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Prevention And Management Of Postpartum Haemorrhage, Comparing The Efficacy Of Different Uterotonics Or The Use Of Balloon Tamponade

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Abstract

Postpartum haemorrhage (PPH) remains a leading cause of maternal morbidity and mortality worldwide. Prevention and prompt, evidence-based management are essential to reduce deaths and long-term complications. Active management of the third stage of labour with a uterotonic immediately after birth is the cornerstone of prevention. When PPH occurs, a tiered response—additional uterotonics, tranexamic acid, uterine balloon tamponade (UBT), and, if needed, surgical/hysterectomy interventions—can be life-saving. This article reviews current evidence comparing commonly used uterotonics (oxytocin, carbetocin, misoprostol, ergometrine) for prevention and first-line treatment, summarizes the role of tranexamic acid as an adjunct, and examines the effectiveness and appropriate use of uterine balloon tamponade (Bakri, condom/ESM-UBT and other balloons) as a temporizing or definitive measure. Key randomized trials, systematic reviews, and guideline recommendations are synthesized to provide practical recommendations for clinicians and health systems.

Keywords: Prevention and management of postpartum haemorrhage, efficacy, uterotonics, balloon tamponade

1. Introduction

Postpartum haemorrhage—commonly defined as blood loss ≥500 mL after vaginal birth or ≥1000 mL after cesarean delivery (or blood loss causing hemodynamic instability)—is responsible for a substantial portion of maternal deaths, especially in low- and middle-income countries. Prevention through routine use of an effective uterotonic during the third stage of labour (active management) reduces PPH incidence; however, some women still experience severe bleeding that requires escalation of care. Over the past decade the evidence base expanded to include large randomized trials comparing agents (e.g., oxytocin versus heat-stable carbetocin), multiple systematic reviews, and robust data on tranexamic acid and uterine balloon tamponade devices. This review focuses on comparative efficacy, safety, operational issues (cold chain, administration route), and the place of balloon tamponade in modern PPH algorithms.

2. Uterotonics for prevention and first-line management

Oxytocin — the standard first choice

Oxytocin (10 IU IV/IM) is universally recommended as the first-line uterotonic for PPH prevention during the third stage of labour because of its strong evidence base for reducing blood loss and its relatively favorable side-effect profile. Most international guidelines (WHO and other national bodies) continue to endorse oxytocin as the uterotonic of choice when quality-assured oxytocin with an unbroken cold chain is available. Operational limitations: oxytocin requires refrigeration and is temperature-sensitive, which complicates distribution in low-resource settings.

Carbetocin — effective and heat-stable alternative

Carbetocin is a long-acting oxytocin analogue. The CHAMPION trial and subsequent analyses showed single-dose carbetocin (including a heat-stable formulation) is non-inferior to multiple-dose oxytocin infusions for preventing PPH after vaginal birth and cesarean delivery, and may reduce the need for additional uterotonics in some settings. Heat-stable carbetocin is an attractive alternative where cold chain is unreliable; however, cost and availability remain considerations for many health systems. Several more recent trials and reviews report lower requirement for additional uterotonics and less blood loss with carbetocin in cesarean deliveries, but guideline endorsement varies by resource setting and cost-effectiveness analyses.

Misoprostol — a pragmatic option where injectables are limited

Misoprostol (oral, sublingual, or rectal) is a prostaglandin E1 analogue that induces uterine contraction and is thermostable, inexpensive, and easy to administer. It is less effective than oxytocin at preventing severe PPH in some studies but remains a pragmatic alternative in community or low-resource settings where oxytocin or carbetocin are unavailable or the cold chain is unreliable. Misoprostol has a higher side-effect profile (shivering, pyrexia, diarrhea) but can be life-saving when parenteral uterotonics are not feasible.

Ergometrine and oxytocin-ergometrine combinations

Ergometrine (methylergometrine) causes strong uterine contraction but has more cardiovascular side effects (hypertension, nausea). Where used, it is often combined with oxytocin (e.g., Syntometrine) to enhance haemostatic effect. For women with pre-eclampsia or hypertension, ergometrine is relatively contraindicated. Several guideline reviews show benefits in reducing blood loss but caution on safety and monitoring.

Comparative efficacy — what the evidence shows

- **Prevention (routine prophylaxis):** Oxytocin remains the uterotonic of choice where available and properly stored. Heat-stable carbetocin is non-inferior to oxytocin and may reduce need for additional uterotonics, especially after cesarean delivery, making it an excellent option in settings without reliable cold chain. Misoprostol is inferior to oxytocin for preventing severe PPH but is useful where oxytocin/carbetocin are not feasible.
- **Treatment (first-line after PPH onset):** High-dose or repeated oxytocin, addition of second-line uterotonics (ergometrine, carboprost where available), and misoprostol (as adjunct) remain standard. Evidence supports carbetocin for prophylaxis more than as a rescue agent; cost and availability limit its universal adoption.

Tranexamic acid (TXA) as an essential adjunct

Tranexamic acid, an antifibrinolytic agent, does not replace uterotonics but reduces bleeding-related mortality when administered early in PPH. The WOMAN trial established that TXA given within 3 hours of birth reduces death due to bleeding; subsequent systematic reviews and guideline updates reaffirm early TXA (1 g IV, repeat once if needed) as part of PPH management. The mortality benefit is time-sensitive—earlier administration yields better outcomes. TXA is inexpensive, widely available, and safe in the obstetric population.

