RMJ

Original Article

Cost-Effectiveness of Carbetocin vs Oxytocin for Preventing Postpartum Hemorrhage in Women at High Risk for Postpartum Hemorrhage Undergoing Cesarean Section at Buddhachinaraj Phitsanulok Hospital

Boonchai Nakariyakul[1], Phattharawadee Singfaikaew[2], Waranchit Chomchuen[2], Krittika Nakariyakul[3], Nilawan Upakdee[4]*

[1] Department of Obstetrics and Gynecology, Buddhachinaraj Phitsanulok Hospital, Phitsanulok, Thailand

[2] Pharmacy Program in Pharmaceutical Care, Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok, Thailand

[3] Department of Pharmacy, Buddhachinaraj Phitsanulok Hospital, Phitsanulok, Thailand

[4] Department of Pharmacy Practice, Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok, Thailand

Citation: Nakariyakul B, Singfaikaew P, Chomchuen W, Nakariyakul K, Upakdee N. Cost-effectiveness of carbetocin vs oxytocin for preventing postpartum hemorrhage in women at high risk for postpartum hemorrhage undergoing cesarean section at Buddhachinaraj Phitsanulok Hospital. *Res Med J*. 20XX;XX(X):e275739. doi:10.33165/rmj.2027.e275739

*** Corresponding Author:** nilawanu@nu.ac.th

Received: 30 May 2025
Revised: 2 December 2025
Accepted: 24 December 2025
Published: 28 January 2026

Abstract

Background: Postpartum hemorrhage (PPH) is a serious and dangerous complication following a cesarean section that carries a significant risk of bleeding and can result in shock or death.

Objective: To compare the cost-effectiveness of 100 μg of carbetocin with that of 10 units of oxytocin for the prevention of PPH in women at high risk for PPH undergoing cesarean section.

Methods: A decision tree model was used to assess cost-effectiveness from societal and payer perspectives over a one-year time horizon, using a 3% discount rate and data from hospital records and published studies. Robustness was evaluated using with one-way and probabilistic sensitivity analyses.

Results: From the societal perspective, carbetocin demonstrated a cost saving of ฿828.16 ($25.18) and yielded an incremental gain of 0.04 quality-adjusted life years (QALYs). In contrast, the payer's perspective revealed an additional cost of ฿632.69, with an incremental cost-effectiveness ratio of ฿14 243.20 ($433.14) per QALY gained. Carbetocin was notably more effective in preventing severe PPH, with a prevention rate of 44.4% compared with 16.3% observed with oxytocin. Sensitivity analysis identified treatment response as the most influential factor in the economic model.

Conclusions: Carbetocin is a cost saving and clinically effective option for managing PPH in women at high-risk for PPH undergoing cesarean section. Its performance remains within the acceptable willingness-to-pay threshold established by Thai context (฿160 000 per QALY), making it a viable candidate for broader policy inclusion.

Keywords: Cost-effectiveness, Postpartum hemorrhage, Carbetocin, Oxytocin, Cesarean section

Introduction

Postpartum hemorrhage (PPH) represents a major challenge in obstetric care and is defined as blood loss exceeding 500 mL after vaginal delivery over 1000 mL following

cesarean section within 24 hours.[1, 2] Such bleeding can lead to severe anemia, hypovolemic shock, or even maternal death.[3, 4] PPH typically results from uterine atony, retained placental tissue, trauma to the genital tract, or coagulation disorders, with uterine atony being the most common cause. Globally, the World Health Organization estimates that approximately 70 000 maternal deaths each year are attributable to PPH, accounting for nearly one-fifth of all maternal fatalities.[3, 5] In Thailand, PPH caused 49 maternal deaths in 2022, representing 22% of all maternal deaths,[6] and Buddhachinaraj Phitsanulok Hospital reported a 3.5% incidence among total deliveries. Although oxytocin remains the standard uterotonic agent for PPH prevention, emerging evidence indicates that carbetocin may offer greater effectiveness, particularly in women at high risk for PPH undergoing cesarean section.

