
Wastlund, D (2019 - BJOG)[36]	National Health Service	2016-17	Values were identified from relevant literature by two authors, systematic reviews using UK data were prioritised where possible. Where multiple sources where available, those which provided ranges were prefered and if not, a decision was made by consensus or arbitration by the senior author.
Wastlund, D (2019 - PLOS Med)[37]	National Health Service	2017	Costs were determined using a combination of expert opinion, relevant scientific literature and NHS reference costs.

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Question	Petrou, S (2011)	Jit, M (2010)	Round, JA (2011)	Schroeder, E (2011)	Essex, E (2012)	HN (2015)
1. Was the study objective presented in a clear, specific and measurable manner? (Y/N)	7	7	0	7	7	7
2. Were the perspective of the analysis (societal, third-party payer, etc) and reasons for its selection stated? (Y/N)	4	0	0	0	0	4
3. Were variable estimates used in the analysis from the best available source (i.e randomized control trial - best, expert opinion - worst)? (Y/N)	8	8	8	8	0	8
4. If estimates came from a subgroup analysis, were the groups prespecified in the beginning of the study? (Y/N)	0	0	0	0	1	0
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? (Y/N)	9	9	9	9	9	0
6. Was incremental analysis performed between alternatives for resources and costs? (Y/N)	6	6	6	6	6	6
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated? (Y/N)	5	5	5	5	5	0
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3%-5%) and justification given for the discount rate? (Y/N)	7	7	7	7	7	7
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described? (Y/N)	8	8	8	8	8	8
10. Were the primary outcome measure (s) for the economic evaluation clearly stated and did they include the major short-term. Was justification given for the measures/scales used? (Y/N)	6	6	6	6	6	6
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for measures and scales used? (Y/N)	7	7	7	7	7	7
12. Were the economic model (including structure), study methods and analysis, and the components of numerator and denominator displayed in a clear, transparent manner? (Y/N)	8	8	8	8	8	8
13. Were the choice of economic model, main assumptions, and limitations if the study stated and justified? (Y/N)	7	0	0	7	0	7
14. Did the author (s) explicitly discuss direction and magnitude of potential biases? (Y/N)	6	0	0	0	0	0
15. Were the conclusions/recommendations of the study justified and based on the study results? (Y/N)	8	8	8	8	8	8
16. Was there a statement disclosing the source of funding for the study? (Y/N)	3	0	3	3	3	3
Total (Max 100)	**99**	**79**	**75**	**89**	**75**	**79**
Overall assessment	**High**	**High**	**High**	**High**	**High**	**High**

Question	Walker, KF (2017)	Ussher, M (2016)	Parisaei, M (2016)	Lain, SJ (2017)	Carolan-Rees, G (2015)	Coomarasamy, A (2016)
1. Was the study objective presented in a clear, specific and measurable manner? (Y/N)	7	7	0	7	7	7
2. Were the perspective of the analysis (societal, third-party payer, etc) and reasons for its selection stated? (Y/N)	0	4	0	0	0	0
3. Were variable estimates used in the analysis from the best available source (i.e randomized control trial - best, expert opinion - worst)? (Y/N)	8	8	0	8	0	8
4. If estimates came from a subgroup analysis, were the groups prespecified in the beginning of the study? (Y/N)	0	0	0	0	0	0
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? (Y/N)	9	9	0	9	9	9
6. Was incremental analysis performed between alternatives for resources and costs? (Y/N)	6	6	6	6	0	6
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated? (Y/N)	5	0	0	0	0	5
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3%-5%) and justification given for the discount rate? (Y/N)	7	7	7	7	7	7
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described? (Y/N)	8	8	8	8	8	8
10. Were the primary outcome measure (s) for the economic evaluation clearly stated and did they include the major short-term. Was justification given for the measures/scales used? (Y/N)	6	6	0	6	6	6
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for measures and scales used? (Y/N)	7	7	7	7	0	7
12. Were the economic model (including structure), study methods and analysis, and the components of numerator and denominator displayed in a clear, transparent manner? (Y/N)	8	8	8	8	8	8
13. Were the choice of economic model, main assumptions, and limitations if the study stated and justified? (Y/N)	7	7	0	0	0	7
14. Did the author (s) explicitly discuss direction and magnitude of potential biases? (Y/N)	6	6	0	0	0	6
15. Were the conclusions/recommendations of the study justified and based on the study results? (Y/N)	8	8	8	8	8	8
16. Was there a statement disclosing the source of funding for the study? (Y/N)	3	3	3	3	3	3
Total (Max 100)	95	94	47	77	56	95
Overall assessment	High	High	Low	High	Medium	High

