Risk factors for postpartum haemorrhage in twin pregnancies and haemorrhage severity

CW Kong *, William WK To

ABSTRACT

Introduction: This study evaluated risk factors for postpartum haemorrhage (PPH) in twin pregnancies, particularly factors associated with major PPH (blood loss of >1000 mL), to facilitate identification of high-risk twin pregnancies.

Methods: This retrospective cohort study included all women with twin pregnancies who delivered at a tertiary obstetric unit in Hong Kong from 2009 to 2018 and experienced PPH (blood loss of ≥500 mL). Postpartum haemorrhage was classified using three thresholds for blood loss volume: ≥500 mL (all PPH), >1000 mL (major PPH), and >1500 mL (severe PPH). Risk factors for each threshold of PPH were analysed.

Results: In total, there were 680 twin pregnancies. The overall incidence of all PPH (≥500 mL) in this cohort was 27.8%, including minor PPH (500-1000 mL, 20.1%), major but not severe PPH (1001-1500 mL, 4.4%), and severe PPH (>1500 mL, 3.2%). Logistic regression analysis showed that general anaesthesia and the use of oxytocin were significant risk factors for all PPH (≥500 mL); general anaesthesia, in vitro fertilisation, antepartum haemorrhage, placental abruption, and placenta praevia were significant risk factors for major PPH (>1000 mL); in vitro fertilisation, placenta praevia, and obesity were significant risk factors for severe PPH (>1500 mL).

Conclusion: Women with twin pregnancies who have obesity, conception by in vitro fertilisation, or placenta praevia exhibit a high risk of severe PPH. They should deliver in obstetric units with readily available blood product transfusions and the appropriate expertise for prompt management of severe PPH.

Hong Kong Med J 2023;29:295–300
https://doi.org/10.12809/hkmj219830

CW Kong *, MB, ChB, MSc
WWK To, MD

Department Obstetrics and Gynaecology, United Christian Hospital, Hong Kong SAR, China

* Corresponding author: melizakong@gmail.com

This article was published on 27 Jul 2023 at www.hkmj.org.

New knowledge added by this study

- Risk factors for severe postpartum haemorrhage differ between twin pregnancies and singleton pregnancies.
- Women with twin pregnancies who have obesity, conception by in vitro fertilisation, or placenta praevia exhibit a high risk of severe postpartum haemorrhage.

Implications for clinical practice or policy

- Women with twin pregnancies who have obesity, conception by in vitro fertilisation, or placenta praevia should deliver in obstetric units with readily available blood product transfusions and the appropriate expertise for prompt management of severe postpartum haemorrhage.
- The delivery of twin pregnancies with the above risk factors should involve a multidisciplinary team of experienced obstetricians, anaesthetists, interventional radiologists, and haematologists.

Introduction

In many developed countries, the incidence of twin pregnancies is rising because of the increase in maternal age and increasing use of assisted reproductive procedures.[1,2] Postpartum haemorrhage (PPH) is more common in twin pregnancies than in singleton pregnancies; this is usually attributed to substantial distension of the uterus in twin pregnancies, which leads to uterine atony after delivery.[3,4] Risk factors for severe PPH in singleton pregnancies include hypertensive disorders, failure to progress during the second stage of labour, oxytocin augmentation, instrumental delivery, and fetal macrosomia.[5] However, there have been few studies concerning specific risk factors for PPH in twin pregnancies because twin pregnancy itself is considered a risk factor for PPH. This study evaluated risk factors for PPH in twin pregnancies, particularly factors associated with major PPH, to facilitate identification of high-risk twin pregnancies. Better preparation for peripartum management of these high-risk twin pregnancies should allow a multidisciplinary approach involving experienced obstetricians, anaesthetists, haematologists, and radiologists to reduce maternal morbidity and mortality associated with massive haemorrhage.