Clinical studies have shown that carbetocin reduces the risk of PPH ≥ 500 mL than oxytocin (risk ratio, 0.72; 95% CI, 0.52-1.00) and is effective in preventing PPH ≥ 1000 mL compared with no treatment.[7] Despite these advantages, carbetocin is not listed on Thailand's National Essential Medicines List, leading to inconsistent use across health facilities.[8]

This study was conducted to address the gap in economic evidence regarding the use of carbetocin in Thailand. It compared the cost-effectiveness of 100 μg of carbetocin with that of 10 units of oxytocin for the prevention of PPH in women at high-risk for PPH undergoing cesarean section. Women at high-risk for PPH were defined as those with at least one recognized risk factor for PPH, including more than 2 previous cesarean sections, a prior history of PPH, administration of tocolytic agents within 4 hours before delivery, prolonged labor exceeding 12 hours, precipitated labor, grand multiparity (parity ≥ 4), polyhydramnios, uterine fibroids, twin pregnancy, and maternal complications such as pregnancy-induced hypertension, liver disease, placenta previa, coagulation disorders, or placental abruption. The findings of this study are intended to inform national drug formulary decisions and guide future maternal health policy.[9]

Methods

Study Design

This study employed a cost-effectiveness analysis to compare carbetocin and oxytocin for the prevention of PPH, defined as blood loss exceeding 1000 mL after cesarean delivery, in women at high risk for PPH undergoing cesarean section. A high-risk status was defined as having at least one major PPH risk factor, including multiple previous cesarean sections, a prior history of PPH, recent tocolytic use, prolonged or precipitous labor, grand multiparity, polyhydramnios, uterine fibroids, twin pregnancy, or maternal complications such as pregnancy-induced hypertension, placenta previa, coagulopathy, liver disease, or placental abruption. The analysis incorporated societal and healthcare payer perspectives, considering a one-year time frame and applying a 3% annual discount rate.

Research Tools and Inputs

The decision tree model was adapted from a previously published Colombian cost-effectiveness study[10] and modified to reflect clinical practice in Thailand (Figure 1). The model began with women at high risk for PPH undergoing cesarean section, defined as those with at least one established risk factor, including more than 2 previous cesarean sections, a prior history of PPH, recent use of tocolytic agents within 4 hours before delivery, prolonged labor (≥ 12 hours), precipitated labor, grand multiparity (parity ≥ 4),

polyhydramnios, uterine fibroids, twin pregnancy, and maternal complications such as pregnancy-induced hypertension, liver disease, placenta previa, coagulopathy, or placental abruption. Prophylactic uterotonics were administered according to routine practice: women with a single risk factor received 10 units of oxytocin via intravenous (IV) bolus or infusion, whereas those with 2 or more risk factors received 100 μg of carbetocin as a single IV dose. The first branch of the model determined whether PPH occurred. If no PPH developed, the pathway was terminated. If PPH occurred, management followed standard clinical protocols. First-line treatment involved additional doses of oxytocin or carbetocin. If bleeding persisted, second-line additional medical therapy was administered, including ergometrine 0.2 mg (1 mL of a 0.2 mg/mL solution) via intramuscular or IV injection or rectal misoprostol 800-1000 μg (4-5 tablets of 200 μg). When indicated, 1-2 units of packed red cells (PRC) were transfused. Failure to respond to pharmacologic therapy prompted surgical interventions, including balloon tamponade or hysterectomy, depending on clinical severity. All pathways and model assumptions were reviewed and validated by obstetrician, pharmacist and health economist. The decision-tree model was constructed and analyzed using Excel version 2021 (Microsoft Corp).