Question	Vatish, M (2017)	Orlovic, M (2016)	Duckworth, S (2016)	Campbell, HE (2018)	Bick, D (2017)	van der Nelson, H (2017)
1. Was the study objective presented in a clear, specific and measurable manner? (Y/N)	7	7	7	7	7	7
2. Were the perspective of the analysis (societal, third-party payer, etc) and reasons for its selection stated? (Y/N)	4	0	4	4	0	4
3. Were variable estimates used in the analysis from the best available source (i.e randomized control trial - best, expert opinion - worst)? (Y/N)	0	8	0	0	8	8
4. If estimates came from a subgroup analysis, were the groups prespecified in the beginning of the study? (Y/N)	0	0	1	0	0	0
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? (Y/N)	9	9	9	9	9	9
6. Was incremental analysis performed between alternatives for resources and costs? (Y/N)	6	0	6	0	6	6
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated? (Y/N)	0	0	0	0	5	5
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3%-5%) and justification given for the discount rate? (Y/N)	7	7	7	0	7	7
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described? (Y/N)	8	8	8	8	8	8
10. Were the primary outcome measure (s) for the economic evaluation clearly stated and did they include the major short-term. Was justification given for the measures/scales used? (Y/N)	6	6	6	6	6	6
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for measures and scales used? (Y/N)	7	7	7	0	7	7
12. Were the economic model (including structure), study methods and analysis, and the components of numerator and denominator displayed in a clear, transparent manner? (Y/N)	8	8	8	8	8	8
13. Were the choice of economic model, main assumptions, and limitations if the study stated and justified? (Y/N)	7	7	7	7	7	7
14. Did the author (s) explicitly discuss direction and magnitude of potential biases? (Y/N)	0	6	6	6	6	6
15. Were the conclusions/recommendations of the study justified and based on the study results? (Y/N)	8	8	8	8	8	8
16. Was there a statement disclosing the source of funding for the study? (Y/N)	0	3	3	3	3	3
Total (Max 100)	77	84	87	66	95	99
Overall assessment	High	High	High	Medium	High	High

Question	Xydopoulos, G (2019)	Jacklin, PB (2017)	Jones, M (2019)	Waugh, J (2017)	Khan, KS (2018)	Luni, Y (2017)	Bowers, J (2016)
1. Was the study objective presented in a clear, specific and measurable manner? (Y/N)	7	7	7	7	7	7	0
2. Were the perspective of the analysis (societal, third-party payer, etc) and reasons for its selection stated? (Y/N)	0	0	0	0	4	0	0
3. Were variable estimates used in the analysis from the best available source (i.e randomized control trial - best, expert opinion - worst)? (Y/N)	0	8	8	8	8	0	0
4. If estimates came from a subgroup analysis, were the groups prespecified in the beginning of the study? (Y/N)	0	1	0	0	0	0	0
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? (Y/N)	0	9	9	9	9	0	0
6. Was incremental analysis performed between alternatives for resources and costs? (Y/N)	6	6	6	6	6	0	6
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated? (Y/N)	0	5	5	5	0	0	0
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3%-5%) and justification given for the discount rate? (Y/N)	7	7	7	7	7	7	7
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described? (Y/N)	8	8	8	8	8	0	8
10. Were the primary outcome measure (s) for the economic evaluation clearly stated and did they include the major short-term. Was justification given for the measures/scales used? (Y/N)	6	6	6	6	6	6	0
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for measures and scales used? (Y/N)	7	7	7	7	7	7	7
12. Were the economic model (including structure), study methods and analysis, and the components of numerator and denominator displayed in a clear, transparent manner? (Y/N)	8	8	8	8	8	0	0
13. Were the choice of economic model, main assumptions, and limitations if the study stated and justified? (Y/N)	7	7	7	7	7	0	7
14. Did the author (s) explicitly discuss direction and magnitude of potential biases? (Y/N)	6	6	6	0	6	0	0
15. Were the conclusions/recommendations of the study justified and based on the study results? (Y/N)	8	8	8	8	8	0	8
16. Was there a statement disclosing the source of funding for the study? (Y/N)	3	3	3	3	3	3	0
Total (Max 100)	73	96	95	89	94	30	43
Overall assessment	Medium	High	High	High	High	Low	Low

