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Outcomes for women admitted for labour care to alongside midwifery units in the UK following a postpartum haemorrhage in a previous pregnancy: A national population-based cohort and nested case-control study using the UK Midwifery Study System (UKMidSS)☆,☆☆

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ABSTRACT

Background: Women who have experienced a postpartum haemorrhage (PPH) 'requiring treatment or transfusion' are typically advised to plan birth in obstetric-led settings in subsequent pregnancies. Many UK alongside midwifery units (AMU) admit women for labour care following a previous PPH. We aimed to describe outcomes in women admitted for labour care to AMUs following a previous PPH, compare outcomes with other multiparous women admitted to the same AMUs, and explore risk factors for recurrence.

Methods: A national cohort and nested case-control study using the UK Midwifery Study System (UKMidSS), between August 2018 and April 2019. Multivariable Poisson regression and logistic regression were performed to compare outcomes and investigate risk factors for recurrence.

Findings: Women who experienced a previous PPH were significantly more likely than comparison women to: have a PPH requiring transfer to obstetric care (4·2% vs. 2·4%, aRR=1·65, 95% CI 1·14–2·38), be transferred to obstetric care for any reason (17·8% vs 11·9%; aRR=1·41; 95% CI 1·09–1·83), and have any PPH≥ 500 ml (22·7% vs 11·1%, aRR=1·86, 95% CI 1·49–2·32). Among women with a previous PPH, previous blood loss > 1500 ml; uterotonics for previous PPH; Caesarean associated with previous PPH; gestation at admission and higher birthweight were independent risk factors for PPH.

Conclusion: Women considering birth in an AMU after a previous PPH should be advised that they are at increased risk of experiencing a subsequent PPH requiring transfer to obstetric care, compared with other multiparous women who have not had a PPH. The absolute risk of a subsequent PPH in this group is low and comparable to the overall risk of having a PPH among women having a spontaneous vaginal birth in England.

Statement of significance

Issue

The extent of increased risk of postpartum haemorrhage among women who experienced a postpartum haemorrhage in a previous pregnancy, and who are at otherwise 'low risk' of complications, is uncertain.

What is already known

Having had a postpartum haemorrhage (PPH) in a previous pregnancy increases the risk of having a PPH in a subsequent birth.

What this Paper Adds

Women admitted for labour care in a midwifery unit following a

☆ on behalf of the UK Midwifery Study System (UKMidSS).☆☆ For UKMidSS see separate document listing collaborator group.

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previous PPH were significantly more likely than other multiparous women who had not had a PPH to have a subsequent PPH requiring transfer to obstetric care. The absolute risk of recurrent PPH requiring obstetric care was low and comparable to the overall risk of having a PPH > 1000 ml among women having a spontaneous vaginal birth.

Introduction

Primary postpartum haemorrhage (PPH) is typically defined as a blood loss of at least 500 mls within 24 hours after birth, with the WHO defining blood loss of at least 1000mls as 'severe'. [1] As visual estimation of blood loss is often inaccurate, it is recommended that clinical signs and symptoms of hypovolaemia, alongside the woman's weight, should also be taken into account when diagnosing a PPH. [2] The incidence of postpartum haemorrhage (PPH) has been increasing in high resource countries across the world. [3–8]

Women who have had a PPH are at increased risk of recurrence in a subsequent pregnancy. [9–11] In the United Kingdom (UK), women who have had a "previous PPH requiring treatment or transfusion" are advised to plan birth in a hospital obstetric unit (OU) or labour ward to reduce the risk of adverse outcome. [12] This is in contrast to advice for women who are healthy with straightforward pregnancies and without previous complications, who are advised that they may choose where to have their baby. [12] For women with uncomplicated pregnancies, planning birth in a midwifery unit is considered "particularly suitable", because it is associated with benefits for the woman in terms of a lower chance of intervention during labour and birth, with no difference in neonatal outcomes, compared with planning birth in a hospital 'consultant-led' obstetric unit or labour ward. [12] In the UK, midwifery units can be either 'alongside' (AMU), that is located in the same building as an obstetric unit, or 'freestanding', on a site that is geographically separate from an obstetric unit. [13] Around 15% of women gave birth in a midwifery unit in 2015, around 80% of whom gave birth in an AMU. [14]

In a study carried out in England in 2008–10, around 1–2/1000 women admitted to midwifery units were reported as having had a "previous PPH requiring treatment or transfusion". [15] Unpublished data from a national study in all UK AMUs in 2016 showed that around 1.5% of women admitted to AMUs were recorded as having a PPH in a previous pregnancy, which may include some women who had a PPH not 'requiring treatment or transfusion'. [16] A survey of UK midwifery unit admission criteria, in 2018–19, found that around one third of midwifery units had admission criteria in relation to previous PPH that were more inclusive than national guidance, whereby previous PPH was explicitly not a barrier to admission for labour care. [17]

In this study, we aimed to provide evidence about the risks and outcomes associated with previous PPH in women admitted to AMUs, to inform women's decision-making and midwifery unit admission criteria. Our primary objective was to explore and describe clinical characteristics, and maternal and perinatal outcomes, in women admitted for labour care to an AMU in the UK following a PPH in a previous pregnancy, and compare outcomes in this group with other multiparous women admitted for labour care to the same AMUs. As a secondary objective we investigated risk factors for PPH in the cohort of women admitted to an AMU after a previous PPH.