Methods

This retrospective study included all women with twin pregnancies who delivered at >24 weeks of gestation in a single tertiary obstetric training unit from 2009 to 2018 (10-year period) and experienced

雙胞胎孕婦產後出血的風險因素與出血嚴重程度研究

江采華、杜榮基

引言：本研究評估雙胞胎產後出血的風險因素，着重調查主要產後出血（流血量>1000毫升）的風險因素，以便辨認高風險的雙胞胎孕婦。

方法：本回顧性隊列研究包括了所有在2009至2018年間於香港一間產科醫院分娩後有產後出血（流血量≥500毫升）的雙胞胎孕婦。產後出血按不同流血量分為三類：≥500毫升（所有產後出血）、>1000毫升（主要產後出血）及>1500毫升（嚴重產後出血）；我們分析了每個產後出血類別的風險因素。

結果：本研究共有680位懷有雙胞胎的孕婦，全部產後出血（≥500毫升）的整體發生率是27.8%，包括次要產後出血（500-1000毫升，20.1%）、主要產後出血但未達至嚴重出血（1001-1500毫升，4.4%）和嚴重產後出血（>1500 毫升，3.2%）。邏輯迴歸分析發現使用全身麻醉和催產素是全部產後出血（≥500毫升）的重要風險因素；使用全身麻醉、體外人工受孕、產前出血、胎盤早期剝離和胎盤前置是主要產後出血（>1000毫升）的重要風險因素；而體外人工受孕、胎盤前置和肥胖症則是嚴重產後出血（>1500毫升）的重要風險因素。

結論：有肥胖症、體外人工受孕和胎盤前置的雙胞胎孕婦會有較高風險出現嚴重產後出血，她們應在容易獲取血庫製品和有及時處理嚴重產後出血經驗的醫院分娩。

PPH (blood loss of ≥500 mL). Obstetric data for these women were identified using a comprehensive obstetric database; their electronic and paper records were then carefully reviewed. Various maternal demographic and clinical characteristics (eg, maternal age, parity, method of conception, body mass index, mode of delivery, cause of PPH, and antenatal complications such as gestational diabetes and pre-eclampsia) were compared between women with and without PPH to identify possible risk factors. Postpartum haemorrhage was classified using three thresholds for blood loss volume: ≥500 mL (all PPH), >1000 mL (major PPH), and >1500 mL (severe PPH). Risk factors for each threshold of PPH were analysed. Women with intrauterine fetal death of one or both twins were excluded from analysis.

In our unit, PPH was managed using a standard protocol, which began with various oxytocic agents including oxytocin/ergometrine, oxytocin bolus and infusion, and carboprost injections. If medical treatment was unable to control haemorrhage, second-line conservative procedures involving either intrauterine balloon tamponade or compression sutures were used depending on the clinical situation, as well as the attending obstetrician's clinical judgement.

Data entry and analysis were performed using SPSS (Windows version 24.0; IBM Corp, Armonk [NY], United States). Possible risk factors were analysed by the Chi squared test or Fisher's exact test, as appropriate. P values <0.05 were considered statistically significant. Logistic regression analysis was conducted to identify significant risk factors for PPH in twin pregnancies. Statistically significant risk factors identified in univariate analysis were entered into a stepwise logistic regression model. Odds ratios and corresponding 95% confidence intervals were calculated.

TABLE 1. Total blood loss according to cause of postpartum haemorrhage*

Total blood loss, mL	Uterine atony (n=147)	Placenta praevia/ accreta (n=34)	Genital tract trauma (n=8)	P value
500-1000	127 (86.4%)	6 (17.6%)	4 (50.0%)	<0.001
1001-1500	9 (6.1%)	21 (61.8%)	0	
>1500	11 (7.5%)	7 (20.6%)	4 (50.0%)	