	Wastlund, D (2019 - PLOS Med)	Wastlund, D (2019 - BJOG)
1. Was the study objective presented in a clear, specific and measurable manner? (Y/N)	7	7
2. Were the perspective of the analysis (societal, third-party payer, etc) and reasons for its selection stated? (Y/N)	0	0
3. Were variable estimates used in the analysis from the best available source (i.e randomized control trial - best, expert opinion - worst)? (Y/N)	0	0
4. If estimates came from a subgroup analysis, were the groups prespecified in the beginning of the study? (Y/N)	0	0
5. Was uncertainty handled by (1) statistical analysis to address random events, (2) sensitivity analysis to cover a range of assumptions? (Y/N)	9	9
6. Was incremental analysis performed between alternatives for resources and costs? (Y/N)	6	6
7. Was the methodology for data abstraction (including the value of health states and other benefits) stated? (Y/N)	5	5
8. Did the analytic horizon allow time for all relevant and important outcomes? Were benefits and costs that went beyond 1 year discounted (3%-5%) and justification given for the discount rate? (Y/N)	7	7
9. Was the measurement of costs appropriate and the methodology for the estimation of quantities and unit costs clearly described? (Y/N)	8	8
10. Were the primary outcome measure (s) for the economic evaluation clearly stated and did they include the major short-term. Was justification given for the measures/scales used? (Y/N)	6	6
11. Were the health outcomes measures/scales valid and reliable? If previously tested valid and reliable measures were not available, was justification given for measures and scales used? (Y/N)	7	7
12. Were the economic model (including structure), study methods and analysis, and the components of numerator and denominator displayed in a clear, transparent manner? (Y/N)	8	8
13. Were the choice of economic model, main assumptions, and limitations if the study stated and justified? (Y/N)	7	7
14. Did the author (s) explicitly discuss direction and magnitude of potential biases? (Y/N)	6	0
15. Were the conclusions/recommendations of the study justified and based on the study results? (Y/N)	8	8
16. Was there a statement disclosing the source of funding for the study? (Y/N)	3	3
Total (Max 100)	87	81
Overall assessment	High	High

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Supplementary material 5 - Extracted costs for antenatal care

Activity costed	Economic evaluations for National guidelines	Review articles	Primary research studies			
			Unit costs reported	Range	Mean (SD)	Comments
Estimated cost for standard midwife antenatal appointment	Not costed	£27.34 / 20 minute appointment [1], £224.99 / pregnancy for community care [2], £264.56 / pregnancy for midwife-led hospital care [2], £131.94 / hour [3]	£76.03 / appointment [4], £146.25 / appointment [5], £60.49 / appointment [6]	£27.34 - £146.25	£70.82 (£45.92)	Only 'per appointment' estimates used
Estimated cost for a standard obstetric antenatal appointment	Not costed	£114.14 / follow-up appointment [1], £515.55 / pregnancy[2]	£43.36 [7], £166.68 / appointment [4], £312.29 / appointment [8], £153.94 / appointment [5], £124.12 / appointment [6]	£43.36 - £312.29	£152.42 (£89.36)	Only 'per appointment' estimates used

Activity costed	Economic evaluations for National guidelines	Review articles	Primary research studies			
			Unit costs reported	**Range**	**Mean (SD)**	**Comments**
Estimated cost for any antenatal appointment	£95.75 / appointment [9]	Not costed	£115.62 / appointment [10], £103.28 / appointment [11]	£95.75 - £115.62	£104.88 (£10.03)	Only 'per appointment' estimates used
Estimated cost for a glucose tolerance test	£23.73[9]	£24.26 [3]	£26.16 [12], £13.03 [11]	£13.03 - £26.16	£21.80 (£5.94)	
Estimated cost for attendance to maternity day unit/triage	Not costed	Not costed	£150.37 / visit [13], £415.65 / visit [8], £6.56 for nurse-led or £15.49 for doctor-led triage review [14]	£6.56 - £415.65	£147.02 (£190.79)	

Activity costed	Economic evaluations for National guidelines	Review articles	Primary research studies			
			Unit costs reported	Range	Mean (SD)	Comments
Estimated cost for an antenatal inpatient admission	Not costed	Not costed	£330.84 on antenatal ward or £1115.87 on labour ward [15], £366.00 / day [16], £1403.55 / admission [17], £298.47 / day [13], £758.18 / day for first three days and £448.01 / day after this [10], £466.91 / day [18], £457.75 / day [4], £867.59/day for first five days and £414.55 / day after this [8], £414.55 / day [5], £447.12 / day [19], £1658.89 for standard antenatal stay, £304.45 for additional bed days [14]	£298.47 - £1,115.87	£524.11 (£239.07)	Only 'per day' estimates used

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Activity costed	Economic evaluations for National guidelines	Review articles	Primary research studies			
			Unit costs reported	Range	Mean (SD)	Comments
Estimated cost for an ultrasound scan (sonographer)	£139.85 [9]	£74.90 / first scan and £61.83 / subsequent scans [1], £56.07 / scan [20], £42.24 / scan [21], £142.95 / 3 scans [3]	£57.66 / scan [22], £121.87 / scan [4], £120.49 / scan [11], £120.72 / scan [6], £112.21 / scan [23]	£42.24 - £139.85	£86.86 (£36.13)	Only 'per scan' estimates used
Estimated cost for an ultrasound scan (specialist)	Not costed	Not costed	£77.82/ scan [18], £127.55 / scan [8], £143.65 / scan [6]	£77.82 - £143.65	£116.34 (£34.32)	Only 'per scan' estimates used