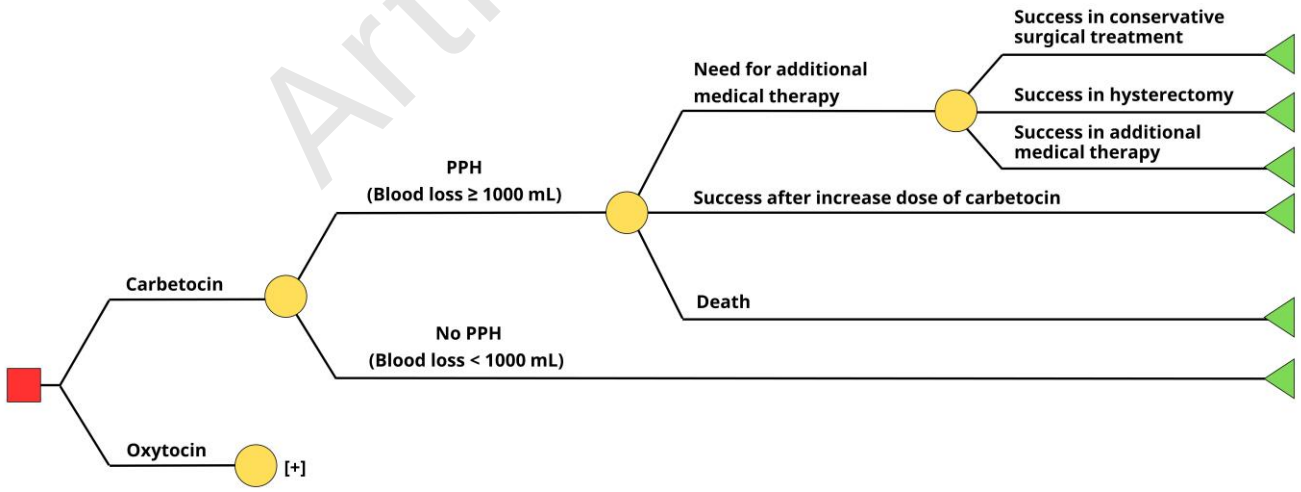
Model Assumptions

All women who were unresponsive to the initial treatment were assumed to follow standard escalation protocols. When a pregnant woman did not respond to carbetocin or oxytocin treatment, supplementary medications were administered.

Probability Inputs

Clinical probabilities, such as treatment success rates and complication frequencies, were derived from hospital records from 2020 to 2023. These probabilities were stratified by treatment type and adjusted as needed to address data limitations, including zero-event occurrences (Table 1).

Figure 1. Decision Tree Model for Postpartum Hemorrhage in Women Undergoing Cesarean Section



Abbreviation: PPH, postpartum hemorrhage.

Note: For oxytocin pathway is as above of carbetocin [+].

Cost Data Inputs

Direct medical costs included drug acquisition, additional treatments, and surgical procedures. Additional therapy costs included ergometrine 1 mL, misoprostol 800 µg, and 1-2 units of PRC. Direct nonmedical costs (eg, transportation and food) were drawn from the national standards cost list. Indirect costs capture productivity loss due to hospitalization. All figures were updated to 2024 values using Thailand's Consumer Price Index for healthcare and household expenditures (Table 1).

Utility Values

Health-related quality of life was quantified using utility values ranging from 0 (death) to 1 (perfect health).[11] The utility data for this study were gathered from literature reviews,[12] primarily derived from EQ-5D-5L datasets adapted for Thailand. In cases of no data in that health state, estimates were supported by expert opinion (Table1).

Table 1. Input Parameters Used in the Analysis for Cesarean Section

Parameter	Value	SE	Distribution	Source
Probability				
Treatment with carbetocin				
Probability of blood loss < 1000 mL after carbetocin	0.4442	0.0453	Beta	Hospital database
Probability of blood loss ≥ 1000 mL after carbetocin with survival	0.5558	0.0567	Beta	Hospital database
Probability of blood loss ≥ 1000 mL with survival but requiring additional medical therapy	0.5558	0.0567	Beta	Hospital database
Probability of blood loss ≥ 1000 mL with survival, nonresponse to dose escalation, and failure of additional medical therapy, requiring uterine artery ligation or balloon tamponade	0.0010	0.0001	Beta	Hospital database
Probability of blood loss ≥ 1000 mL with survival, nonresponse to dose escalation, and failure of additional medical therapy, with successful control of bleeding following hysterectomy	0.0108	0.0011	Beta	Hospital database
Probability of blood loss ≥ 1000 mL and survival, responsive to additional therapy	0.9883	0.0532	Beta	Hospital database
Treatment with oxytocin				
Probability of blood loss < 1000 mL after oxytocin	0.1630	0.0166	Beta	Hospital database
Probability of blood loss ≥ 1000 mL after oxytocin with survival	0.8370	0.0840	Beta	Hospital database
Probability of blood loss ≥ 1000 mL with survival but requiring additional medical therapy	0.8370	0.0840	Beta	Hospital database
Probability of blood loss ≥ 1000 mL with survival, nonresponse to dose escalation, and failure of additional medical therapy, requiring uterine artery ligation or balloon tamponade	0.0010	0.0001	Beta	Hospital database

Table 1. Input Parameters Used in the Analysis for Cesarean Section (Continued)