* Data are shown as No. (%), unless otherwise specified

Results

In total, there were 47 076 deliveries during the study period, including 686 deliveries of multiple pregnancies (680 twin pregnancies and six triplet pregnancies); only twin pregnancies were included in the final analysis. Concerning the mode of delivery, 99 women (14.6%) had normal vaginal delivery of both twins, 67 women (9.9%) had instrumental or vaginal breech delivery of one or both twins, and 514 women (75.6%) had caesarean delivery of one or both twins, of which 17 women had combined deliveries (the first twin was delivered vaginally and the second twin was delivered by caesarean section). The overall incidence of all PPH (≥500 mL) in this cohort of twin pregnancies was 27.8% (189/680), including minor PPH (500-1000 mL, 137/680 [20.1%]), major but not severe PPH (1001-1500 mL, 30/680 [4.4%]), and severe PPH (>1500 mL, 22/680 [3.2%]). In our database, the overall incidence of all PPH (27.8% vs 5.7% [2649/46 390]), as well as the incidences of major PPH [>1000 mL; including severe PPH] (7.6% vs 0.86% [397/46 390]) and severe PPH [>1500 mL] (3.2% vs. 0.44% [204/46 390]), were all significantly higher in twin pregnancies than in singleton pregnancies during the study period (P<0.001). Most instances of PPH in twin pregnancies (147/189, 77.8%) were caused by uterine atony; other causes were placenta praevia or accreta (34/189, 18.0%) and genital tract trauma (8/189, 4.2%). Although most instances of PPH in twin pregnancies were caused by uterine atony, 86.4% of women with uterine atony had only minor PPH (500-1000 mL); in contrast, 82.4% of women with placenta praevia had major PPH >1000 mL (Table 1).

Concerning the treatment of PPH in this cohort, 89.4% of women (169/189) had a successful outcome with medical treatment alone. In 20 patients, medical treatment was insufficient and

second-line procedures were required: 12 patients received intrauterine balloon tamponade, four patients received compression sutures, and four patients underwent uterine artery embolisation. Three of the 20 patients subsequently required hysterectomy despite medical treatment and second-line procedures; the peripartum hysterectomy rate was 0.4% (3/680). There were no maternal deaths in this cohort.

Maternal characteristics and their associations with each type of PPH are shown in Table 2. Nulliparity and the use of oxytocin were significantly associated with all PPH ≥500 mL but not major PPH >1000 mL or severe PPH >1500 mL. Univariate analysis showed that in vitro fertilisation, maternal obesity, antepartum haemorrhage, placenta praevia, placental abruption, caesarean delivery, general anaesthesia, and intrapartum pyrexia were