Methods

Study design

We carried out a national population-based cohort and nested case-control study, identifying and collecting data about all women with a previous PPH admitted for labour care in all AMUs across the UK between 1st August 2018 and 30th April 2019, and a comparison cohort of multiparous women who had not had a previous PPH, matched on time of admission to the same AMUs.

Data collection

We used the UK Midwifery Study System (UKMidSS), a research infrastructure covering all 123 AMUs in the UK in 2018–19. UKMidSS methods have been described elsewhere. [18] In each AMU, midwife 'reporters' received monthly emails from the UKMidSS co-ordinating centre and in response reported the number of women with a previous PPH who were admitted for labour care to the AMU in the previous month (including zero if they had no women with a 'previous PPH' to report). They also reported data about total admissions and births in the AMU each month. On reporting a woman who had experienced a previous PPH, electronic case report forms (CRFs) were automatically generated in a secure web-based environment to collect further detailed anonymous information confirming the eligibility of the woman, including details of previous births and any previous PPH, socio-demographic and clinical characteristics, pregnancy and labour care, and maternal and neonatal outcomes. Reporters also identified and entered data about a comparison cohort, selected as the multiparous woman, without a previous PPH, admitted to the AMU immediately before each woman who had a previous PPH. All data were anonymous and entered directly from women's notes and/or hospital electronic patient records, so would have reflected the information available to the midwives caring for the woman in labour.

Email reminders were sent for overdue (by at least three months) monthly reports and outstanding data entry (CRFs not complete six weeks after reporting), and further monthly status report emails summarised reporting and data entry completion, and listed data queries about missing or invalid data which were generated automatically in the CRF.

Outcomes

The primary outcome for our main analysis was a PPH requiring transfer for obstetric care, chosen as a marker of more severe PPH that was not solely dependent on estimation of blood loss, which is known to be inaccurate. [19] For that analysis, we investigated a number of secondary maternal outcomes: transfer to the care of an obstetrician during labour or within 24 hours of birth for any reason; 'straightforward vaginal birth' (i.e. birth without forceps, ventouse or Caesarean, with no third/fourth degree perineal tear and no blood transfusion); instrumental birth; Caesarean birth; any PPH≥ 500 ml; maternal blood transfusion; maternal admission for higher level care (i.e. admission to a high dependency unit or intensive care unit for additional observation or treatment beyond routine postnatal care); and maternal death. We also investigated the following neonatal outcomes: Apgar score < 7 at 5 minutes; neonatal unit admission; initiation of breastfeeding; stillbirth/neonatal death.

Data and definitions

The 'previous PPH' group comprised of women admitted for labour care in an AMU who were recorded in their notes as having a PPH≥ 500 ml, or a blood transfusion for a PPH before discharge home, in any previous pregnancy of ≥ 24 weeks' gestation. Women fitting these criteria, and who went on to give birth in the same admission were included, irrespective of where they gave birth.

We collected the following data about the previous PPH: estimated total blood loss, treatment received, mode of birth and primary underlying cause of PPH. If the woman had a PPH in more than one previous pregnancy, we collected these data about the PPH with the largest blood loss volume.

We collected data about any other complications in a previous pregnancy (retained placenta requiring manual removal, Caesarean

birth, other); medical conditions known prior to the start of labour care (essential hypertension, cardiac disease, thromboembolic disorder, atypical antibodies, hyperthyroidism, diabetes, renal disease, epilepsy, other); current pregnancy risk factors identified prior to admission (body mass index (BMI)> 35 kg/m^2, Group B Streptococcus, post-term pregnancy, pre-eclampsia/pregnancy-induced hypertension, gestational diabetes, malpresentation, other); and 'complicating conditions' identified at the start of care in labour (e.g. prolonged rupture of membranes), using the list of complications indicating need for transfer to obstetric-led care in national guidelines. [12]

We derived the three-class version of the National Statistics Socio-economic Classification (NS-SEC), using the 'simplified method, [20] from the woman's occupation (or her partner's where the woman was out of work or where her occupation was not known), including categories for 'employed, but occupation unrecorded' and 'employment status not recorded'. To derive a measure of area deprivation UKMidSS reporters entered women's postcodes into a bespoke 'look-up' website which returned a 'score' for the Children in Low-income Families Local Measure, [21] which they then entered into the CRF with other data. This score represents the proportion of children living in families in receipt of out-of-work benefits or tax credits where their reported income was less than 60% of UK median income, based on the local area in which they live. [21] Cut-offs derived using data on the number of babies in 2018 in the UK from official birth records were used to create deciles and quintiles.