Parameter	Value	SE	Distribution	Source
Probability of blood loss ≥ 1000 mL with survival, nonresponse to dose escalation, and failure of additional medical therapy, with successful control of bleeding following hysterectomy	0.0100	0.0010	Beta	Hospital database
Probability of blood loss ≥ 1000 mL and survival, responsive to additional therapy	0.9890	0.0530	Beta	Hospital database
Direct medical costs, ฿				
Cost of carbetocin	756.7040	185.6122	Gamma	CGD, Hospital database
Cost of oxytocin	91.8060	153.9490	Gamma	CGD, Hospital database
Cost of additional therapy (ergometrine 1 mL, misoprostol 800 µg, 1-2 units of PRC) following carbetocin	326.3660	70.5954	Gamma	CGD, Hospital database
Cost of additional therapy (ergometrine 1 mL, misoprostol 800 µg, 1-2 units of PRC) following oxytocin	252.9620	28.9286	Gamma	CGD, Hospital database
Cost of surgical intervention (balloon tamponade, uterine artery ligation)	13 233.3300	2793.3673	Gamma	Hospital database
Cost of hysterectomy	15 933.3300	1549.7449	Gamma	Hospital database
Direct nonmedical costs, ฿				
Transportation cost	327.400	33.3482	Gamma	Standard cost list
Food cost	73.9500	7.5459	Gamma	Standard cost list
Indirect costs, ฿				
Opportunity cost of work for patients due to hospitalization	345.00	35.2041	Gamma	Standard cost list
Utility values				
Utility of cesarean section without PPH	0.8300	0.0200	Beta	Brinones et al,[12] 2020
Utility of PPH with death after primary treatment	0.0000	0.0000	Beta	Brinones et al,[12] 2020
Utility of PPH with survival after primary treatment	0.6700	0.1500	Beta	Brinones et al,[12] 2020
Utility of PPH with additional therapy	0.6700	0.1500	Beta	Brinones et al,[12] 2020
Utility of PPH with surgical intervention (balloon tamponade or uterine artery ligation)	0.5800	0.0586	Beta	Brinones et al,[12] 2020
Utility of PPH with hysterectomy	0.5000	0.0510	Beta	VAS, Expert opinion

Abbreviations: CGD, Comptroller General's Department; PPH, postpartum hemorrhage; PRC, packed red cells; SE, standard error; VAS, visual analog scale.

Analyses

The incremental cost-effectiveness ratio (ICER) was computed as follows: ICER = $(C_A - C_B) / (U_A - U_B)$; where C_A = the expected cost of carbetocin treatment, C_B = the expected cost of oxytocin treatment, U_A = the expected utility of carbetocin treatment, and U_B = the expected utility of oxytocin treatment.

Sensitivity Analysis

A one-way sensitivity analysis was conducted to assess the influence of each parameter on the results, which was visualized using tornado diagrams. A probabilistic sensitivity analysis was also performed using Monte Carlo simulations (1000 iterations), applying

beta, gamma, and log-normal distributions for probabilities, costs, and effectiveness, respectively. The results were plotted on a cost-effectiveness plane to evaluate overall model stability.

Results

Base-Case Analysis

From a societal perspective, carbetocin administration resulted in a total treatment cost of ฿2807.00, compared with ฿3635.16 for oxytocin. This translates to a cost saving of ฿828.16 ($25.18). In terms of clinical effectiveness, patients who received carbetocin experienced a gain of 0.04 quality-adjusted life years (QALYs) over those who received oxytocin. Consequently, carbetocin was classified as a dominant strategy. From this perspective, it was more effective and less costly (Table 2).

From a payer's perspective, carbetocin incurred a higher direct medical cost of ฿910.44 compared with ฿277.75 for oxytocin. Nevertheless, the ICER was calculated at ฿14 243.20 per QALY gained (approximately $433.14), which is well below Thailand's threshold of ฿160 000 per QALY. These findings suggest that despite its higher acquisition cost, carbetocin continues to be a cost-effective option for women at high risk for PPH undergoing cesarean section (Table 3).

Sensitivity Analysis

A one-way sensitivity analysis was conducted to evaluate the model's robustness by assessing how changes in individual parameters influence the results. This approach helps identify the variables with the greatest impact on cost-effectiveness and ensures that the conclusions remain consistent across plausible uncertainty ranges. The outcomes of these analyses were determined (Figures 2 and 3). The utility value for cesarean section without PPH was the most influential parameter affecting incremental QALYs and costs. Additionally, varying the probability of PPH with nonresponse to initial treatment and requiring further intervention from 0.4446 to 0.6669 produced notable changes in the model's outcomes. These findings indicate the parameters to which the model is most sensitive and therefore require careful consideration in clinical and policy contexts. The main conclusions remain stable even when key inputs vary within reasonable ranges, supporting the model's credibility and demonstrating that the cost-effectiveness of carbetocin holds across plausible clinical scenarios.