TABLE 2. Associations of pregnancy characteristics with postpartum haemorrhage*

	PPH ≥500 mL			PPH >1000 mL			PPH >1500 mL		
	No (n=491)	Yes (n=189)	P value	No (n=628)	Yes (n=52)	P value	No (n=658)	Yes (n=22)	P value
Parity			0.02			0.31			0.65
Nulliparous	292 (59.5%)	130 (68.8%)		387 (61.6%)	35 (67.3%)		407 (61.9%)	15 (68.2%)	
Multiparous	199 (40.5%)	59 (31.2%)		241 (38.4%)	17 (32.7%)		251 (38.1%)	7 (31.8%)	
Previous miscarriage	70 (14.3%)	37 (19.6%)	0.06	92 (14.6%)	15 (28.8%)	0.009	100 (15.2%)	7 (31.8%)	0.07
Advanced maternal age ≥35 years	212 (43.2%)	87 (46.0%)	0.28	277 (44.1%)	24 (46.2%)	0.46	289 (43.9%)	10 (45.5%)	1.0
In vitro fertilisation	130 (26.5%)	66 (34.9%)	0.02	158 (25.2%)	38 (73.1%)	<0.001	181 (27.5%)	15 (68.2%)	<0.001
Monochorionicity	74 (15.1%)	29 (15.3%)	0.51	96 (15.3%)	7 (13.5%)	0.45	99 (15.0%)	4 (18.2%)	0.76
Previous caesarean delivery	62 (12.6%)	18 (9.5%)	0.44	75 (11.9%)	5 (9.6%)	0.46	78 (11.9%)	2 (9.1%)	0.73
Preterm delivery <37 weeks	228 (46.4%)	77 (40.7%)	0.11	284 (45.2%)	21 (40.4%)	0.30	298 (45.3%)	7 (31.8%)	0.27
Tocolytic therapy	29 (5.9%)	9 (4.8%)	0.50	37 (5.9%)	1 (1.9%)	0.23	37 (5.6%)	1 (4.5%)	0.83
Active labour before delivery	99 (20.2%)	23 (12.2%)	0.01	117 (18.6%)	5 (9.6%)	0.13	119 (18.1%)	3 (13.6%)	0.78
Induction of labour	24 (4.9%)	12 (6.3%)	0.28	32 (5.1%)	4 (7.7%)	0.35	33 (5.0%)	3 (13.6%)	0.11
Oxytocin induction/ augmentation	38 (7.7%)	30 (15.9%)	0.002	57 (9.1%)	11 (21.2%)	0.07	64 (9.7%)	4 (18.2%)	0.19
Antenatal anaemia (Hb <10 g/dL)	35 (7.1%)	15 (7.9%)	0.43	48 (7.6%)	2 (3.8%)	0.41	48 (7.3%)	2 (9.1%)	0.67
Gestational diabetes	91 (18.5%)	33 (17.5%)	0.42	114 (18.2%)	10 (19.2%)	0.85	120 (18.2%)	4 (18.2%)	1.00
Pre-eclampsia	58 (11.8%)	27 (14.3%)	0.23	76 (12.1%)	9 (17.3%)	0.27	82 (12.5%)	3 (13.6%)	0.74
Other medical disorders	33 (6.7%)	16 (8.5%)	0.41	44 (7.0%)	5 (9.6%)	0.92	48 (7.3%)	1 (4.5%)	0.99
Obesity (BMI ≥25 kg/m^2)	112 (22.8%)	76 (40.2%)	<0.001	161 (25.6%)	27 (51.9%)	<0.001	173 (26.3%)	15 (68.2%)	0.001
Antepartum haemorrhage	16 (3.3%)	23 (12.2%)	<0.001	27 (4.3%)	12 (23.1%)	<0.001	30 (4.6%)	9 (40.9%)	<0.001
Placenta praevia	3 (0.6%)	12 (6.3%)	<0.001	6 (1.0%)	9 (17.3%)	<0.001	7 (1.1%)	8 (36.4%)	<0.001
Placenta abruption	1 (0.2%)	6 (3.2%)	0.002	5 (0.8%)	2 (3.8%)	0.09	5 (0.8%)	2 (9.1%)	<0.001
Mode of delivery			<0.001			0.002			0.45
Normal vaginal	83 (16.9%)	16 (8.5%)		95 (15.1%)	4 (7.7%)		96 (14.6%)	3 (13.6%)	
Instrumental	63 (12.8%)	3 (1.6%)		66 (10.5%)	0		66 (10.0%)	0	
Caesarean	345 (70.3%)	169 (89.4%)		466 (74.2%)	48 (92.3%)		495 (75.2%)	19 (86.4%)	
General anaesthesia	18 (3.7%)	43 (22.8%)	<0.001	31 (4.9%)	30 (57.7%)	<0.001	39 (5.9%)	22 (100%)	<0.001
Intrapartum pyrexia	3 (0.6%)	7 (3.7%)	0.07	5 (0.8%)	5 (9.6%)	<0.001	9 (1.4%)	1 (4.5%)	0.65
Second-line procedure									
Intrauterine balloon	0	12 (6.3%)		0	12 (23.1%)		3 (0.5%)	9 (40.9%)	
Compression suture	0	4 (2.1%)		0	4 (7.7%)		3 (0.5%)	1 (4.5%)	
UAE	0	4 (2.1%)		0	4 (7.7%)		0	4 (18.2%)	
Hysterectomy	0	3 (1.6%)		0	3 (5.8%)		0	3 (13.6%)	