Statistical analysis

We estimated the proportion of women admitted for labour care in AMUs after having had a previous PPH using the total reported number of women (irrespective of parity) admitted for labour care to AMUs as the denominator, and the total number of women for whom a previous PPH was confirmed as the numerator, with 95% confidence intervals (CI).

For the 'previous PPH' group, we described mode of birth, estimated blood loss volume, treatment for PPH and primary cause of PPH in the previous birth affected by PPH. We described the maternal socio-demographic and clinical characteristics and maternal and neonatal outcomes, of the 'previous PPH' and comparison cohorts. For those women in each group who experienced a PPH, we reported the estimated blood loss, treatment for PPH and primary cause of PPH, using frequencies and percentages.

We used univariable and multivariable log Poisson regression to calculate the relative risk (RR) of the primary and secondary outcomes in the 'previous PPH' cohort relative to the comparison group, adjusting (aRR) for parity, maternal age, ethnicity, socio-economic status, area deprivation quintile, smoking, gestation at admission, BMI, pre-existing medical conditions, and previous pregnancy complications in addition to previous PPH (see Supplementary Table S1 for categorisation).

We carried out two post hoc case-control analyses within the 'previous PPH' cohort to investigate associations between explanatory variables and (a) PPH requiring obstetric care, and (b) any PPH $\geq$ 500 ml, using unconditional univariable and multivariable logistic regression, to calculate unadjusted and adjusted odds ratios (OR and aOR) with 95% CI. For the first of these analyses 'cases' were women in the 'previous PPH' cohort who had the primary outcome, i.e. a PPH requiring transfer for obstetric care, and 'controls' were women in the previous PPH cohort who did not have a PPH requiring transfer for obstetric care. In the second of these analyses, 'cases' were women in the 'previous PPH' cohort who had a PPH $\geq$ 500 ml and 'controls' were women in the 'previous PPH' cohort who did not have a PPH$\geq$ 500 ml. Explanatory variables considered for inclusion in these models were maternal socio-demographic and pre-existing clinical characteristics, including those relating to the previous PPH, and characteristics arising during pregnancy, where $p < 0{\cdot}10$ in the univariable analysis, or if univariable analyses indicated that their association with the outcome was confounded by another variable. In these post-hoc exploratory analyses, a threshold of $p < 0.10$ was chosen to ensure that all potentially important variables were tested for inclusion in the models. We tested the contribution of each variable to the fit of the data to the models using the Wald test, and variables for which $p < 0{\cdot}05$ were retained in the models.

We anticipated that some of the data required to generate body mass index (BMI) and information about smoking would be unrecorded in women's notes, and that this 'missing' data would not be randomly distributed, so we provided the option at data entry of indicating that height, weight or smoking information were 'not recorded' and used this category in our analysis. The only other variable with a substantial proportion of missing data was socioeconomic status which are typically also not missing at random. [22] Approaches such as multiple imputation would not therefore be appropriate. We therefore included separate 'employed but occupation unrecorded' and 'employment status not recorded' categories and used these in our analyses.

Robust variance estimation was used to allow for the clustering of women within units. For all analyses using the primary outcome we used $p < 0{\cdot}05$ to assess statistical significance and for all secondary outcomes we used $p < 0{\cdot}01$; absolute p-values are reported throughout. We used Stata 17·0 for all analyses. [23]

Sample size and power

Based on a previous study we estimated the proportion of all women (irrespective or parity) admitted for labour care to midwifery units after a PPH in a previous pregnancy to be approximately 1·5%. [16] Using data from the same study we estimated there to be approximately 126, 000 admissions for labour care in total to AMUs per year. We originally aimed to collect data for 12 months resulting in approximately 1900 women in the 'previous PPH' cohort and the same number in the comparison cohort. Two studies of recurrence of PPH, carried out in general populations rather than in this population of otherwise 'low risk' women, suggested that previous PPH was associated with a tripling of the odds of PPH in a subsequent pregnancy. [9,10] Assuming that 1% of the comparison group would have a PPH requiring transfer, with these anticipated numbers we estimated that we would have 80% power at the 5% level of significance to detect a RR of PPH requiring transfer of 2·1 or greater in the group with a previous PPH. For a more common outcome, e.g. transfer for any reasons, and assuming a 10% transfer rate in the comparison group, we would have 80% power at the 5% level to detect a RR of transfer of 1·3 or greater in the 'previous PPH' group. When it became clear that units were reporting a higher than anticipated number of eligible women in the 'previous PPH' cohort we reduced the duration of data collection to 9 months. The actual number of 'previous PPH' and comparison group women identified during the study period generated 80% power at the 5% level to detect a RR of 1·6 or greater in the 'previous PPH' group for the primary outcome For the case-control analyses, investigating factors associated with a PPH requiring transfer, the number of cases and controls generated 80% power at the 5% level to detect ORs of 2·9 or greater for an exposure variable with a frequency of 5%.

