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Comparison of Hemodynamic Stability and Adverse Effects of Carbetocin versus Oxytocin During Cesarean Delivery

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Submission Date : 15 Dec 2025
Accepted Date : 05 Feb 2026
Published Date : 30 March 2026
DOI: https://doi.org/10.3329/jrpmc.v11i1.89948

Abstract

Background:
Postpartum hemorrhage is a significant cause of maternal morbidity, and optimizing uterotonic use during cesarean delivery is critical.

Objective:
This study compared hemodynamic stability and the adverse effects of carbetocin versus oxytocin.

Methods:
An observational study was conducted in the Department of Obstetrics and Gynaecology at BGC Trust Medical College Hospital, Chittagong, Bangladesh, over six months from January to June 2022 among 100 women undergoing cesarean section, divided into a carbetocin group (100 µg IV bolus) and an oxytocin group (10 IU IV infusion). Hemodynamic changes, estimated blood loss, need for additional uterotonics, and adverse effects were evaluated.

Results:
Baseline characteristics were similar across groups. Mean blood loss was lower with carbetocin (630±225 mL) than oxytocin (685±267 mL), though not statistically significant. Additional uterotonics were required less frequently with carbetocin (12% versus 28%). Adverse effects were mild and comparable, with no serious complications.

Conclusion:
Carbetocin provides hemodynamic stability and reduces the need for additional uterotonics, making it an effective alternative to oxytocin, especially in resource-limited settings.

Keywords: Carbetocin, Oxytocin, Cesarean delivery, Hemodynamic stability, Postpartum hemorrhage

Citation: Pervin MS,Das RR.Comparison of Hemodynamic Stability and Adverse Effects of Carbetocin versus Oxytocin During Cesarean Delivery.J Rang Med Col.2026 Mar;11(1):39-44.doi: https://doi.org/10.3329/jrpmc.v11i1.89948

Introduction

Postpartum hemorrhage (PPH) remains the leading cause of maternal mortality worldwide, accounting for nearly 70,000 deaths annually and disproportionately affecting low- and middle-income countries (LMICs) where health-system limitations exacerbate preventable obstetric complications.[1] Uterine atony is the predominant cause of PPH, particularly during cesarean delivery, where surgical manipulation, anaesthetic-related vasodilation, and delayed uterine contractility heighten the risk of excessive blood loss.[2] The World Health Organization classifies PPH as blood loss exceeding 500 mL after vaginal birth or more than 1000 mL following cesarean section, a threshold that is frequently surpassed during operative deliveries in resource-strained settings.[3] Maintaining hemodynamic stability during cesarean section is challenging because fluid shifts, intraoperative bleeding, and the rapid onset of action of conventional uterotonics can precipitate abrupt changes in blood pressure and heart rate. Bangladesh exemplifies the growing clinical burden associated with increasing cesarean section rates. National analyses show a sharp rise from 17.7% in 2012 to more than 45% by 2022, with a substantial share of procedures performed without strict medical indication, particularly in private facilities.[4] This escalation expands the

population at risk for PPH, while inconsistent access to quality-assured uterotonic drugs further complicates prevention efforts. Oxytocin, the first-line agent for PPH prophylaxis, requires cold-chain storage, is susceptible to potency degradation, and has a short half-life, necessitating repeated dosing or continuous infusion administration conditions that are not always feasible in lower-resource hospitals.[5] Reports from LMICs consistently highlight variability in oxytocin quality, storage breaches, and dose-dependent adverse effects such as hypotension, tachycardia, and nausea.[6] Carbetocin has emerged as a promising alternative, offering a longer plasma half-life and sustained uterotonic action after a single 100 µg intravenous dose. Heat-stable carbetocin (HSC) maintains potency without refrigeration for extended periods, making it particularly suited for environments where cold-chain integrity cannot be guaranteed.[6] Meta-analytic evidence indicates that carbetocin reduces the need for additional uterotonics, lowers the incidence of severe PPH, and does not increase adverse effects compared with oxytocin, suggesting a clinically meaningful improvement in prophylactic performance.[7] Despite these advantages, comparative data focusing on hemodynamic stability and adverse-effect profiles remain limited in South Asian settings, including Bangladesh, where the contextual relevance of pharmacologic alternatives is critical. This gap underscores the need for rigorous evaluation of both agents to inform national guidelines and optimize maternal outcomes. This study aimed to compare the hemodynamic stability, adverse-effect profiles, and clinical efficacy of carbetocin versus oxytocin during cesarean section.