Abbreviations: BMI = body mass index; Hb = haemoglobin; PPH = postpartum haemorrhage; UAE = uterine artery embolisation

* Data are shown as No. (%), unless otherwise specified

significantly associated with various types of PPH. Logistic regression analysis revealed that general anaesthesia and the use of oxytocin were significant risk factors for all PPH ≥500 mL; general anaesthesia, in vitro fertilisation, antepartum haemorrhage, placental abruption, and placenta praevia were significant risk factors for major PPH >1000 mL; in vitro fertilisation, placenta praevia, and obesity were significant risk factors for severe PPH >1500 mL (Table 3).

Discussion

Incidence and cause of postpartum haemorrhage in twin pregnancies

This cohort study showed that the incidence of PPH was significantly higher in twin pregnancies than in singleton pregnancies. More than one in four of all twin pregnancies (27.8%) had PPH, compared with only about one in 20 (5.7%) singleton pregnancies. Uterine atony caused most instances of PPH (77.8%) in our cohort of twin pregnancies. There has been speculation that because the uterus is more distended in twin pregnancies than in singleton pregnancies, uterine muscle contraction and retraction is weaker after delivery, leading to an increased incidence of uterine atony.[6] However, we found that most cases of uterine atony–related PPH (86.4%) were mild, with blood loss of 500-1000 mL; morbidity from minor PPH is expected to be low. In contrast, the incidence of major PPH (>1000 mL; including severe PPH) was 7.6%; more than one-third (20/52) of the affected women required second-line procedures or hysterectomy. A previous study showed that blood loss of >1000 mL occurred in 24% of twin pregnancies[6]; another study revealed that the incidence of blood loss of >1500 mL was 3.9%.[7] Although the incidence of major PPH varies among studies, it is clear that the potential for morbidity related to major or severe PPH requires specific attention to this high-risk group. Postpartum haemorrhage ≥500 mL remains a useful threshold for attention from frontline staff[8]; however, we suggest modifying the definition for PPH in twin pregnancies to >1000 mL regardless of the mode of delivery, rather than the threshold of ≥500 mL used for singleton pregnancies. Because many twin pregnancies involve only minor PPH that can be managed with basic measures, a blood loss threshold of >1000 mL would be a more effective criterion for identifying high-risk women who will require more advanced management such as blood product transfusions or second-line uterine-sparing procedures.

Risk factors for postpartum haemorrhage in twin pregnancies

Efforts to identify risk factors for severe PPH in twin pregnancies may allow evaluation of available interventions to reduce such risks; they may also enable advance recognition of high-risk pregnancies, thereby facilitating staff and resource allocation during delivery to optimise peripartum management and reduce morbidity from maternal haemorrhage. In a retrospective cohort study of 1081 twin pregnancies in the United States, logistic regression analysis revealed that risk factors for PPH requiring blood transfusion were nulliparity, diabetes, intrapartum use of magnesium sulphate, low haematocrit level, low platelet count, and administration of general anaesthesia.[7] A study of 171 twin pregnancies in Japan investigated risk factors for major PPH >1000 mL after vaginal delivery; gestational age ≥39 weeks, combined birth weight >5500 g, induction of labour, oxytocin administration during labour, and prolonged labour

TABLE 3. Logistic regression analysis of risk factors for different degrees of postpartum haemorrhage

