Peripartum hysterectomy: an economic analysis of direct health care costs using routinely collected data

Running title: Peripartum hysterectomy: direct health care costs using routine data

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Abstract

Objective: To estimate resource use and costs associated with peripartum hysterectomy for the English National Health Service.

Design/Settings: Analysis of linked Clinical Practice Research Datalink and Hospital Episodes Statistics (CPRD-HES) data.

Population: Women undergoing peripartum hysterectomy between 1997 and 2013 and matched controls.

Main outcome measures: Primary care, hospital outpatient and inpatient attendances and costs (£, 2015 prices).

Methods: Inverse probability weighted generalised estimating equations were used to model the non-linear trend in healthcare service use and costs over time, accounting for missing data, adjusting for maternal age, body mass index, delivery year, smoking and socio-economic indicators.

Results: The study sample included 1362 women (192 cases and 1170 controls) who gave birth between 1997 and 2013; 1088 (153 cases and 935 controls) of these were deliveries between 2003 and 2013 when all categories of hospital resource use were available. Based on the 2003-2013 delivery cohort, peripartum hysterectomy was associated with a mean adjusted additional total cost of £5,380 (95%CI £4,436 to £6,687) and a cost-ratio of 1.76 (95%CI 1.61 to 1.98) over 5-years of follow-up compared to controls. Inpatient costs, mostly incurred during the first year following surgery, accounted for 78% excluding or 92% including delivery-related costs.

Conclusion: Peripartum hysterectomy is associated with increased healthcare costs driven largely by increased post-surgery hospitalisation rates. To reduce healthcare costs and improve outcomes for women who undergo hysterectomy, interventions that reduce avoidable repeat hospitalisations following surgery such as providing active follow-up, treatment and support in the community should be considered.

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Tweetable abstract

Large NHS data on peripartum hysterectomy suggest active community follow-up could reduce

cost,#HealthEconomics

Introduction

Obstetric haemorrhage is a leading cause of maternal morbidity and mortality worldwide (1, 2). The global burden of obstetric haemorrhage varies widely between low and high-income countries. It is a leading cause of maternal mortality in low-income countries and the primary cause of nearly one quarter of all maternal deaths globally (1, 3, 4). Maternal deaths secondary to severe bleeding during childbirth are relatively rare in high-income countries. In the United Kingdom (UK) for example, there were nine maternal deaths between 2006 and 2008 that resulted directly from haemorrhage (5). However, these deaths represent only the tip of the iceberg; many mothers go on to suffer complications and disabilities, which directly or indirectly result from severe bleeding-related complications. Peripartum hysterectomy is a life-saving operation performed if other more conservative management strategies for postpartum haemorrhage have failed and represents the removal of the uterus within 24 hours of delivery (6). One UK population based case control study (7) estimated the incidence of the procedure at 4.1 cases per 10,000 births.

The risk factors for peripartum hysterectomy include previous caesarean delivery, non-white ethnic origin, and advanced maternal age. In recent years, more women, particularly in high-income countries, have chosen to delay childbearing until later on in life. The UK Office for National Statistics (ONS) reported that 53% of all live births in England and Wales in 2015 were born to mothers aged 30 and over, representing 5% and 13% point increases from 2005 and 1995, respectively (9). The number of babies born through caesarean section is also on the increase (10). The number of women experiencing postpartum haemorrhage and requiring peripartum hysterectomy may therefore increase in the future if current trends towards increasing maternal age and caesarean deliveries continue. Surgery may be associated with complications requiring immediate medical attention whilst the mother is still in hospital. Long term complications of surgery include difficulty breastfeeding, depression, and sexual and urinary complications (11). The economic consequences of peripartum hysterectomy could be substantial and will likely fall on both hospital and community care providers. Service providers need to plan for effective postsurgical follow up and counselling, but published data on the economic burden of peripartum hysterectomy, which might in turn inform clinical and budgetary service planning, is lacking.

Using nationally representative data of primary and secondary healthcare service use in England, this study estimates the direct health care service use and costs associated with peripartum hysterectomy for the National Health Service (NHS) in England and identifies key cost drivers.

Methods

Data sources

This empirical investigation was based on data from the Clinical Practice Research Datalink (CPRD) and Hospital Episode Statistics (HES). The CPRD is the observational data and interventional research service arm of the NHS in England (12). CPRD is nationally representative of the UK population in terms of age, sex and ethnicity and covers approximately 6.9% of the UK population (13). The HES dataset contains hospital records (inpatient admissions and outpatient and emergency department attendances) for the majority of patients attending secondary care services within the NHS in England (14). Linkage of the two datasets was performed by a trusted third party and data were supplied in a pseudo-anonymised format. Linked CPRD-HES data were available for deliveries from 1997 to 2013. Outpatient data were only available from 2003 onwards.