3. Uterine balloon tamponade (UBT): role, devices, and evidence

Mechanism and common devices

UBT achieves haemostasis by applying intrauterine pressure to tamponade bleeding (mostly effective for atonic uterus and some localized bleeding). Devices include the commercially available Bakri balloon, Sengstaken-Blakemore-style balloons, and low-cost options such as condom catheter balloon (often used in ESM-UBT packages). UBT can be inserted at bedside and inflated with saline; it is considered a temporizing or definitive measure depending on cause and context. PMC+1

Efficacy evidence: systematic reviews and trials

Meta-analyses and observational studies report success rates for UBT in controlling PPH in the range of ~80–90% overall, with some heterogeneity by device, cause of bleeding, and setting. Recent randomized evidence, however, has nuanced the interpretation:

- **Trials:** A notable randomized clinical trial (Rozenberg et al., 2023) found that *early* use of IUBT (combined with second-line uterotonics) did **not** reduce incidence of severe PPH compared with its use after failure of second-line uterotonics. This suggests timing and patient selection matter—UBT may not prevent progression to severe PPH if used too early in a population that would not have progressed, and its greatest value may be **after** failure of pharmacologic measures to avoid invasive surgery. ScienceDirect
- **Systematic reviews and real-world data:** Aggregated studies show high success rates (e.g., pooled estimates around 85.9% in some meta-analyses) and strong survival benefits in low-resource settings when UBT is used as part of a structured PPH package (ESM-UBT). Low-cost UBT solutions (condom-catheter) have been particularly impactful where commercial devices are not available.

4. Practical insights from the evidence

- UBT is **highly useful** when atonic PPH persists despite uterotonics and TXA (or when surgery is not immediately available).
- The **timing** of insertion should be individualized: routine early insertion in all PPH may not reduce severe outcomes versus staged escalation; however, early insertion *after* reasonable pharmacologic attempts fail can avoid laparotomy or hysterectomy in many cases.
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5. Comparative summary: uterotonics vs balloon tamponade

1. **Purpose and level in the algorithm:** Uterotonics are a **preventive and first-line therapeutic** strategy (administered prophylactically and escalated in dose/number after PPH onset). UBT is a **mechanical second-/third-line** therapy used when pharmacologic measures are insufficient or when rapid surgical transfer is impractical.
2. **Efficacy:** For prevention, oxytocin (or heat-stable carbetocin where indicated) is best supported by guidelines and trials. For established PPH refractory to uterotonics, UBT achieves haemostasis in a large proportion of cases (~80–90% in many series), reducing the need for immediate surgery in many settings. Randomized data suggest UBT's optimal impact is after failure of second-line uterotonics rather than indiscriminate early use.
3. **Resource/operational considerations:** Misoprostol and condom-catheter UBT are important in low-resource settings. Heat-stable carbetocin solves the cold-chain problem but may be costlier. Widespread availability of TXA and basic UBT kits is a high-value investment for health systems.

6. Practical algorithmic approach (concise)

1. **Prevention (routine care):** Active management of third stage with oxytocin 10 IU IM/IV (or heat-stable carbetocin where cold chain unavailable and cost allows). Ensure uterotonic stock, trained staff, and IV access at delivery.
2. **When PPH occurs:**
    - Rapid assessment (airway, breathing, circulation), quantify blood loss, call for help, establish IV access, send blood samples.
    - **First-line treatment:** IV oxytocin infusion/boluses + uterine massage. Consider ergometrine or carboprost (if not contraindicated) as second uterotonic.
    - **Adjunct:** Give tranexamic acid (1 g IV) as early as possible (ideally within 3 hours).
    - **If ongoing bleeding despite uterotonics and TXA:** Insert uterine balloon tamponade (Bakri or condom-catheter UBT) and monitor response; arrange blood transfusion and prepare for surgical intervention if tamponade fails. Evidence suggests UBT is effective in stopping hemorrhage in most atonic cases and can avert hysterectomy in many situations.

7. Safety and implementation considerations

- **Monitoring and side effects:** Ergometrine — monitor blood pressure; prostaglandins (carboprost) — watch for bronchospasm/asthma contraindications; misoprostol — shivering/fever. TXA is generally safe; thromboembolic risk in PPH populations has not been shown to be increased in large trials.
- **Training and protocols:** Simulation drills, clear PPH kits (uterotonics, TXA, UBT devices, surgical instruments), and escalation checklists improve outcomes. Low-cost UBT kits and training (ESM-UBT programs) have demonstrated substantial benefit in constrained settings.
- **Supply chain:** Ensuring quality-assured uterotonics (addressing oxytocin heat degradation), access to heat-stable carbetocin where appropriate, and availability of TXA and UBT kits should be system priorities. Cost-effectiveness analyses inform national policy choices.

8. Gaps and areas for future research

- Optimal timing for UBT insertion (early vs. after failure of specific pharmacologic steps) needs further pragmatic trials tailored to different care settings. The Rozenberg trial highlights that indiscriminate early insertion may not always reduce severe outcomes—future work should refine patient selection.
- Cost-effectiveness and real-world implementation studies comparing heat-stable carbetocin to oxytocin in diverse health systems (including workforce and logistic constraints) are needed to guide policy.
- Additional data on routes/doses (e.g., nasal oxytocin formulations, prophylactic TXA in cesarean delivery) and long-term maternal outcomes will help refine protocols.

9. Conclusion and recommendations

Prevention of PPH depends on universal application of active management of the third stage with an effective uterotonic—oxytocin where feasible, and heat-stable carbetocin or misoprostol as alternatives depending on context. When PPH occurs, rapid escalation—additional uterotonics, early tranexamic acid, and timely use of uterine balloon tamponade after failure of pharmacologic therapy—forms an evidence-based pathway that reduces bleeding-related mortality and the need for invasive surgery. Health systems should prioritize availability of quality-assured uterotonics, TXA, UBT kits and staff training to operationalize these interventions effectively.

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