Data sharing

Requests for access to the dataset underlying our findings will be considered by the National Perinatal Epidemiology Unit Data Sharing Committee and should be addressed to the data custodian, Professor Jenny Kurinczuk (jenny.kurinczuk@npeu.ox.ac.uk) in the first instance.

Patient and public involvement (PPI)

The UKMidSS Steering Group includes two lay members who have represented the views of pregnant women and families throughout the design, conduct and interpretation of this study.

Results

Response and prevalence of previous PPH

All 123 AMUs in the UK participated in the study (100% of eligible units), with 98% response to monthly report requests.

A total of 1972 women with a PPH recorded in a previous pregnancy were reported (Fig. 1). Complete data were received for 1883 women who had a previous PPH and 1850 comparison women. After exclusions, there were 1866 women with a confirmed previous PPH for whom we had complete data. A total of 77,917 women were admitted to an AMU over the same nine-month period, meaning that overall 2·4% (95% CI 2·3–2·5) of all women admitted to AMUs were recorded as having had a PPH in a previous pregnancy. Assuming that around 54% of women admitted to AMUs are multiparous, [16] 4·4% (95%CI 4·2–4·6) of multiparous women admitted to AMUs were recorded as having experienced a PPH in a previous pregnancy. In total 97 AMUs (79%) reported at least one woman admitted for labour care after a PPH in a previous pregnancy during the study period. The percentage of women admitted following a previous PPH in each AMU ranged from 0% to 10% (median 1·2%; IQR 0.2–3·6%).

Maternal characteristics

Previous PPH

Among the 'previous PPH' group, 681 (36·5%) had an instrumental birth in the birth affected by PPH and 24 (1·3%) had a Caesarean birth (Table 1). For 158 (8·5%) women, the estimated blood loss volume in the previous PPH was not recorded and, of the remainder, 1461 (85·5%) had an estimated blood loss of $\leq$ 1000 ml. The treatment provided for the previous PPH and the primary underlying cause were not recorded in 418 (22·4%) and 726 (38·9%) women respectively.

Sociodemographic and clinical characteristics

Compared with the comparison women, the 'previous PPH' group were more likely to be of higher socio-economic status, not to have smoked during pregnancy, have had only one previous pregnancy, have had previous pregnancy complications in addition to a previous PPH, give birth at or after 40 weeks' gestation and have a baby weighing more than 3500 g (Table 2).

Table 1
Previous PPH severity, treatment and causes.

	Previous PPH group n = 1866	
	n	%
Mode of birth in pregnancy with PPH		
Spontaneous vertex	1142	61.2
Vaginal breech	7	0.4
Ventouse	212	11.4
Forceps	469	25.1
Caesarean birth	24	1.3
Not recorded	12	0.6
Estimated blood loss (ml)		
500	420	22.5
501–1000	1041	55.8
1001–1500	174	9.3
> 1500	73	3.9
Not recorded	158	8.5
Treatment for PPH[1]		
Uterotonics	1294	69.4
Invasive procedure	43	2.3
Blood products/transfusion	131	7.0
None/immediate clinical care only	103	5.5
Not recorded	418	22.4
Primary underlying cause of PPH		
Uterine atony	548	29.4
Genital tract trauma	461	24.7
Retained products/adherent placenta	131	7.0
Not recorded	726	38.9

[1] Percentages add up to more than 100% as women could have received more than one treatment

Maternal outcomes

Primary outcome

Among the 'previous PPH' group, 78 women (4·2%) experienced a PPH requiring transfer to obstetric care, compared with 42 women (2·4%) in the comparison group (aRR=1·65; 95% CI 1·14–2·38) (Table 3).

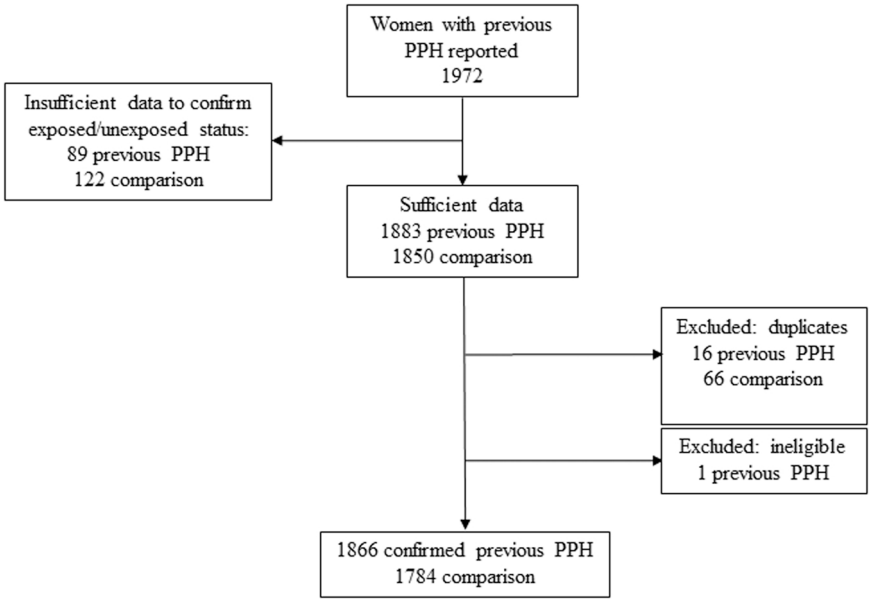

Fig. 1. Flow diagram.