Risk factors	PPH ≥500 mL			PPH >1000 mL			PPH >1500 mL		
	P value	Odds ratio	95% CI	P value	Odds ratio	95% CI	P value	Odds ratio	95% CI
Parity	0.09	0.65	0.39-1.08	0.89	1.08	0.37-3.17	0.55	0.39	0.02-9.41
Previous miscarriages	0.15	1.59	0.84-2.99	0.35	1.79	0.53-6.10	0.19	14.5	0.26-807
In vitro fertilisation	0.19	1.39	0.85-2.29	<0.001	11.34	3.8-33.9	0.025	28.6	1.53-536
Active labour	0.91	0.92	0.22-3.92	0.76	0.67	0.05-8.60	0.41	6.29	0.08-529
Use of oxytocin	0.005	5.83	1.71-19.8	0.11	6.41	0.67-61.3	0.96	0.87	0.01-778
Obesity	0.44	1.21	0.75-1.98	0.12	2.17	0.81-5.83	0.049	22	1.01-477
Antepartum haemorrhage	0.27	1.80	0.63-5.15	0.01	5.62	1.44-21.7	0.46	2.55	0.21-30.8
Placenta praevia	0.77	0.69	0.06-7.85	0.009	70.3	2.90-1703	0.048	24.1	1.02-567
Placenta abruption	0.99	127	0.01-12 730	0.03	134	2.20-8145	0.36	29.9	0.02-41 000
Caesarean delivery	0.16	1.83	0.78-4.29	0.30	2.55	0.43-15.3	0.99	0.002	0.001-170
General anaesthesia	0.001	5.35	2.30-12.4	0.001	45.2	13.9-147	0.98	20.2	0.14-147
Intrapartum pyrexia	0.29	1.13	0.90-1.40	0.051	1.30	0.99-1.68	0.47	1.21	0.71-2.08

Abbreviations: CI = confidence interval; PPH = postpartum haemorrhage

were identified as significant risk factors.[6] Our study showed that the use of oxytocin and administration of anaesthesia were risk factors for PPH ≥500 mL in twin pregnancies. However, in contrast to the previous studies, diabetes and pre-eclampsia were not risk factors for PPH in our cohort. Although univariate analysis indicated that nulliparity was a significant risk factor for PPH ≥500 mL, it did not remain significant in logistic regression analysis.

In vitro fertilisation

In the present study, logistic regression analysis indicated that in vitro fertilisation was a significant risk factor for major PPH >1000 mL and severe PPH >1500 mL. To our knowledge, few studies have specifically investigated the relationship between assisted reproductive technology and PPH. Two retrospective cohort studies of singleton births after assisted reproductive technology revealed that in vitro fertilisation was significantly associated with a higher incidence of PPH, compared with spontaneous conception (odds ratios=1.3-1.46).[9,10] However, published literature has shown inconsistent results regarding the relationship between assisted reproductive technology and PPH in twin pregnancies. A prospective cohort study of 400 dichorionic twin pregnancies did not identify differences in PPH incidence between women who conceived by in vitro fertilisation and women who conceived spontaneously.[11] However, the authors did not report the definition for PPH used in their study. A retrospective cohort study of 1239 twin pregnancies by Bamberg et al[12] revealed no difference in PPH incidence (defined as blood loss of ≥500 mL combined with haemoglobin level <10 mg/dL) between women who conceived by artificial reproductive technologies (eg, hormonal stimulation, intrauterine insemination, or in vitro fertilisation) and women who conceived spontaneously. A case-control study of >3000 women in Norway demonstrated an increased risk of severe PPH (>1500 mL) in singleton pregnancies conceived by in vitro fertilisation compared with controls; it also showed that the effect of in vitro fertilisation on severe PPH was more pronounced in multiple pregnancies. After controlling for maternal factors and pregnancy complications, the adjusted odds ratios for severe PPH after in vitro fertilisation were 1.6 in singleton pregnancies and 7.0 in multiple pregnancies.[13] Direct inter-study comparisons of the effect of in vitro fertilisation on PPH in twin pregnancies are hindered by inconsistent PPH definitions and the involvement of various assisted reproductive techniques. In our study, we strictly defined in vitro fertilisation as assisted reproduction; we found that this risk factor was associated with major PPH and severe PPH but not minor PPH. Overall, in vitro fertilisation appears to be more frequently associated with severe PPH rather than minor PPH. There is speculation that in vitro fertilisation interferes with the formation of the maternal-fetal interface during the early stages of implantation, thereby causing early placental separation and uterine atony that result in PPH.[10,14] Although the confounding effects of placenta praevia and in vitro fertilisation on severe PPH remain controversial,[13] an increased incidence of placenta praevia has been associated with in vitro fertilisation; this use of in vitro fertilisation may contribute to the increased risk of PPH.[15] In our study, logistic regression analysis indicated that placenta praevia and in vitro fertilisation were significant factors for major PPH >1000 mL and severe PPH >1500 mL. Therefore, we suspect that in vitro fertilisation increases the incidence of PPH by increasing the incidence of placenta praevia; however, in vitro fertilisation itself is also an independent risk factor for PPH. Considering the possible increased risk of major PPH in multiple pregnancies conceived by assisted reproductive technology, single embryo transfer should be recommended during in vitro fertilisation to reduce maternal morbidity from major haemorrhage.