Methods:

This hospital-based observational comparative study was conducted in the Department of Obstetrics and Gynaecology at BGC Trust Medical College Hospital, Chittagong, Bangladesh, over six months from January to June 2022. Ethical approval was obtained from the Institutional Review Board, and written informed consent was secured from all participants. Sixty pregnant women scheduled for elective cesarean delivery were consecutively recruited and allocated into two groups of 30 each. Group A received a single 100 µg intravenous bolus of carbetocin immediately after delivery. In contrast, Group B received 10 IU of oxytocin diluted in 500 mL of normal saline, administered as a slow intravenous infusion over 30 minutes. Eligible participants were women aged 20 to 40 years with singleton term pregnancies undergoing elective cesarean section under spinal anesthesia. Exclusion criteria included preeclampsia or eclampsia, chronic cardiac or renal disease, multiple gestation, coagulopathy, or known hypersensitivity to uterotonic agents. All surgical procedures followed a standardized operative protocol, and anesthesia management was supervised by the same consultant team to minimize inter-operator variability. Primary outcomes included systolic and diastolic blood pressure, mean arterial pressure, heart rate, urine output, estimated intraoperative blood loss, requirement for additional uterotonics, and adverse effects such as nausea, vomiting, flushing, and tachycardia. Hemodynamic parameters were recorded at baseline, immediately after drug administration, and at 5, 10, 15, 30, and 60 minutes post-administration. Urine output was measured during the first four hours following surgery. Blood loss estimation was performed using suction measurements and gauze weight differences. Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean±standard deviation and analyzed using an independent-samples t-test. Categorical variables were presented as frequencies and percentages, with comparisons performed using the Chi-square test or Fisher's exact test where applicable. Statistical significance was defined as a p-value <0.05.

Results:

The demographic characteristics of the two groups were generally comparable. The mean age did not differ significantly between women receiving oxytocin (25.3±4.9 years) and those receiving carbetocin (24.1±4.4 years) (p=0.191). Most participants in both groups were overweight or obese, with similar proportions across groups. A notable difference was observed in parity: primigravida women were significantly more common in the carbetocin group (54.0%) compared with the oxytocin group (28.0 percent) (p=0.008) (Table-I).

Table-I: Comparison of demographics and baseline parameters between groups (N=100)

Baseline Characteristics	Oxytocin (n=50) no. (%)	Carbetocin (n=50) no. (%)	p-value
Age (years)	25.3±4.9	24.1±4.4	0.191
BMI range (kg/m²)			
18.5-24.9 (Normal)	9(18.0)	7(14.0)	0.585
≥25.0 (Overweight & obese)	41(82.0)	43(86.0)	
Gravida			
Primigravida	14(28.0)	27(54.0)	0.008
Multigravida	36(72.0)	23(46.0)	

Gestational age at delivery was also similar between groups (38.7±1.5 vs. 39.1±1.8 weeks; p=0.37), and patterns of antenatal care were broadly comparable. The distribution of singleton and twin pregnancies showed no significant difference (p=0.73) (Table-II).