Table 2
Socio-demographic and clinical characteristics in 'previous PPH' and comparison women.

	Previous PPH		Comparison		All	
	n = 1866		n = 1784		n = 3650	
	n	**%**	**n**	**%**	**n**	**%**
Maternal age (years)						
< 20	10	0.5	7	0.5	17	0.5
20–24	179	9.6	188	10.5	367	10.1
25–29	488	26.1	505	28.3	993	27.2
30–34	723	38.7	614	34.4	1337	36.6
35–39	410	22.0	430	24.1	84	23
≥ 40	56	3.0	40	2.2	96	2.6
Missing	0		0		0	
Ethnic group						
White British/Irish	1133	60.7	1045	58.6	2649	72.6
White Other	239	12.8	232	13.0	471	12.9
Asian	325	17.4	298	16.7	623	17.1
Black	92	4.9	101	5.7	193	5.3
Other	77	4.1	108	6.1	185	5.1
Missing	0		0		0	
Socioeconomic status						
Higher managerial, admin, prof	524	28.1	396	22.2	920	25.2
Intermediate	481	25.8	438	24.6	919	25.2
Routine and manual	381	20.4	406	22.8	787	21.6
Unemployed/student	165	8.8	188	10.5	353	9.7
Employed but unrecorded	134	7.2	153	8.6	287	7.9
Employment status not recorded	181	9.7	203	11.4	384	10.5
Missing	0		0			
Area deprivation quintile						
1st	412	22.2	361	20.3	773	21.3
2nd	395	21.3	329	18.5	724	19.9
3rd	363	19.5	338	19.0	701	19.3
4th	347	18.7	349	19.6	696	19.1
5th	342	18.4	401	22.6	743	20.4
Missing	7		6		13	
Smoking status						
Non-smoker during pregnancy	1655	88.7	1495	83.8	3150	86.3
Smoker during pregnancy	140	7.5	219	12.3	359	9.8
Not recorded	71	3.8	70	3.9	141	3.9
Missing	0		0		0	
BMI at booking (kg/m[a])						
< 18.5	47	2.5	51	2.9	92	2.7
18.5–24.9	997	53.5	932	52.3	1824	52.9
25–29.9	549	29.4	490	27.5	977	28.5
30–35.0	180	9.7	215	12.1	384	10.8
> 35	49	2.6	51	2.9	89	2.7
Not recorded	43	2.3	44	2.5	79	2.4
Missing	1		1		2	
Pre-existing medical risk factors[b]						
None	1833	98.2	1765	99.0	3598	98.6
One or more	33	1.8	18	1.0	51	1.4
Missing	0		1		1	
Previous pregnancies ≥ 24 weeks						
1	1343	72.5	1163	65.3	2506	69.0
2	389	21.0	435	24.4	824	22.7
3 or more	121	6.5	182	10.2	303	8.3
Missing	13		4		17	
Previous pregnancy problems[a]						
None	1833	98.2	1765	99.0	3598	98.6
One or more	33	1.8	18	1.0	51	1.4
Missing	0		1		1	
Current pregnancy complications[c]						
None	1728	92.8	1662	93.3	3390	93.0
One or more	134	7.2	120	6.7	254	7.0
Missing	4		2		6	
Gestation at admission (weeks)						
36–37	46	2.5	66	3.7	112	3.1
38	179	9.6	193	10.8	372	10.2
39	477	25.6	514	28.8	991	27.2
40	742	39.8	691	38.8	1433	39.3
≥ 41	422	22.6	319	17.9	741	20.3
Missing	0		1		1	
Birthweight (g)						
< 3000	149	8.0	184	10.3	333	9.1
3000–3499	610	32.7	730	40.9	1340	36.7
3500–3999	765	41.0	655	36.7	1420	38.9
≥ 4000	341	18.3	215	12.1	556	15.2
Missing	1		0		1	

[a] Manual removal of placenta; Caesarean birth, shoulder dystocia and stillbirth (in addition to PPH for previous PPH group)
[b] Essential hypertension; confirmed cardiac disease; thromboembolic disorder; atypical antibodies; hyperthyroidism; diabetes; renal disease; epilepsy
[c] Group B streptococcus; BMI at booking> 35 kg/m^2; post-term; pre-eclampsia/PIH; gestational diabetes; malpresentation; small for gestational age; induction of labour