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Supplementary material 6 - Extracted costs for intrapartum care

Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Induction of labour	£31.17 for drugs only [1]	£33.35 for Propess, £39.53 for vaginal prostaglandin gel/tablet. Inpatient days costed separately[2], £361.77 for induction [3]	£47.56 [4], £518.46-£805.42 in addition to cost of vaginal birth [5], £791.53 in addition to the cost of a vaginal birth [6], £33.35 for Propess pessary, £30.02 for 2 doses of Prostin [7], £28.94 for 2 doses of 3mg dinoprostone tablet [8] £290.60[9]	£31.17 - £805.42	£469.22 (£323.86) Only fully-costed induction included in the summary estimates.
Augmentation of labour	£34.98 [1], £56.96 [10]	£1.90 for oxytocin, £2.97 for amniotomy and oxytocin[2]	£189.16[11], £1.01 for oxytocin, £0.95 for Amnihook [7], £1.10 for oxytocin [12]	£1.10 - £189.16	£41.29 (£68.72)
Epidural	£118.08 [10]	Not costed	£369.89 [11], £693.70 in addition to the cost of a vaginal birth [6], £345.73 [7]	£118.08 - £693.70	£381.85 (£266.89)

Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Spontaneous vaginal birth	£1,170.50 [1], £1,762.19 [10]	£1,888.08 [13], £1,222.87 if within 24 hours of commencing induction of labour[2], £1,905.40 [14]	£1,125.95 for birth without complication or £2,474.24 for birth with complication [11], £1,729.09 [15], £1,460.77-£1,812.38, dependent upon complexity [5], £1,782.05 [6], £1,473.00 [7], £2,572.02 [16], £1,943.23 [17], £1,607.61 [12], £1,648.92 [8], £2,721.27 [18], £2,586.11 [9], £2,343.25 [19]	£1,125.95 - £2,721.27	£1,854.15 (£486.97)

Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Instrumental birth	£1,662.25 [1] , £2,663.45 [10]	£1,633.64 [13], £1194.17 more than a spontaneous vaginal birth [3]	£52.64 - in addition to cost of labour [20], £510.31 - 677.59 for birth plus staffing and overhead costs for labour [11], £2,961.67 [15], £1,922.20 - £2,524.68 (dependent on complexity) [5], £3,100.37 [6], £2,003.28 [7], £3,100.37 [16], £2,866.18 [17], £2,045.26 [12], £2,056.62[8]	£1,633.64 - £3,866.18	£2,378.33 (£552.20) Only estimates of labour and birth included.

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Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Elective Caesarean section	£2,724.24 - £3,494.18 [1], £3,923.25 [10]	£2,166.30 [13], £972.05 more than a spontaneous vaginal birth [3], £3,966.92 [14]	£1,251.51 plus staffing and overhead costs [11], £4,281.45 [15], £2,935.27 - £3,438.43(depends on complexity) [5], £3,380.67 [6], £2,983.79 [7], £3,402.19 [17], £3,385.25 [8], £4,120.81 [18], £1,056.44 [21], £3710.33 [9], £3,506.86 [19]	£1,056.44 - £4,281.45	£3,164.49 (£801.63) Only full estimates of elective Caesarean birth included.

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Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Emergency Caesarean section	£2,724.24 - £3,494.18 [1], £3,923.25 [10]	£3,541.94 [13], £4,143.29 [2], £972.05 more than a spontaneous vaginal birth [3]	£318.78 - in addition to cost of labour [20], £1,251.51 for birth plus staffing and overhead costs for labour [11], £1,432.71 (in addition to cost of vaginal birth) [4], £3,600.98 [15], £3,717.67 - £4,284.10 (dependent on complexity) [5], £4,212.22 [6], £3,795.33 [7], £4,278.73 [16], £4,325.86 [17], £4,039.93 [12], £4,244.57 [8], £4,555.92 [18], £1,056.44 [21], £4,982.21 [9], £4,644.47 [19]	£2,724.24 - £4,982.21	£3864.74 (£867.58) Only estimates of labour and birth included.
Repair 3/4th degree tear	£351.95 [10]		£707.79 [11], £70.37 [12]	£70.37 - £707.79	£376.70 (£321.71)