Table 2. Incremental Cost-Effectiveness Ratio Analysis From a Societal Perspective

Variable	Carbetocin	Oxytocin
Total cost, ฿	2807.00	3635.16
Effectiveness, QALYs	0.74	0.70
Incremental cost, ฿	-828.16	
Incremental effectiveness, QALYs	0.04	
ICER, ฿ per QALY gained	Cost saving (dominant)	

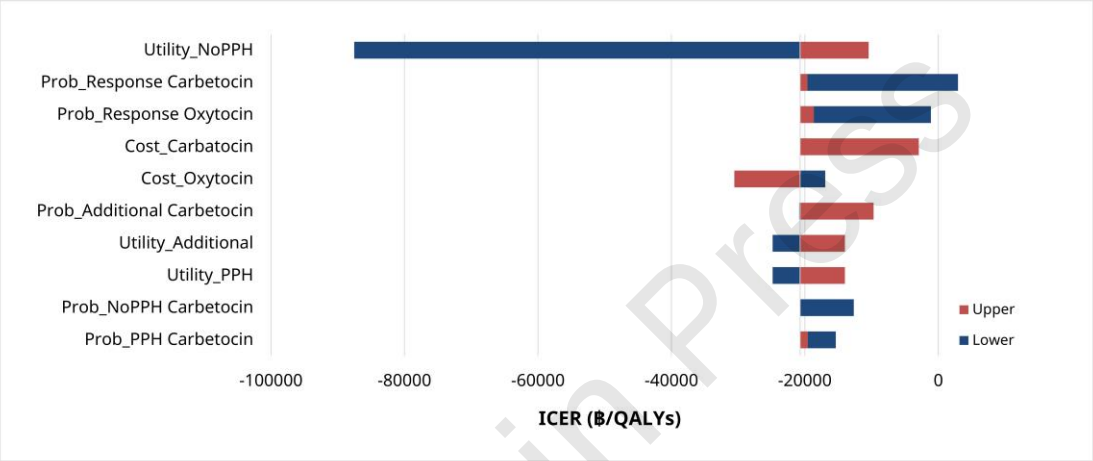
Abbreviations: ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years.

Table 3. Incremental Cost-Effectiveness Ratio From a Payer's Perspective

Variable	Carbetocin	Oxytocin
Total cost, ฿	910.44	277.75
Effectiveness, QALYs	0.74	0.70
Incremental cost, ฿	632.69	
Incremental effectiveness, QALYs	0.04	
ICER, ฿ per QALY gained	14 243.20	

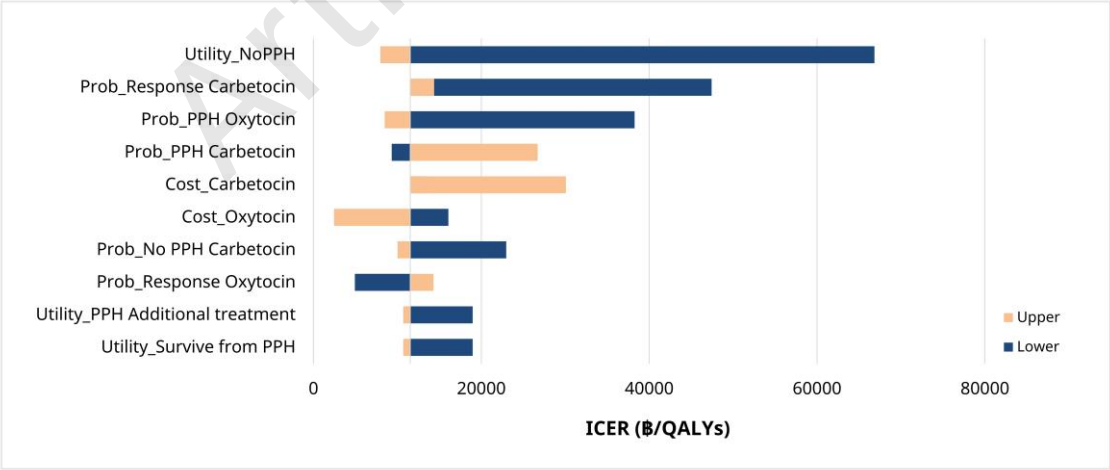
Abbreviations: ICER, incremental cost-effectiveness ratio; QALYs, quality-adjusted life years.

Figure 2. One-Way Sensitivity Analysis of Carbetocin vs Oxytocin for Societal Perspective



Abbreviations: ICER, incremental cost-effectiveness ratio; PPH, postpartum hemorrhage; QALYs, quality-adjusted life years.