General anaesthesia and obesity

In our study, logistic regression analysis revealed that general anaesthesia was a significant risk factor for minor and major PPH, but not severe PPH. Although general anaesthesia may be an independent risk factor for all types of PPH, its relationship with severe PPH could be masked by confounding factors such as placenta praevia—in our centre, most women with placenta praevia deliver under general anaesthesia. There is conflicting evidence regarding the association of obesity with severe PPH. A recent study of risk factors for severe PPH demonstrated that obesity was significantly associated with severe PPH (>1500 mL) in pregnant women (both singleton and multiple pregnancies), but the finding was not supported by other epidemiological analyses.[16] Another cohort study indicated that obesity only slightly increased the risk of PPH; the authors speculated that this result was related to the increasing rate of caesarean delivery among women with obesity.[17] However, a large cohort study of 11 363 singleton pregnancies showed an approximate twofold increase in the risk of major PPH (>1000 mL) among women with obesity, independent of the mode of delivery.[18] The authors found that the higher rates of PPH in women with obesity could not be attributed to either major perineal trauma or retained placenta; they suggested that the increased rate of PPH in women with obesity was related to uterine atony.[18] However, our study was not sufficiently powered to analyse the relationship between obesity and uterine atony.

Limitations

Limitations of this study include its retrospective design and the high rate of caesarean delivery in our cohort (75.6%). The high rate of caesarean delivery in twin pregnancies overall may have introduced sufficient bias that caesarean delivery itself was identified as a risk factor for PPH, as demonstrated in our univariate analyses for minor PPH and major PPH. Units with lower caesarean delivery rates in twin pregnancies may have findings that considerably differ from our results. Nevertheless, we believe that other risk factors for major and severe PPH remain valid regardless of the caesarean delivery rate.

Conclusion

Risk factors for severe PPH in twin pregnancies considerably differed from the risk factors identified in singleton pregnancies. In vitro fertilisation, placenta praevia, and maternal obesity were significant risk factors for severe PPH in twin pregnancies. Women with twin pregnancies who have obesity, conception by in vitro fertilisation, or placenta praevia should deliver in obstetric units with readily available blood product transfusions and the appropriate expertise for prompt management of severe PPH by a multidisciplinary team that includes experienced obstetricians, anaesthetists, interventional radiologists, and haematologists.

Author contributions

Concept or design: Both authors.
Acquisition of data: WWK To.
Analysis or interpretation of data: Both authors.
Drafting of the manuscript: CW Kong.
Critical revision of the manuscript for important intellectual content: WWK To.

Both authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

Both authors have disclosed no conflicts of interest.

Funding/support

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics approval

Formal ethics approval for this research was granted by the Kowloon Central/Kowloon East Research Ethics Committee of Hospital Authority, Hong Kong (Ref No.: KC/KE-17-0065/ER-1). Because this was a retrospective study, the requirement for patient consent was waived by the Committee.