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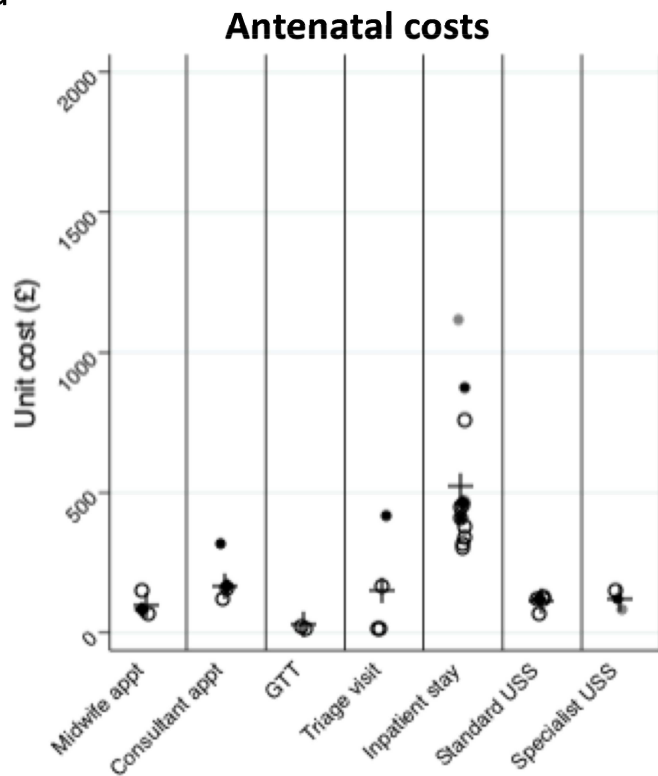| Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Manual removal of placenta	£152.35 for staff and £236.49 for consumables [10]	Not costed	£819.58 [11], £807.09 (in addition to the cost of vaginal birth [6], £81.37 [12]	£81.37 - £819.58	£524.22 (£387.80)
Postpartum haemorrhage (500-1500mL without shock)	£60.40 for staff and £40.32 for consumables [10]	Not costed	£169.34 [12]	£100.72 - £169.34	£135.03 (£85.18)
Major obstetric haemorrhage (>1500mL)	£950.28 for staff, £150.39 for one unit blood transfusion and £40.32 for consumables [10]	Not costed	Not costed	Only one cost provided	

Activity costed	Economic Evaluations for National Guidelines	Review articles	Primary research studies		
			Unit costs reported	Range	Mean (SD)
Examination under anaesthesia for postpartum haemorrhage	Not costed	£3,944.70 [14]	Not costed	Only one cost provided	

1. National Institute for Health and Care Excellence, *Hypertension in pregnancy: diagnosis and management.* 2011: p. 1-51.
2. Alfirevic, Z., et al., *Which method is best for the induction of labour? A systematic review, network meta-analysis and cost-effectiveness analysis.* Health Technol Assess, 2016. **20**(65): p. 1-584.
3. Farrar, D., et al., *The identification and treatment of women with hyperglycaemia in pregnancy: an analysis of individual participant data, systematic reviews, meta-analyses and an economic evaluation.* Health Technol Assess, 2016. **20**(86): p. 1-348.
4. Round, J.A., et al., *Screening for gestational diabetes mellitus: cost-utility of different screening strategies based on a woman's individual risk of disease.* Diabetologia, 2011. **54**(2): p. 256-63.
5. Coomarasamy, A., et al., *PROMISE: first-trimester progesterone therapy in women with a history of unexplained recurrent miscarriages - a randomised, double-blind, placebo-controlled, international multicentre trial and economic evaluation.* Health Technol Assess, 2016. **20**(41): p. 1-92.
6. Lain, S.J., et al., *An economic evaluation of planned immediate versus delayed birth for preterm prelabour rupture of membranes: findings from the PPROMT randomised controlled trial.* BJOG, 2017. **124**(4): p. 623-630.
7. Walker, K.F., et al., *Labour induction near term for women aged 35 or over: an economic evaluation.* BJOG, 2017. **124**(6): p. 929-934.
8. Waugh, J., et al., *Spot protein-creatinine ratio and spot albumin-creatinine ratio in the assessment of pre-eclampsia: a diagnostic accuracy study with decision-analytic model-based economic evaluation and acceptability analysis.* Health Technol Assess, 2017. **21**(61): p. 1-90.

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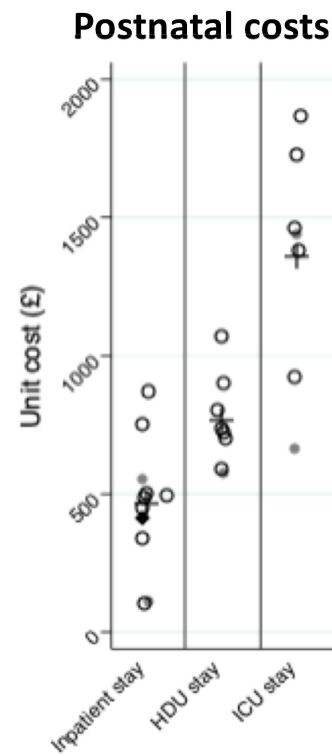
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9. Wastlund, D., et al., *The cost-effectiveness of universal late-pregnancy screening for macrosomia in nulliparous women: a decision-analysis.* BJOG, 2019.