Figure 3. One-way Sensitivity Analysis of Carbetocin vs Oxytocin for Payer's Perspective

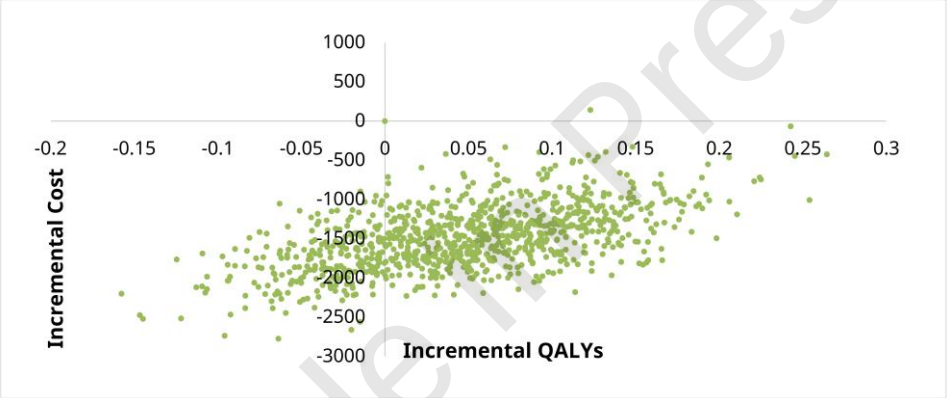


Abbreviations: ICER, incremental cost-effectiveness ratio; PPH, postpartum hemorrhage; QALYs, quality-adjusted life years.

A scatter plot from a societal perspective showed the distribution of incremental costs and QALYs for carbetocin compared with that for oxytocin (Figure 4). A scatter plot displays several individual points to show how results vary across different simulations, allowing readers to see the uncertainty range and pattern in the analysis. Most points appear in the lower-right quadrant of the cost saving plane. This means that carbetocin provides more health benefits (higher QALYs) at a lower cost than oxytocin. When an intervention offers better outcomes while costing less, it is considered dominant, meaning it is cost-effective compared with the alternative.

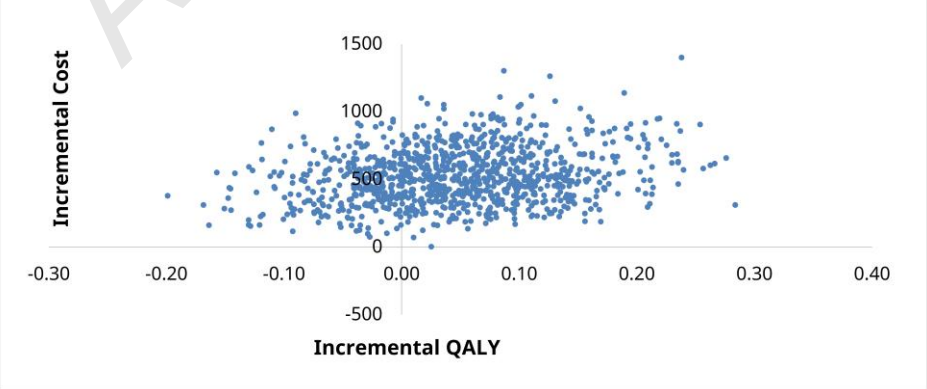
The incremental costs and QALYs for carbetocin compared with those for oxytocin from the payer's perspective were analyzed (Figure 5). Most points appear in the upper-right quadrant, indicating that carbetocin is associated with higher costs and greater health benefits. In this context, its cost-effectiveness depends on whether the additional improvement in QALYs justifies the higher cost relative to the willingness-to-pay threshold.

Figure 4. Probabilistic Sensitivity Analysis of Carbetocin vs Oxytocin From a Societal Perspective



Abbreviation: QALYs, quality-adjusted life years.

Figure 5. Probabilistic Sensitivity Analysis of Carbetocin vs Oxytocin From a Payer's Perspective



Abbreviation: QALYs, quality-adjusted life years.

Discussion

The findings of this study reinforce the growing body of evidence that supports carbetocin as a superior alternative to oxytocin for the prevention of PPH,[15] particularly in women at high risk for PPH undergoing cesarean section. Its enhanced effectiveness is demonstrated through a considerable reduction in the need for additional uterotonics, with a reported reduction of 20.0% compared with 36.7% in the oxytocin group.[16] Additionally, carbetocin recipients experienced lower average blood loss by mean difference at 53.13 (95% CI, 127.35-21.08).[16] From an economic standpoint, carbetocin is cost-effective in the Thai healthcare setting. Despite higher upfront costs, its clinical benefits yield favorable outcomes from societal and payer perspectives. The ICER of ฿14 243.20 per QALY falls well below the national threshold of ฿160 000 per QALY, reinforcing its viability for broader policy adoption. These results are consistent with those of other international studies. For instance, Gil-Rojas et al[10] reported cost savings of Col$ 94 887 in Colombia. Similar trends have been noted in China (total direct cost $161 per birth)[13] and the United Kingdom (total cost savings of £5495).[14] However, Briones et al[12] presented contrasting results from the Philippines, citing an ICER of $13 187 per QALY, indicating a lower level of cost-effectiveness from a societal perspective.