Secondary maternal outcomes

Women in the 'previous PPH' group were significantly more likely than the comparison group to be transferred for obstetric care during labour or after birth (17·8% vs 11·9%; aRR=1·41; 95% CI 1·09–1·83) (Supplementary Table S2). Apart from transfer for PPH, most of this excess was accounted for by other transfers after birth for retained placenta and perineal repair (Supplementary Table S3). The 'previous PPH' group were also significantly more likely than the comparison group to have any PPH≥ 500 ml (22·7% vs 11·1%; aRR=1·86; 95% CI 1·49–2·32) (Supplementary Table S2). Within the 'previous PPH' group and the comparison group, among women who had a PPH≥ 500 ml, the proportion who were transferred for obstetric care for PPH was similar. Among women who had a previous PPH, 423 women had a PPH≥ 500 ml (Supplementary Table S2), of whom 78 (18%) were transferred to obstetric care for PPH. In the comparison group, 198 women had a PPH≥ 500 ml (Supplementary Table S2), of whom 42 (21%) were transferred to obstetric care for PPH.

We found no statistically significant differences between the two groups for the other secondary maternal outcomes investigated: straightforward vaginal birth, instrumental birth, Caesarean birth, birth in water, 3rd/4th degree perineal trauma, maternal blood transfusion, maternal admission for higher level care (Supplementary Table S2).

There were no maternal deaths in either group.

PPH blood loss, treatment and cause

In women who experienced a PPH requiring transfer to obstetric care, estimated blood loss volume, treatment and underlying cause of PPH were similar in the two groups, with a slightly higher proportion of women with estimated blood loss greater than 1500 ml in the 'previous PPH' group (37·8% vs 23·8%) (Table 4).

Estimated blood loss, treatment for PPH and primary underlying cause of PPH for women who had any PPH≥ 500 ml are shown in Supplementary Table S4.

Neonatal outcomes

We found no statistically significant associations between having a PPH in a previous pregnancy and any of the neonatal outcomes studied: Apgar< 7 at 5 min, initiation of breastfeeding and neonatal unit admission (Supplementary Table S5). There was one intrapartum stillbirth and one neonatal death in the cohort, neither clearly related to previous PPH.

Factors associated with PPH among women with a PPH in a previous pregnancy

In women admitted to an AMU for labour care following a PPH in a

Table 3
Primary outcome.

	Events	Births			Unadjusted		Adjusted[a]	
	n	n	%	95% CI	RR	95% CI	aRR	95% CI
Postpartum haemorrhage requiring transfer to obstetric care								
Comparison group	42	1783	2.4	1.7–3.2	1		1	
Previous PPH group	78	1865	4.2	3.3–5.2	1.78	(1.24–2.53)	1.65	(1.14–2.38)

[a] Adjusted for: parity, maternal age, ethnicity, socioeconomic status, area deprivation quintile, smoking status, birthweight, gestation at admission, BMI, previous pregnancy complications (in addition to previous PPH), medical risk factors

Table 4
Estimated blood loss, PPH treatment and causes, in women with a PPH requiring transfer.

	Previous PPH		Comparison		All	
	n = 78		n = 42		n = 120	
	n	%	n	%	n	%
Estimated blood loss (ml)						
500–1000	23	31.1	16	38.1	39	33.6
1001–1500	23	31.1	16	38.1	39	33.6
1501–2000	18	24.3	5	11.9	23	19.8
> 2000	10	13.5	5	11.9	15	12.9
Missing	4		0		4	
Treatment for PPH[a]						
Uterotonics	72	92.3	41	97.6	113	94.2
Invasive procedure	7	9.0	4	9.5	11	9.2
Blood products/transfusion	9	11.5	5	11.9	14	11.7
Tranexamic acid	3	3.9	0	0.0	3	2.5
None/immediate clinical care only	2	2.6	1	2.4	3	2.5
Other	2	2.6	10	12.8	12	10.0
Primary underlying cause of PPH						
Uterine atony	48	61.5	19	45.2	67	55.8
Genital tract trauma	6	7.7	7	16.7	13	10.8
Retained products/adherent placenta	12	15.4	12	28.6	24	20.0
Not recorded	8	10.3	4	9.5	12	10.0

[a] Percentages add up to more than 100% as women could have received more than one treatment

previous pregnancy we found that only estimated blood loss volume in the previous PPH was significantly associated with having a subsequent PPH requiring transfer for obstetric care (Supplementary Tables S6-S8). Women with a previous PPH of greater than 1500 ml were significantly more likely to have a PPH requiring transfer to obstetric care (OR=2·66; 95% CI 1·18–6·01), although numbers of cases were small and confidence intervals wide (Supplementary Table S8).