10. National Institute for Health and Care Excellence, *Intrapartum Care for healthy women and babies. Clinical Guideline CG 190.* . 2014.

11. Schroeder, E., et al., *Cost effectiveness of alternative planned places of birth in woman at low risk of complications: evidence from the Birthplace in England national prospective cohort study.* BMJ, 2012. **344**: p. e2292.

12. Bick, D., et al., *A multicentre, randomised controlled trial of position during the late stages of labour in nulliparous women with an epidural: clinical effectiveness and an economic evaluation (BUMPES).* Health Technol Assess, 2017. **21**(65): p. 1-176.

13. Mistry, H., et al., *A structured review and exploration of the healthcare costs associated with stillbirth and a subsequent pregnancy in England and Wales.* BMC Pregnancy Childbirth, 2013. **13**: p. 236.

14. Gallos, I., et al., *Uterotonic drugs to prevent postpartum haemorrhage: a network meta-analysis.* Health Technol Assess, 2019. **23**(9): p. 1-356.

15. Essex, H.N., et al., *Cost-Effectiveness of Nicotine Patches for Smoking Cessation in Pregnancy: A Placebo Randomized Controlled Trial (SNAP).* Nicotine Tob Res, 2015. **17**(6): p. 636-42.

16. Ussher, M., et al., *The London Exercise And Pregnant smokers (LEAP) trial: a randomised controlled trial of physical activity for smoking cessation in pregnancy with an economic evaluation.* Health Technol Assess, 2015. **19**(84): p. vii-xxiv, 1-135.

17. Campbell, H.E., et al., *Healthcare and wider societal implications of stillbirth: a population-based cost-of-illness study.* BJOG, 2018. **125**(2): p. 108-117.

18. Jones, M., et al., *A dynamic, modifiable model for estimating cost-effectiveness of smoking cessation interventions in pregnancy: application to an RCT of self-help delivered by text message.* Addiction, 2019. **114**(2): p. 353-365.

19. Wastlund, D., et al., *Screening for breech presentation using universal late-pregnancy ultrasonography: A prospective cohort study and cost effectiveness analysis.* PLoS Med, 2019. **16**(4): p. e1002778.

20. Eddama, O., et al., *Study of progesterone for the prevention of preterm birth in twins (STOPPIT): findings from a trial-based cost-effectiveness analysis.* Int J Technol Assess Health Care, 2010. **26**(2): p. 141-8.

21. Jacklin, P.B., et al., *A cost-effectiveness comparison of the NICE 2015 and WHO 2013 diagnostic criteria for women with gestational diabetes with and without risk factors.* BMJ Open, 2017. **7**(8): p. e016621.

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Supplementary File 8 – Presentation of unit costs by cost perspective quoted in source paper

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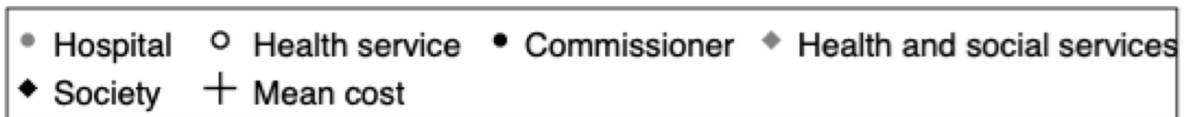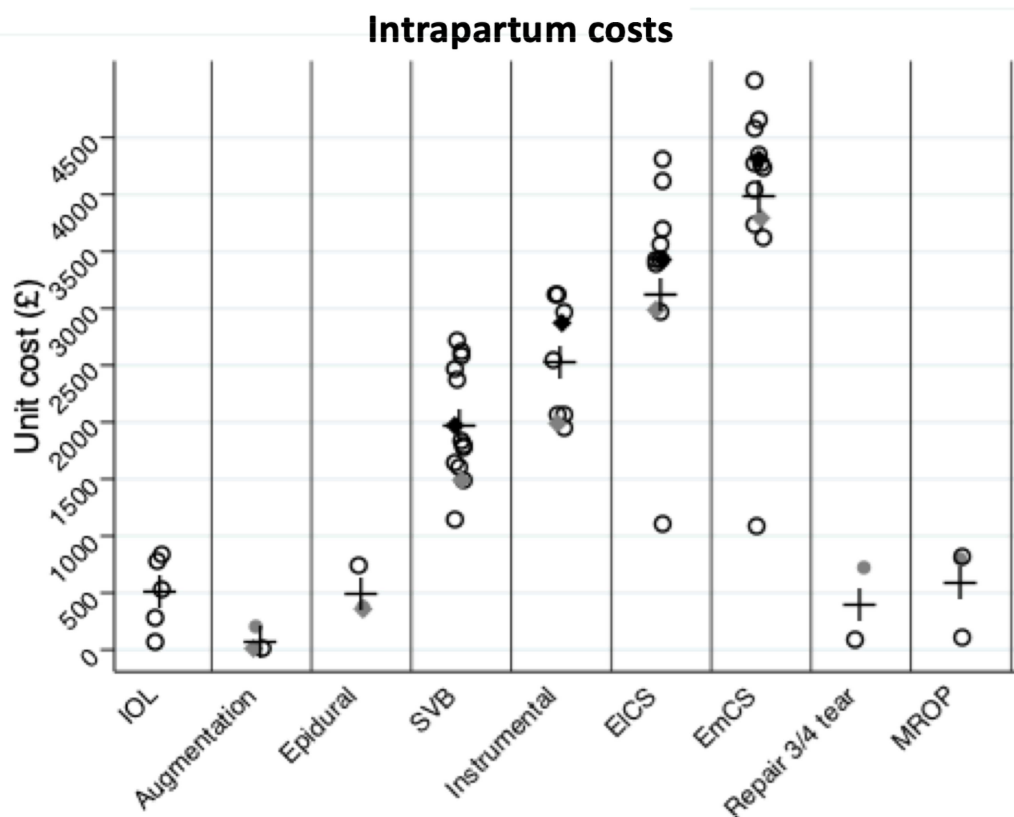
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Supplementary material 7 - Extracted costs for postnatal care