This study tested 3 key hypotheses. First, carbetocin would be more clinically effective than oxytocin in preventing severe PPH, which was confirmed by the significantly lower incidence of blood loss > 1000 mL in the carbetocin group.[16] Second, carbetocin would be more cost-effective than oxytocin, supported by a cost saving of ฿828.16 from a societal perspective and a highly favorable ICER from a payer's perspective. Third, sensitivity analyses confirmed the robustness of these conclusions, with probabilistic simulations consistently favoring carbetocin in cost-effectiveness comparisons.[10, 17]

When compared with those of previous international studies, the findings of this analysis provide a coherent and consistent pattern of evidence supporting the value of carbetocin. Similar reductions in blood loss and postoperative use of uterotonics have been reported in Colombia, China, and the United Kingdom, all of which demonstrated favorable economic outcomes despite higher acquisition costs. The divergent results observed in the Philippines highlight the influence of contextual factors such as health system costs and clinical practice patterns. The integration of these data suggests that the advantages of carbetocin are most evident in settings with comparable risk profiles and resource structures, reinforcing the relevance of our findings to the Thai context.

It is also important to consider patient-related factors that may have influenced the observed outcomes. In our setting, carbetocin is administered only to women presenting with 2 or more high-risk factors for PPH, resulting a greater baseline severity and a higher likelihood of complications. These characteristics may contribute to increased procedural complexity or the need for additional therapeutic interventions. Decisions regarding second-line uterotonics and surgical management were made based on the clinical judgment of the attending obstetrician. Importantly, the prescription of carbetocin in the study hospital is restricted to specialist obstetricians, thereby minimizing variability related to surgeon experience and reducing the likelihood that operator-related factors affected the differences between groups.

The limitations of this study include the reliance on retrospective hospital data, which may affect the completeness and accuracy of the information and limit the generalizability of the findings to other settings. Additional limitations include the need to use assumed values for several zero-event parameters during sensitivity analyses,

which may influence estimate precision. Utility values were sourced from international literature and were reviewed by Thai clinical experts to improve their contextual relevance. Future research incorporating prospective, multicenter data and real-world cost information would strengthen the robustness and applicability of future economic evaluations in this area.

Conclusions

Carbetocin demonstrated both clinical and economic superiority over oxytocin in preventing PPH in women at high risk for PPH undergoing cesarean section. It not only delivers better health outcomes but also represents a cost saving measure from a societal perspective and a cost-effective choice from a payer's perspective. These findings support its inclusion in national treatment protocols and essential drug formularies, especially in settings where maternal health risks are high. As healthcare systems in Thailand continue to evolve, incorporating such value-based practices will be critical for improving maternal outcomes while ensuring economic sustainability.

Additional Information

Acknowledgments: We acknowledge the contributions of Nattaphat Setthakunwat, who helped with study coordination. This work was conducted as part of an undergraduate thesis in the Pharmacy Program in Pharmaceutical Care, Faculty of Pharmaceutical Sciences, Naresuan University, Phitsanulok, Thailand.

Ethics Approval: The study protocol received ethical approval from the Human Research Ethics Committee of Buddhachinaraj Phitsanulok Hospital, Phitsanulok (No. 045-2567 on 25 April 2024) and Naresuan University, Phitsanulok (No. 183/2024 on 10 June 2024).

Financial Support: This study was supported by a grant from the Faculty of Pharmaceutical Sciences, Naresuan University (P-033/2567, Phattharawadee Singfaikaew and Waranchit Chomchuen).

Clinical Trial Consideration: This study does not report on a clinical trial.

Conflict of Interest: The authors declare no conflict of interest.

Author Contributions:
Conceptualization: Boonchai Nakariyakul, Nilawan Upakdee
Data Curation: Phattharawadee Singfaikaew, Waranchit Chomchuen, Nilawan Upakdee
Formal Analysis: Phattharawadee Singfaikaew, Waranchit Chomchuen, Nilawan Upakdee
Funding Acquisition: Phattharawadee Singfaikaew, Waranchit Chomchuen
Investigation: Boonchai Nakariyakul, Nilawan Upakdee
Methodology: All authors
Resources: Krittika Nakariyakul
Visualization: Sitang Philom
Writing – Original Draft: Krittika Nakariyakul, Nilawan Upakdee
Writing – Review & Editing: Boonchai Nakariyakul, Phattharawadee Singfaikaew, Krittika Nakariyakul, Nilawan Upakdee