Study population

The study population included women aged ≥16 years who delivered between 7th April 1997 and 31st December 2013 and registered with a GP surgery contributing data to the linked CPRD-HES dataset. Cases were identified through CRPD and/or HES records using ICD-10, Office of Population Censuses and Surveys (OPCS) 4 and READ codes for peripartum hysterectomy and were defined as women who had a hysterectomy at any time from delivery to discharge for the same hospitalisation episode. Controls were defined as women giving birth between 1997 and 2013 matched to cases by maternal age. Up to six controls were selected for each case.

Follow-up period

The follow-up start date was defined as the date of the delivery event. The follow-up end date was the earliest of the following: the date the woman stopped registration with the current general practice if she moved out of the area, 5 years after the start date or 31st December 2014.

Definition and valuation of outcomes and services

Cumulative healthcare service use and costs covering primary and secondary health care services over 1, 3 and 5 years of follow-up were estimated, grouped by the following clinical settings and resource categories:

i) Primary care consultations;
ii) Primary care prescriptions;
iii) Primary care medical tests and investigations;
iv) Hospital outpatient attendances and procedures;
v) Hospital admissions, inpatient and day cases, including delivery-related admissions;
vi) Hospital admissions, inpatient and day cases, excluding delivery-related admissions.

For i) to vi) above, composite cost outcomes were constructed by summing costs across categories for each woman at each follow-up time point.

Primary care services were valued by attaching unit costs derived from national compendia to resource inputs. Consultations included face-to-face or telephone contacts in surgery or home settings with a general practitioner, practice nurse or other professional. Consultation costs were derived from the Personal Social Services Research Unit (PSSRU) Unit Costs of Health and Social Care 2015 compendium (15). Prescription costs were obtained from the prescription cost analysis 2015 database (16), electronic searches of the British National Formulary (BNF) 2015 (17) and where required searches of the literature. Average costs at the BNF sub-paragraph level were used where the unit cost of prescriptions were extracted from the prescription cost analysis database. Procedure costs were obtained from secondary sources. Further details of the approaches used to cost primary care services and sources of cost data are provided in Tables S1 and S2 of the accompanying supplementary information file.

Secondary care service use included admitted care (inpatient and day case admissions) and outpatient attendances and procedures. Inpatient admissions were sub-categorised as delivery and non-delivery events. The HRG4+2014-15 Reference Cost Grouper (18) was used to generate Health Resource Group (HRG) codes for each outpatient attendance, day case and inpatient admission, at the Full Consultant Episode (FCE) level. HRG codes were matched to the appropriate costs in the 2014-15 Reference Costs Main Schedules (19) based on the clinical specialty, inpatient length of stay (short-stay versus long-stay) and type of admission (elective versus non-elective). Inpatient stays were considered as short-stays for day long admissions and long-stays for admissions lasting two or more days in line with NHS reference costs calculations (19). Excess bed-day costs associated with inpatient admissions and unbundled HRG codes associated with high cost drugs, devices and procedures were automatically generated by the Grouper software. These were then assigned unit costs from the 2014-15 reference costs main schedules. Inpatient costs were analysed at the spell level by summing FCE costs within spells to generate total costs per inpatient spell.

Statistical Analysis

Characteristics of cases and controls were compared using t-tests for continuous variables and chi-square tests for categorical variables. Initial exploration of the data was conducted to guide selection of the appropriate analytic strategy. Inverse probability weighted generalised estimating equations (20) were used to model non-linear trends in healthcare service use and costs over time, accounting for missing data, and adjusting for maternal age, BMI, year of delivery, smoking status and socio-economic indicators at baseline. In the models, the total follow-up period was divided into one-year intervals and interval-specific weights calculated as the inverse cumulative product of the probability of being observed over a given interval using the method of van der Wal and Geskus (2011) (21). Inverse probability weighting ensures that observations with a high probability of being missing (for example costs incurred in the later years of follow-up) are given more weight than observations with a low probability of being missing (for example costs incurred in the earlier years of follow-up) (22). A sensitivity analysis explored the effects of excluding women with data covering less than the minimum one year follow-up period applied within the inverse probability weighting model.