Among women admitted to an AMU for labour care following a PPH in a previous pregnancy, we also investigated the factors associated with having any subsequent PPH ≥ 500 ml (Supplementary Tables S9-S12). Estimated blood loss volume greater than 1500 ml in the previous PPH (aOR=1·75; 95% CI 1·14–2·71); uterotonics for treatment of previous PPH (aOR=1·36; 95% CI 1·07–1·73); Caesarean birth in the previous pregnancy affected by PPH (aOR=2·91; 95% CI 1·27–6·71); and birthweight of at least 4500 g (aOR=3·52; 95% CI 1·78–6·94) were all independently associated with a PPH ≥ 500 ml (Supplementary Table S12).

Discussion

Main findings

Among women who were admitted to an AMU for labour care, following a PPH in a previous pregnancy, 4·2% had a subsequent PPH requiring transfer to obstetric care, compared with 2·4% in multiparous women admitted to the same AMUs who had not had a PPH before, a relative increase in risk of 65% after adjustment for other factors. The 'previous PPH' group also had a significantly increased risk of transfer for any reason (17·8% vs 11·9%), with most of the excess risk accounted for by transfers for retained placenta and perineal repair (in addition to transfers for PPH), and of having any PPH≥ 500 ml (22·7% vs 11·1%), compared with other multiparous women. Other maternal and neonatal outcomes in the two groups were similar.

Among women who had a PPH in a previous pregnancy, having an estimated blood loss greater than 1500 ml was significantly associated with having any subsequent PPH≥ 500 ml as well as having a subsequent PPH requiring transfer for obstetric care.

Over 75% of AMUs reported admitting at least one woman for labour care following a PPH in a previous pregnancy during the study period. Of these women, 36% had an instrumental birth in the previous pregnancy affected by PPH, and 78% had a previous PPH with estimated blood loss ≤ 1000 ml. Among women with a previous PPH, estimated blood loss in the previous PPH, treatment received and the underlying cause of the previous PPH were not recorded in women's notes in 9%, 22% and 39% of women respectively.

Strengths and limitations

The main strength of this study is its national population-based design, which reduces the risk of the biases associated with local, hospital-based studies. All 123 AMUs in the UK participated in the study (100% of eligible units), with 98% response to monthly report requests and complete data returned for over 90% of women reported, reducing the possibility of selection bias.

Our aim was to compare outcomes for women admitted to AMUs after a PPH in a previous pregnancy with those for other multiparous women admitted to the same units for labour care. We cannot therefore compare outcomes for women who had a previous PPH directly with outcomes for similar women admitted to hospital obstetric units.

Women admitted to an AMU for labour care having had a PPH in a previous pregnancy were identified, and data about them entered, by UKMidSS reporters in each unit. It is possible that some women who had

a previous PPH may have been missed, but we do not have other sources of data against which we can validate our data.

There is little consistency in clinical practice as to how blood loss is measured. Although quantitative measurement of blood loss is becoming more common at all births, [24] at the time of data collection visual estimation was typically used, which is known to be inaccurate and inconsistent. [19,25] We selected our primary outcome for this study, PPH requiring transfer to obstetric care, as a pragmatic indicator of severity that was not dependent on estimated blood loss. National guidance does not give a threshold for transfer to obstetric care in the presence of PPH. [12] The threshold for transfer may vary in different units, for different midwives and in different circumstances. It is possible that when looking after women who are known to have had a PPH in a previous pregnancy midwives might overestimate blood loss and/or be more inclined to transfer the woman to obstetric care as a precaution. If this were the case our estimates of increased risk for these women would be an overestimate. However, our data suggest that within both groups, among women who had a PPH, the proportion that were transferred was similar, so the excess risk of PPH requiring transfer for obstetric care among women with a previous PPH is likely to be explained by their excess risk of having any PPH.

Other evidence and clinical implications

Our findings are consistent with other evidence which suggests that previous PPH is a risk factor for PPH in a subsequent birth, [9,10] however in our study the magnitude of the increased relative risk was smaller. Previous studies in Australia, Scotland and Sweden, using data from 1994 to 2002, 1986–2005 and 1997–2009 respectively, all reported a three-fold increased risk of recurrence of PPH in a second pregnancy in women who had a PPH in their first pregnancy. [9–11] For our 'previous PPH' cohort, the risk of PPH requiring transfer to obstetric care was less than doubled (65%), and the risk of having any PPH $\geq$ 500 ml, most of which were managed within the midwifery unit without transfer, was slightly higher (86%). It is likely that our cohort was highly selected, both as a result of 'self-selection' by women and through a risk assessment process by midwives, and therefore the women in our 'previous PPH' group may have been less likely to have other characteristics and conditions associated with an increased risk of PPH. We are not aware of any national data against which to compare. However, for example, compared with a cohort of women recorded as having a PPH in a study carried out in two English hospitals in 2009, our 'previous PPH' cohort appear to be less likely to have a range of pre-existing medical conditions, and much less likely to have given birth by Caesarean birth in the birth affected by PPH. [26]

The absolute risk of having a PPH requiring transfer to obstetric care in our cohort was just over 4% in women with a PPH in a previous pregnancy, compared with just over 2% in the comparison group. Just under 70% of those who had a PPH requiring transfer experienced a blood loss of greater than 1000 ml. Data from a national study in Wales in 2017, after the introduction of a quantitative blood loss measurement quality improvement programme, showed that just under 5% of all unassisted vaginal births were affected by blood loss $>$ 1000 ml, [24] suggesting that the absolute risk of PPH requiring obstetric care in our cohort is comparable to national data about PPH after unassisted vaginal birth.