References

1. Eriksson AW, Fellman J. Temporal trends in the rates of multiple maternities in England and Wales. Twin Res Hum Genet 2007;10:626-32.
2. Ananth CV, Chauhan SP. Epidemiology of twinning in developed countries. Semin Perinatol 2012;36:156-61.
3. Kramer MS, Berg C, Abenhaim H, et al. Incidence, risk factors, and temporal trends in severe postpartum hemorrhage. Am J Obstet Gynecol 2013;209:449.e1-7.
4. Conde-Agudelo A, Belizán JM, Lindmark G. Maternal morbidity and mortality associated with multiple gestations. Obstet Gynecol 2000;95:899-904.
5. Sheiner E, Sarid L, Levy A, Seidman DS, Hallak M. Obstetric risk factors and outcome of pregnancies complicated with early postpartum hemorrhage: a population-based study. J Matern Fetal Neonatal Med 2005;18:149-54.
6. Suzuki S, Kikuchi F, Ouchi N, et al. Risk factors for postpartum hemorrhage after vaginal delivery of twins. J Nippon Med Sch 2007;74:414-7.
7. Blitz MJ, Yukhayev A, Pachtman SL, et al. Twin pregnancy and risk of postpartum hemorrhage. J Matern Fetal Neonatal Med 2020;33:3740-5.
8. Prevention and management of postpartum haemorrhage: Green-top Guideline No.52 [editorial]. BJOG 2017;124:e106-49.
9. Healy DL, Breheny S, Halliday J, et al. Prevalence and risk factors for obstetric haemorrhage in 6730 singleton births after assisted reproductive technology in Victoria Australia. Hum Reprod 2010;25:265-74.
10. Hayashi M, Nakai A, Satoh S, Matsuda Y. Adverse obstetric and perinatal outcomes of singleton pregnancies may be related to maternal factors associated with infertility rather than the type of assisted reproductive technology procedure used. Fertil Steril 2012;98:922-8.
11. Moini A, Shiva M, Arabipoor A, Hosseini R, Chehrazi M, Sadeghi M. Obstetric and neonatal outcomes of twin pregnancies conceived by assisted reproductive technology compared with twin pregnancies conceived spontaneously: a prospective follow-up study. Eur J Obstet Gynecol Reprod Biol 2012;165:29-32.
12. Bamberg C, Fotopoulou C, Neissner P, et al. Maternal characteristics and twin gestation outcomes over 10 years: impact of conception methods. Fertil Steril 2012;98:95-101.
13. Nyfløt LT, Sandven I, Oldereid NB, Stray-Pedersen B, Vangen S. Assisted reproductive technology and severe postpartum haemorrhage: a case-control study. BJOG 2017;124:1198-205.
14. Sacha CR, Mortimer RM, James K, et al. Placental pathology of term singleton live births conceived with fresh embryo transfer compared with those conceived without assisted reproductive technology. Fertil Steril 2022;117:758-68.
15. Romundstad LB, Romundstad PR, Sunde A, von Düring V, Skjaerven R, Vatten LJ. Increased risk of placenta previa in pregnancies following IVF/ICSI; a comparison of ART and non-ART pregnancies in the same mother. Hum Reprod 2006;21:2353-8.
16. Siddiqui A, Azria E, Howell EA, Deneux-Tharaux C; EPIMOMS Study Group. Associations between maternal obesity and severe maternal morbidity: findings from the French EPIMOMS population-based study. Paediatr Perinat Epidemiol 2019;33:7-16.
17. Butwick AJ, Abreo A, Bateman BT, et al. Effect of maternal body mass index on postpartum hemorrhage. Anesthesiology 2018;128:774-83.
18. Fyfe EM, Thompson JM, Anderson NH, Groom KM, McCowan LM. Maternal obesity and postpartum haemorrhage after vaginal and caesarean delivery among nulliparous women at term: a retrospective cohort study. BMC Pregnancy Childbirth 2012;12:112.