Adjusted estimates of cumulative healthcare utilisation counts, lengths of stay and costs, and between-group differences in counts, length of stay and costs, were obtained from the regressions by summing interval-specific estimates over the time period of interest, a strategy originally reported in Lin (2000) (23) and also Willan et al. (24). For example, the mean cumulative total costs and between-group difference in cumulative total costs over 5-years of follow-up were obtained by summing the interval-specific mean cost estimates for years 1 to 5. Standard errors and 95% confidence intervals were obtained using bootstrapping. For completeness, the analyses were also repeated by restricting to women with complete data over 1, 3 and 5-years of follow-up. All analyses were conducted using the statistical package R (25). Further details are provided in the supplementary file.

Results

Summary of data

Figure 1 shows the selection of cases and controls for inclusion in the study. A total of 195 women who had undergone peripartum hysterectomy and 1171 controls were identified from the linked CPRD-HES records. Four women (three cases and one control) were excluded because of inconsistencies in data coding. The final sample thus comprised 1362 women, 192 of whom were in the hysterectomy group and 1170 in the control group. One thousand and eighty-eight women (153 cases and 935 controls), representing 80% of the total study sample, gave birth between 2003 and 2013 and so had hospital outpatient data in addition to primary and hospital admission care data. All 1362 women were included in the 1997-2013 cohort, but only the 1088 were included in the 2003-2013 cohort. Baseline characteristics of the sample are summarised in Table 1. The median duration of follow-up was 5 years and the median age at delivery was 34 years. Women in the hysterectomy group were similar to controls in terms of age, BMI and smoking status, but were more likely to deliver at a lower gestational age (median: 38 weeks versus 40 weeks, p-value<0.001), to be of non-White ethnicity (21% versus 11%, p-value = 0.002), to have a history of placenta disease (34% versus 2%, p-value<0.001) and to have a caesarean delivery (85% versus 28%, p-value < 0.001). The proportion of women with complete observations decreased over time from 85% at 1-year post-delivery to slightly over 50% at 5-years post-delivery (Figure 1). Compared to women with complete data at 5-years, those with incomplete data were more likely to be younger (maternal age34 versus 35 years, p-value < 0.001) and to hail from an ethnic minority background (12% versus 8%, p-value < 0.001) (See Table S3 of the supplementary file).

Healthcare utilisation

Estimates of health service use from the weighted regression are presented in Table 2. Compared with controls, women in the hysterectomy group had more consultations (adjusted rate ratio (RR) 1.29 (95%CI 1.15 to 1.52), almost twice as many prescriptions (RR 1.91, 95%CI 1.49 to 2.60) and twice as many tests and investigations (RR 2.19, 95%CI 1.84 to 2.68) in primary care settings during the first year following delivery. The hysterectomy group also had higher rates of hospital admissions (RR 1.31, 95%CI 1.23 to 1.42), over three times more hospitalisation episodes if delivery-related admissions are excluded (RR 3.13, 95%CI 2.51 to 4.01) and twice as many outpatient attendances (RR 1.96, 95%CI 1.62 to 2.38)[1].

Cumulative rates of health service use over 3 and 5-years of follow-up are also presented in Table 2 and displayed graphically in Figure S1 of the supplementary file by clinical setting and resource category. Except for rates of hospital admissions, including those that were delivery-related, rates across other resource categories increased over time in both groups, but the cumulative rate ratio decreased. Over 5-years of follow-up, women in the hysterectomy group attended 0.84 (95%CI -0.85 to 2.78) more primary care consultations and had 0.01 (95%CI -0.19 to 0.79) more outpatient appointments, but also had 0.15 (95%CI -0.39 to 0.07) fewer hospital admissions if deliveries are included and 0.12 (95%CI -0.05 to 0.31) more admissions excluding deliveries. The number of medical tests and prescriptions in primary care were also higher, but the number of hospital admissions plateaued by the end of the first year of follow-up so that between group difference in admissions rates were not statistically significant over 5-years of follow-up.

Inpatient length of stay

Estimates of hospital length of stay are presented in Table S4. In the first-year following delivery, the average length of stay per inpatient spell was 14.6 days in the hysterectomy group and 4.0 days in the control group. Restricting the analysis to non-delivery related admissions reduced the average length of hospital stay during the first-year to 2.73 days in the hysterectomy group and 0.31 in the control group, generating a between-group difference of 2.42 (95%CI 1.63 to 3.26) days. The average inpatient length of stay across cumulative inpatient spells throughout 5-years of follow-up was also longer in the hysterectomy group. The between-group difference, however, remained relative constant at approximately 10.58 (95%CI 8.34 to 13.30) days if delivery-related admissions are included, but increased to 3.20 (95%CI 1.78 to 5.38) days excluding delivery-related admissions.