Activity Costed	Economic Evaluations for National Guidelines	Review Articles	Primary research articles		
			Unit cost reported	Range	Mean (SD)
Maternal inpatient stay on postnatal ward	£676.44 / day [1], £431.56 / day [2]	£74.62 for average postnatal stay [3], £459.63/day [4]	£330.84 / day [5], £549.09 / day [6], £112.95 / day [7], £870.10 / day [8], £1,289.57 / admission [9], £488.42/day [10] £103.00 - £757.00/day [11], £407.83 / day [12], £1,406.39 for average length of stay (<3 days) [13], £754.14 / standard 36-hour postnatal stay [14], £470.19 / day [15], £20.47 / hour (staff costs only) [16], £447.12 / day [17]	£103.00 – £870.10	£471.12 (£211.26) Full costs only included.

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Activity Costed	Economic Evaluations for National Guidelines	Review Articles	Primary research articles		
			Unit cost reported	Range	Mean (SD)
Maternal inpatient stay in HDU	£936.17 / day [1], £636.44/day [2]		£804.38 / day [5], £95.12 for 4 hours [7], £712.17 / day [18], £700.37/day [10], £890.00 / day [11], £587.40 / day (level 1), £734.52 / day (level 2) [15], £2,150.63 for first 2 days [17]	£570.72 - £1075.32	£764.75 (£277.20)
Maternal inpatient stay in ITU	£1,737.28 / day [1]	Not costed	£1,729.56 / day [19], £1,444.56 / day [6], £665.82 / day [7], £1,367.21 / day [18], £1,449.00 / day [11], £924.14 / day [15], £3,722.01 for first 2 days [17]	£665.82 - £1,861.01	£1,397.32 (£606.35)

1. National Institute for Health and Care Excellence, *Hypertension in pregnancy: diagnosis and management.* 2011: p. 1-51.
2. National Institute for Health and Care Excellence, *Intrapartum Care for healthy women and babies. Clinical Guideline CG 190. .* 2014.