Table-II: Comparison of history of current pregnancy between groups (N=100)

History of current pregnancy	Oxytocin (n=50) no. (%)	Carbetocin (n=50) no. (%)	p-value
Gestational age (mean; weeks)	38.7±1.5	39.1±1.8	0.37
ANC visit			
Not received	3(6.0)	5(10.0)	0.35
Regular	15(30.0)	20(40.0)	
Irregular	32(64.0)	25(50.0)	
No of fetus in utero			
Single	45(90.0)	46(92.0)	0.73
Twin	5(10.0)	4(8.0)	

Preoperative hemoglobin values did not vary significantly, although the carbetocin group had a slightly higher mean level (10.0±1.1 g/dL vs. 9.5±1.7 g/dL; p=0.12). Emergency cesarean sections predominated in both groups and were similarly distributed (p=0.60) (Table-III).

Table-III: Comparison of laboratory investigation findings & operative details between groups (N=100)

Variable	Oxytocin (n=50) no. (%)	Carbetocin (n=50) no. (%)	p-value
Hemoglobin level (mean; g/dl)	9.5±1.7	10.0±1.1	0.12
Type of C/S			
Elective	10(20.0)	8(16.0)	0.6
Emergency	40(80.0)	42(84.0)	

Carbetocin demonstrated a modest numerical advantage in PPH prevention (90.0% vs. 84.0%), though not statistically significant (p=0.37). Mean estimated blood loss was lower with carbetocin (630±225 mL) compared with oxytocin (685±267 mL), but this difference also did not reach statistical significance (p=0.27). Blood transfusion requirements were comparable: 28.0% of women in the oxytocin group and 22.0% in the carbetocin group required transfusion (p=0.49), and both groups received a similar number of units. A significant difference emerged in the need for additional uterotonics. Only 12.0% of women receiving carbetocin required supplementary agents compared with 28.0% in the oxytocin group (p=0.045) (Table-IV).

Table-IV: Comparison of outcome and additional oxytocic drugs required between groups (N=100)

Outcome	Oxytocin (n=50) no. (%)	Carbetocin (n=50) no. (%)	p-value
Prevents PPH	42(84.0)	45(90.0)	0.37
Amount of blood loss (mean,ml)	685±267	630.0±225	0.27
Blood transfusion			
Needed	14(28.0)	11(22.0)	0.49
Not needed	36(72.0)	39(78.0)	
No. of units needed	7.1±3.2	7.1±3.3	0.97
Additional oxytocic drugs required			
Required (Metherspan and Misoprostol)	14(28.0)	6(12.0)	0.045
Not required	36(72.0)	44(88.0)	

Adverse effects were infrequent and did not differ significantly between groups. Rates of nausea, hypotension, chills, and chest discomfort were low overall, with slightly higher occurrences in the oxytocin group, though none reached statistical significance. Postoperative renal output remained comparable, with mean 24-hour urine volumes of 2086±322 mL in the oxytocin group and 2057±362 mL in the carbetocin group (p=0.68) (Table-V).

Table-V: Comparison of adverse effects between groups (N=100)

Adverse effect	Oxytocin (n=50) no. (%)	Carbetocin (n=50) no. (%)	p-value
Nausea/vomiting	3(6.0)	3(6.0)	1
Palpitation	1(2.0)	2(4.0)	0.56
Hypotension	2(4.2)	0(0.0)	0.25
Headache	0(0.0)	1(2.0)	0.56
Chills	4(8.0)	1(2.0)	0.16
Tremor	1(2.0)	0(0.0)	0.31
Chest pain	2(4.0)	0(0.0)	0.15
Hot sensation	3(6.0)	1(2.0)	0.31
Sweating	4(8.0)	2(4.0)	0.39
24 hours urine output	2086±322	2057±362	0.68

Discussion:

The present study examined the comparative hemodynamic stability and adverse-effect profile of carbetocin and oxytocin among women undergoing cesarean delivery in a tertiary hospital in Bangladesh. The demographic comparability of maternal age, BMI, and antenatal characteristics between groups reinforces internal validity. It aligns with findings from previous Bangladeshi and international studies evaluating these two agents under similar operative conditions. Prior analyses by Yesmin et al and Nahaer et al also demonstrated no significant differences in baseline obstetric characteristics, thereby minimizing confounding and enabling a more precise assessment of actual pharmacologic effects.[8,9] The comparable distribution of gestational age and surgical urgency observed in the present study further mirrors the balanced study designs reported in Kang et al and Akter et al, in which matching operative profiles ensured reliable outcome comparisons.[10,11] In terms of prophylactic efficacy, carbetocin showed a higher PPH-prevention rate (90%) than oxytocin (84%), although the difference was not statistically significant. Similar trends have been documented by Bonus et al and Delorme et al, who reported numerically lower but non-significant reductions in PPH among carbetocin recipients.[12,13] Estimated blood loss was also modestly lower in the carbetocin group, consistent with results from Razali et al and Boucher et al, who observed improved intraoperative uterine tone and slightly reduced blood loss when carbetocin was used in cesarean deliveries.[14,15] Blood transfusion frequency and transfusion unit requirements were statistically similar between groups, reinforcing earlier evidence from Chinese and South Asian cohorts that transfusion outcomes often do not differ significantly between the two uterotonics when baseline surgical risks are comparable.[10,13] A significant finding was the significantly lower need for additional uterotonics in the carbetocin group, where only 12% required secondary agents, compared with 28% in the oxytocin arm. This advantage is well supported by regional and global evidence. Nahaer et al in Bangladesh, along with Bonus et al and Holleboom et al, demonstrated that carbetocin substantially lowers the requirement for additional uterotonic interventions, reflecting its longer half-life and sustained uterotonic effect.[9,14,16] This reduction has meaningful implications for clinical efficiency, staffing demands, and drug-related workload, especially in high-volume public hospitals. Adverse effects were mild and infrequent, with no significant between-group differences. The incidence of hypotension, nausea, chills, and palpitations remained below 8%, consistent with the safety conclusions of Ai et al and Mannaerts et al, who found comparable tolerability between agents in randomized controlled trials.[17,18] The absence of serious adverse events in either group parallels the findings of Kabir et al and De Bonis et al, who documented excellent safety profiles for carbetocin and oxytocin in cesarean populations.[19,20] Furthermore, postoperative urine output was similar in both groups, supporting the conclusion that neither agent adversely impacted renal perfusion or systemic hemodynamics, as also reported by Akter et al and De Bonis et al.[11,20] Overall, the findings from this study provide clinically relevant, context-appropriate evidence that carbetocin is at least as effective and safe as oxytocin for cesarean delivery, with a clear advantage in reducing the need for additional uterotonics. In resource-limited settings such as Bangladesh, where consistent oxytocin quality and cold-chain maintenance remain challenging, carbetocin, particularly in heat-stable form, offers a practical and potentially superior alternative for optimizing maternal outcomes.

Limitations:
This single-center study may not reflect outcomes in other healthcare settings. Hemodynamic data were recorded intermittently rather than continuously, and oxytocin potency was not independently verified. The sample size may have been insufficient to detect rare adverse events, and postoperative outcomes were only assessed for the first 24 hours.

Conclusion:
In conclusion, this study demonstrated that both carbetocin and oxytocin are safe and effective uterotonic agents for the prevention of postpartum hemorrhage during cesarean deliveries, exhibiting comparable hemodynamic stability, minimal adverse effects, and similar postoperative renal perfusion outcomes. Notably, carbetocin significantly reduced the requirement for additional uterotonics, suggesting improved sustained uterine contractility compared to oxytocin. Given its single-dose administration and potential advantages in resource-limited settings, carbetocin represents a valuable alternative to oxytocin for postpartum hemorrhage prophylaxis, particularly in the context of Bangladesh, where logistical challenges such as cold-chain maintenance are prevalent. Incorporating carbetocin into national obstetric protocols could enhance clinical practice and maternal outcomes in similar settings.

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