Healthcare costs per woman by clinical setting

The cost of primary care consultations, prescriptions and tests were combined to generate total cost of primary care services for each woman. Similarly, total admitted care costs were generated by combining costs for inpatient and day case admissions. Estimates of between-group difference were greater than zero on the

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[1] Outpatient attendance rates were based on analyses of the 2003-2013 cohort.

cost-difference scale and greater than 1 on the cost-ratio scale (Table S5). This suggest that costs were significantly higher for the hysterectomy group compared with controls across all resource categories considered. The ratio of admitted care costs in the hysterectomy group to the admitted care costs in the control group decreased over the five years of follow-up, but the respective ratios for primary care and hospital outpatient costs remained relatively constant over the same period. Overall, the between-group difference in costs at 5-years post-delivery ranged from £406 (95%CI £179 to £668) for primary care services to £4,609 (95%CI £3,930 to £5,813) for inpatient admissions including deliveries.

Total healthcare cost per woman

Total cost estimates based on analysis of complete cases, by follow-up period, are presented in Table S6. Adjusted estimates of the total cost of primary and secondary care services at 1, 3 and 5-years post-delivery from the weighted regression are presented in Table 3 and Figure S2 where total cost estimates over varying periods of follow-up can be read off the graphs. Based on the 1997-2013 cohort, peripartum hysterectomy was associated with a mean additional total cost of £5,016 (95%CI £4,293 to £6,314) and a cost-ratio of 1.89 (95%CI 1.71 to 2.14) compared with controls over five years of follow-up. Excluding delivery-related inpatient costs reduced the 5-year additional costs to £1,864 (95%CI £1,119 to £2,904) and the cost ratio to 1.85 (95%CI 1.44 to 2.33). Separate estimates from the 2003-2013 delivery cohort, which includes outpatient attendances, produced a mean additional total cost of £5,380 (95%CI £4,436 to £6,687) including delivery-related inpatient costs and £2,211 (95%CI £1,234 to £3,331) excluding delivery-related inpatient costs at 5-years post-delivery. A major component of the total cost difference was attributable to inpatient admissions; on average, these accounted for more than 92% of the cost difference at 1-year post-delivery and 78% to 92% at 5-years post-delivery. A sensitivity analysis carried out to assess the impact of excluding women with less than 1-year follow-up data produced slightly higher additional total cost estimates for the hysterectomy group compared with controls (Table S7).

Discussion

Main Findings

In this paper, we have quantified the direct healthcare costs associated with peripartum hysterectomy for the English healthcare services using linked CPRD-HES data. On average, women undergoing peripartum hysterectomy attended more consultations and had twice as many prescriptions and medical tests in primary care settings during the first year postpartum than counterparts that had not undergone this surgery. Outpatient attendances and non-delivery related inpatient admission rates among the hysterectomy group were also higher, as were average and cumulative inpatient lengths of stay. Health service use remained higher over the longer 5-year postpartum period, but the adjusted rate ratios were not significant for all resource categories.

Strengths and limitations

The datasets used are nationally representative of the population of England and appropriate analytic methods were employed to minimise any biases resulting from incomplete follow-up. However, the main analyses included women with less than complete follow-up during the first year postpartum. This may have biased our results if these women are more likely to have worse outcomes requiring more support and services than those with complete data during this period. The sensitivity analysis carried out to assess this assumption produced slightly higher additional total cost estimates for the hysterectomy group compared with controls (Table S7). Thus, our estimates should be considered a lower bound for service utilisation and costs. Furthermore, our estimates do not include non-health service and wider societal costs such as lost earnings, out-of-pocket medical expenses and potential impacts on families and informal carers that may arise as a result of peripartum hysterectomy. These broader costs associated with the procedure could be high in comparison to direct healthcare costs and should be quantified in future studies to gain a more accurate picture of the overall burden of peripartum hysterectomy to society (26).

Interpretation in light of other evidence

We have purposefully not adjusted for mode of delivery in our analyses as it was not possible within the data to disentangle the causal pathway to the peripartum hysterectomy. It is possible that a more distal factor, such as placental disorders, was identified leading to a change in management i.e. change in mode of delivery, which in turn was partially causative of the postpartum haemorrhage. Adjustment for a factor such as mode of delivery which is on the causal pathway would therefore be inappropriate in this case. Nearly one third of the women undergoing peripartum hysterectomy had evidence of placental disease according to their delivery admission data of which 9% were placenta accreta. A major cause of placenta accreta is scarring from prior caesarean delivery (27, 28). Owing to small numbers, we were unable to run our analysis on women for whom we were confident had complete fertility records, thus enabling us to account for prior caesarean delivery. However, it is recognised that prior caesarean delivery is a major risk factor for severe postpartum haemorrhage and, as such, with increasing rates of caesarean delivery it is plausible that we will see a rise in the number of peripartum hysterectomies. Development and refinement of alternative methods of management of postpartum haemorrhage is therefore desirable to reduce the necessity for peripartum hysterectomy.