3. Thomas, C.M. and S. Cameron, *Can we reduce costs and prevent more unintended pregnancies? A cost of illness and cost-effectiveness study comparing two methods of EHC.* BMJ Open, 2013. **3**(12): p. e003815.
4. Gallos, I., et al., *Uterotonic drugs to prevent postpartum haemorrhage: a network meta-analysis.* Health Technol Assess, 2019. **23**(9): p. 1-356.
5. Petrou, S., et al., *Cost-effectiveness analysis of prostaglandin E2 gel for the induction of labour at term.* BJOG, 2011. **118**(6): p. 726-34.
6. Eddama, O., et al., *Study of progesterone for the prevention of preterm birth in twins (STOPPIT): findings from a trial-based cost-effectiveness analysis.* Int J Technol Assess Health Care, 2010. **26**(2): p. 141-8.
7. Schroeder, E., et al., *Cost effectiveness of alternative planned places of birth in woman at low risk of complications: evidence from the Birthplace in England national prospective cohort study.* BMJ, 2012. **344**: p. e2292.
8. Ussher, M., et al., *The London Exercise And Pregnant smokers (LEAP) trial: a randomised controlled trial of physical activity for smoking cessation in pregnancy with an economic evaluation.* Health Technol Assess, 2015. **19**(84): p. vii-xxiv, 1-135.
9. Walker, K.F., et al., *Labour induction near term for women aged 35 or over: an economic evaluation.* BJOG, 2017. **124**(6): p. 929-934.
10. van der Nelson, H.A., et al., *Carbetocin versus oxytocin for prevention of post-partum haemorrhage at caesarean section in the United Kingdom: An economic impact analysis.* Eur J Obstet Gynecol Reprod Biol, 2017. **210**: p. 286-291.
11. Bick, D., et al., *A multicentre, randomised controlled trial of position during the late stages of labour in nulliparous women with an epidural: clinical effectiveness and an economic evaluation (BUMPES).* Health Technol Assess, 2017. **21**(65): p. 1-176.
12. Campbell, H.E., et al., *Healthcare and wider societal implications of stillbirth: a population-based cost-of-illness study.* BJOG, 2018. **125**(2): p. 108-117.
13. Orlovic, M., et al., *Estimating the incidence and the economic burden of third and fourth-degree obstetric tears in the English NHS: an observational study using propensity score matching.* BMJ Open, 2017. **7**(6): p. e015463.
14. Bowers, J. and H. Cheyne, *Reducing the length of postnatal hospital stay: implications for cost and quality of care.* BMC Health Serv Res, 2016. **16**: p. 16.
15. Khan, K.S., et al., *A randomised controlled trial and economic evaluation of intraoperative cell salvage during caesarean section in women at risk of haemorrhage: the SALVO (cell SALVage in Obstetrics) trial.* Health Technol Assess, 2018. **22**(2): p. 1-88.
16. Luni, Y., et al., *A prospective cohort study evaluating the cost-effectiveness of carbetocin for prevention of postpartum haemorrhage in caesarean sections.* J Obstet Gynaecol, 2017. **37**(5): p. 601-604.
17. Waugh, J., et al., *Spot protein-creatinine ratio and spot albumin-creatinine ratio in the assessment of pre-eclampsia: a diagnostic accuracy study with decision-analytic model-based economic evaluation and acceptability analysis.* Health Technol Assess, 2017. **21**(61): p. 1-90.
18. Coomarasamy, A., et al., *PROMISE: first-trimester progesterone therapy in women with a history of unexplained recurrent miscarriages - a randomised, double-blind, placebo-controlled, international multicentre trial and economic evaluation.* Health Technol Assess, 2016. **20**(41): p. 1-92.
19. Jit, M., et al., *The cost-effectiveness of vaccinating pregnant women against seasonal influenza in England and Wales.* Vaccine, 2010. **29**(1): p. 115-22.

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Supplementary material 9 - Summary of UK Department of Health reference costs 2015-16 and 2018-19

Activity costed	Department of Health Reference costs 2015-16 [5]	Department of Health Reference costs 2018-19 [4]
Estimated cost for antenatal appointment	Non-consultant-led outpatient attendance for obstetrics - £117.16 Consultant-led outpatient attendance for obstetrics - £141.95	Tariff for all care within an average maternity pathway is costed as a composite, with higher prices paid for higher levels of obstetric complexity or presence of medical co-morbidities: £1,019-£2,713.00.
Estimated cost for attendance to maternity day unit/triage	£259.48 (NZ16Z - Day case)	
Estimated cost for an antenatal inpatient admission	£1,133.76 for first day and £184.67 for every day after (NZ16Z - Antenatal Routine Observation)	
Estimated cost for an ultrasound scan	Sonography-led: £109.07 / scan (NZ21Z) Specialist-led: £151.15 / scan (NZ22Z)	
Induction of labour	£537.90-£850.96 in addition to cost of normal vaginal delivery	Upgrades the price for vaginal birth to a higher level of complexity.
Epidural	£537.90-£850.96 in addition to cost of normal vaginal delivery	
Spontaneous vaginal birth	£1,832.10-£2,259.20	£1,957-£3,357, depends on level of complexity and additional activity
Instrumental birth	£2,441.01-£3,204.83	£1,957-£3,357, depends on level of complexity and additional activity
Elective Caesarean section	£3,383.41-£5,042.31	£3,357
Emergency Caesarean section	£4,594.77-£6,867.95	
Repair 3/4th degree tear	£242.06-£762.75 in addition to cost for normal vaginal birth	£0.00 - £1,400.00 (upgrades vaginal birth price to £3,357, if not already being paid)
Manual removal of placenta	£242.06-£762.75 in addition to cost for normal vaginal birth	£0.00 - £1,400.00 (upgrades vaginal birth price to £3,357, if not already being paid)

Examination under anaesthesia for postpartum haemorrhage	£242.06-£762.75 in addition to cost for normal vaginal birth	£0.00 - £1,400.00 (upgrades vaginal birth price to £3,357, if not already being paid)
Maternal inpatient stay on postnatal ward / maternity HDU	Immediate postnatal admission included in cost of birth until a pre-specified length of stay (varies according to mode of birth). After this, £48.95-1,890.19/day.	Days after 6-9 days paid at £347.00 / day
Maternal inpatient stay in ITU	£3,097.25 / day	To be negotiated locally