Predicting PPH is a key factor in being able to advise women about birth place decisions. [2] In our study, the only factor known before admission in labour that was significantly associated with PPH requiring transfer, among women who had experienced a PPH before, was estimated blood loss in the previous PPH. Women who had an estimated blood loss of $>$ 1500 ml in a previous PPH were almost three times more likely than other women with a previous PPH to have a subsequent PPH requiring transfer to obstetric care. Additional factors associated with any PPH$\geq$ 500 ml in this group included having treatment with uterotonics for the previous PPH and having a Caesarean birth in the previous PPH affected birth. This information can be used by women, and the clinicians looking after them, to inform birth place decision-making. It is essential therefore that women's notes include appropriate information about estimated blood loss, treatment and mode of birth in previous births affected by PPH so that clinicians and women can be appropriately informed.

National data for England from the period when this study was carried out showed that PPH occurred in 14% of all spontaneous vertex births in 2018–19. [27] In our study, 23% of the 'previous PPH' group and 11% of our comparison group, experienced a PPH$\geq$ 500 ml in an AMU, and for around 80% of these women in both groups the PPH was managed in the AMU by midwives, without transfer to obstetric care. Current UK clinical guidance for the management of PPH was developed primarily for consultant-led obstetric units. [2] National guidance about intrapartum care for healthy women with straightforward pregnancies recommends calling for help as soon as there is recognition of PPH alongside the provision of immediate clinical treatment including, for example, bladder emptying, uterine massage, administration of uterotonic drugs, intravenous fluids, application of controlled cord traction if the placenta has not been delivered, and transfer of the woman to obstetric care where appropriate. [12] With the continued widespread use of the estimation of blood loss it is possible that in our study blood loss of $\geq$ 500 ml only became evident to midwives once bleeding had settled and further care was felt not to be indicated. Maternal and neonatal outcomes for women were good in our study, and indicative of appropriate management of any PPH that occurred. High proportions of women in both groups had a 'straightforward vaginal birth' (i.e. birth without forceps, ventouse or Caesarean, with no third/fourth degree perineal tear and no blood transfusion), and just over 1% of women required admission for higher level (enhanced/intensive) care.

Conclusions and implications for policy and practice

Admission of women who have had a PPH in a previous pregnancy is widespread in UK AMUs. Women who have had a previous PPH and are considering birth in an AMU should be advised of the absolute risks, and that they are at an increased risk of experiencing a subsequent PPH that will require transfer for obstetric care, compared with other multiparous women who have not had a PPH before. The absolute risks of having a PPH requiring transfer, and of having a PPH that is managed within the AMU, are comparable with available national data for women having a spontaneous vaginal birth. Among women who have had a previous PPH, having had a PPH$>$ 1500 ml, having had uterotonic treatment for a previous PPH, and having had a Caesarean birth all independently increase the chances that a woman will have a recurrence of PPH. It is essential that these details about any previous PPH are recorded in women's notes. Maternal and neonatal outcomes were generally good for all women in our cohort and are indicative of appropriate management of PPH in AMUs.

Details of ethics approval

UKMidSS received ethics approval from NRES Committee South West – Frenchay (REC Ref. 15/SW/0166) in May 2015. This study was approved by substantial amendment to the original approval on 7th June 2018.

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CRediT authorship contribution statement

Alessandra Morelli: Data curation, Formal analysis, Writing – original draft, Project administration. **Rachel Rowe:** Funding acquisition, Conceptualization, Methodology, Data curation, Formal analysis, Supervision, Project administration, Writing – original draft, Writing – review & editing. **Jane Rogers:** Conceptualization, Writing – original draft. **Julia Sanders:** Conceptualization, Writing – original draft. **Jennifer J Kurinczuk:** Funding acquisition, Conceptualization, Writing – original draft.

Conflict of interest

AM is currently a-part time Clinical Midwifery fellow for the National Maternity and Perinatal Audit, and was a Midwifery Lecturer at Oxford Brookes University and a bank Midwife at King's College Hospital NHS Foundation Trust during the conduct of the study. JS holds NIHR grants not related to this project, and is a member of TSCs funded by NIHR. RR reports funding from NIHR Policy Research Programme and NIHR Research for Patient Benefit Programme. JK is involved in multiple research grants paid to Oxford University.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.wombi.2022.11.002.

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