References

1. Mavrides E, Allard S, Chandraharan E, et al. Prevention and management of postpartum haemorrhage. *BJOG*. 2016;124:e106-e149. doi:10.1111/1471-0528.14178
2. The Royal Thai College of Obstetricians and Gynaecologists. Clinical Practice Guideline: Prevention and management of postpartum hemorrhage. 20 March 2020. Accessed 2 December 2025. https://www.rtcog.or.th/photo/cpg/OB-63-020_summary.pdf
3. World Health Organization. A roadmap to combat postpartum hemorrhage between 2023 and 2030. 31 March 2024. Accessed 2 December 2025. https://iris.who.int/bitstream/handle/10665/373221/9789240081802-eng.pdf
4. Chongsomchai C. Postpartum hemorrhage, PPH. *Srinagarind Med J*. 2010;25(Suppl):151-158.
5. World Health Organization. Evaluating the quality of care for severe pregnancy complications. Update 8 January 2016. Accessed 2 December 2025. https://www.who.int/publications/i/item/9789241502221
6. DoH Dashboard. Maternal mortality rate. Department of Health, Ministry of Public Health; 2022. Accessed 2 December 2025. https://dashboard.anamai.moph.go.th/dashboard/mmr/index?year=2022
7. Gallos ID, Williams HM, Price MJ, et al. Uterotonic agents for preventing postpartum hemorrhage: a network meta-analysis. *Cochrane Database Syst Rev*. 2018;4(4).CD011689. doi:10.1002/14651858.CD011689.pub2
8. National Drug System Development Committee. *National List of Essential Medicines B.E. 2565 (2022)*. Royal Thai Government Gazette. 2022;139(Special Part 182Ng):11. Published 5 August 2022. Accessed 2 December 2025. https://www.ratchakitcha.soc.go.th/DATA/PDF/2565/E/182/T_0011.PDF
9. Gong J, Chen Z, Zhang Y, et al. Risk-factor model for postpartum hemorrhage after cesarean delivery: a retrospective study based on 3498 patients. *Sci Rep.* 2022;12(1):22100. doi:10.1038/s41598-022-23636-5
10. Gil-Rojas Y, Lasalvia P, Hernández F, Castañeda-Cardona C, Rosselli D. Cost-effectiveness of carbetocin versus oxytocin for prevention of postpartum hemorrhage resulting from uterine atony in women at high-risk for bleeding in Colombia. *Rev Bras Ginecol Obstet*. 2018;40(5):242-250. doi:10.1055/s-0038-1655747
11. Health Intervention and Technology Assessment Program, Ministry of Public Health. *A guide to health technology assessment for Thailand*. The Graphico Systems Co, Ltd; 2009. https://www.hitap.net/th/document/health-technology-assessment-manual-thailand
12. Briones JR, Talungchit P, Thavorncharoensap M, Chaikledkaew U. Economic evaluation of carbetocin as prophylaxis for postpartum hemorrhage in the Philippines. *BMC Health Serv Res*. 2020(1);20:975. doi:10.1186/s12913-020-05834-x
13. You JHS, Leung TY. Cost-effectiveness analysis of carbetocin for prevention of postpartum hemorrhage in a low-burden high-resource city of China. *PLoS One*. 2022;17(12): e0279130. doi:10.1371/journal.pone.0279130
14. Matthijsse S, Andersson FL, Gargano M, Yip Sonderegger YL. Cost-effectiveness analysis of carbetocin versus oxytocin for the prevention of postpartum hemorrhage following vaginal birth in the United Kingdom. *J Med Econ*. 2022;25(1):129-137. doi:10.1080/13696998.2022.2027669
15. El Behery MM, El Sayed GA, El Hameed AA, Soliman BS, Abdelsalam WA, Bahaa A. Carbetocin versus oxytocin for prevention of postpartum hemorrhage after cesarean delivery in high-risk women: a randomized open-label trial. *J Matern Fetal Neonatal Med*. 2016;29(8):1257-1260. doi:10.3109/14767058.2015.1043882
16. Sudjai D, Thambumroong S. Prophylaxis post-cesarean hemorrhage using carbetocin versus oxytocin in high-risk women: a double-blind randomized controlled trial. *J Med Assoc Thai*. 2022;105(6):498-504. doi:10.35755/jmedassocthai.2022.06.13318
17. Arif N, Tahir UA, Aftab K, Rasheed T, Chandio K. Efficacy and safety of carbetocin in prevention of postpartum hemorrhage. *Pakistan Journal Medical & Health Sciences*. 2023;17(2):734-737. doi:10.53350/pjmhs2023172734