We have not investigated the health consequences of peripartum hysterectomy in this paper nor conducted analyses to identify the clinical specialties within which the long-term economic burden associated with peripartum hysterectomies fall. A previous UK study (2) reported that much of the immediate comorbidity following peripartum hysterectomy is related to the surgery itself, with further surgery for organ damage not uncommon. It is possible that these sequelae of surgery continue to generate health service use, but this needs to be evaluated in appropriate longitudinal studies. Overall, our analyses suggest inpatient admissions accounted for 78% to 92% of the additional total costs over 5-years depending on whether or not the cost of delivery-related admissions are included in the calculations (2). Future research will aim to disentangle additional hospital costs associated with peripartum hysterectomy across both clinical specialties and periods of follow-up with the view to targeting service planning and intervention development.

The comparatively high rates of service use among women undergoing peripartum hysterectomy have resource implications for service delivery. We have estimated that, on average, this is equivalent to an additional £5,380 (or £2,211 excluding delivery-admission costs) in primary and secondary care costs over the first five years postpartum compared with women who do not have a hysterectomy, adjusting for demographic and clinical characteristics. There are no published estimates of the current incidence of peripartum hysterectomy for England or the UK as whole. The only available figures were published almost a decade ago and suggest a rate of 4.1 per 10,000 births (7). A more recent estimate based on an unpublished analysis of linked CPRD-HES data reported a rate of 3.6 per 10,000 live births (8). Based on the higher of the two incidence estimates and ONS data reporting 664,399 live births in England in 2015, our cost estimates translate into a total additional cost to the NHS in England for the 5-year period following this life-saving surgery of £1,456,234 when delivery costs are taken into account and £599,727 excluding delivery-related hospitalisation costs. Given that peripartum hysterectomies are undertaken in life-threatening situations, our cost estimates would suggest that the direct healthcare costs appear modest over the short to medium term.

Perhaps more pertinent is the potential to incorporate our cost estimates into future economic evaluations of medical and surgical interventions aimed at preventing peripartum hysterectomies or ameliorating their sequelae. Although robust evidence on the clinical effectiveness of preventive and treatment interventions is accumulating (6, 29, 30), economic evaluations of these interventions are currently lacking; our data can act as a significant new resource that informs cost inputs into future economic evaluations. More generally, our study demonstrates the utility of large-scale routine electronic health records for research purposes and for informing health policy and service delivery.

Conclusion

Peripartum hysterectomy is associated with increased healthcare costs during the first five years postpartum, primarily driven by increased inpatient hospitalisation costs in the first year postpartum. To improve outcomes for women who undergo hysterectomy and reduce healthcare service use and costs, consideration should be given to interventions that reduce avoidable repeat hospitalisations following surgery such as providing active follow-up, treatment and support in the community.

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Disclosure of Interests

None

Contribution to Authorship

FAA conducted the data analysis, drafted and coordinated write up of the manuscript. **KMF, LJT** and **SP** conceived the study. **AAS** extracted and prepared the data for the analysis. All authors contributed to writing up of the manuscript.

Details of ethics approval

None required this is secondary analysis of routinely collected data

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Legends

Figure 1: Flow chart of study population (note outpatient data from HES is available from 2003 onwards)

Figure S1: Adjusted estimates of cumulative healthcare utilisation for cases and controls

Figure S2: Cumulative total healthcare utilisation cost per patient at each year of follow-up

Table 1: Summary characteristics of cases and controls

Table 2: Healthcare service use associated with peripartum hysterectomy

Table 3: Total healthcare cost estimates associated with peripartum hysterectomy over 5-years of follow-up

Table S1: Unit costs for primary care consultations (£, 2015 price year)

Table S2: Unit costs for medical tests (£, 2015 price year)

Table S3: Characteristics of women with and without missing observations at 5 years post-delivery

Table S4: Adjusted estimates of hospital length of stay per inpatient spell (days) for cases and controls

Table S5: Health service costs by clinical setting associated with peripartum hysterectomy

Table S6: Total cost estimates based on analysis of complete cases using Generalised Linear Modelling with Gamma distribution with identity link function

Table S7: Total cost estimates based on data excluding 240 women (34 cases and 206 controls) with less than one-year of complete data