ISSN: 2766-9556

Journal of Clinical Case Studies and Reviews

Review Article Open Access

# Early Detection of Postpartum Haemorrhage Using a Calibrated Blood-Collection Drape: A Narrative Review of the Bundled Response in Secondary-Level Hospitals

**Amira Haddad[1*], Lena Bergstrom[2] and Fatima Mendes[3]**

[1]Department of Obstetrics, Armorica Institute of Clinical Medicine, Nantes, France

[2]Department of Anaesthesia, Gothia University Hospital, Gothenburg, Sweden

[3]Department of Midwifery, Mondego Institute of Clinical Medicine, Coimbra, Portugal

***Correspondence to:** Amira Haddad, Department of Obstetrics, Armorica Institute of Clinical Medicine, Nantes, France

**Received:** 14 February 2023; **Accepted:** 24 July 2023; **Published:** 21 September 2023

**Copyright:** © 2023 AH, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

## Abstract

*Bleeding after childbirth kills more women than anything else, and it does so along a predictable path: the loss is underestimated by eye, the diagnosis is made late, and the treatments that would have worked are given out of order or not at all. A plastic drape marked with volume graduations addresses the first step of that sequence.*

***Objectives:*** *To review the published evidence on early detection of postpartum haemorrhage using a calibrated blood-collection drape and on the first-response treatment bundle that follows it: how inaccurate visual estimation is, what objective measurement changes, and what the bundled response achieves.*

***Material and Methods:*** *Narrative review of randomised trials, cluster trials, Cochrane reviews, multicountry surveys and society guidance indexed in PubMed and the major obstetric and global health journals. No new patient data were generated; every estimate quoted is one published by the original investigators.*

***Results:*** *Haemorrhage accounts for 27.1 per cent of maternal deaths worldwide, the largest single cause. In a cluster-randomised trial of 210,132 women across 78 secondary-level hospitals, a calibrated drape combined with a first-response bundle reduced a composite of severe haemorrhage, laparotomy for bleeding or death from bleeding from 4.3 to 1.6 per cent (risk ratio 0.40, 95% CI 0.32 to 0.50). Detection of haemorrhage rose from 51.1 to 93.1 per cent and adherence to the bundle from 19.4 to 91.2 per cent. Tranexamic acid given within three hours of birth reduced death from bleeding from 1.7 to 1.2 per cent.*

***Conclusion:*** *The drape is not a treatment and does not act alone; it was tested inside a package that included training, supply trolleys, local champions and audit, and the trial cannot separate their contributions. What it does establish is that measuring blood rather than estimating it is achievable at scale in district hospitals, and that what follows measurement is a different standard of care.*

***Abbreviations:*** *PPH – Postpartum Haemorrhage, TXA – Tranexamic Acid, WHO – World Health Organization, RR – Risk Ratio, CI – Confidence Interval, IQR – Interquartile Range.*

**Keywords:** *Postpartum Haemorrhage; Blood Loss Measurement; Calibrated Drape; Care Bundle; Maternal Mortality*

## Introduction

Of the women who die from causes related to pregnancy, more die of bleeding than of anything else. A WHO systematic analysis attributed 27.1 per cent of maternal deaths worldwide to haemorrhage, ahead of indirect causes, hypertensive disorders and sepsis (Figure 3) [1]. Most of that bleeding happens after the baby is born, in the hours when the woman is still in the facility and still reachable.

Postpartum haemorrhage is common as well as lethal. Systematic review puts its incidence in the region of one in twenty deliveries by the conventional 500 mL definition, with wide variation by setting and by how loss is measured [2], and severe haemorrhage has been rising rather than falling in several high-income countries [3,4]. The gap between incidence and mortality is almost entirely a function of how quickly it is recognised and how completely it is treated [20].

Recognition is the weak link. Blood loss is conventionally assessed by looking at it, and looking at it is unreliable in a direction that matters [5,6]. This review examines what happens when the estimate is replaced by a measurement, taking as its centre the cluster-randomised trial that tested a calibrated blood-collection drape alongside a first-response treatment bundle in 210,132 women [7].

## Material and Methods

**Search strategy:** PubMed and the archives of the major obstetric, midwifery and global health journals were searched for studies of the detection and first-line treatment of postpartum haemorrhage. Search terms combined postpartum haemorrhage with blood loss estimation, calibrated drape, quantitative blood loss, care bundle, tranexamic acid, uterotonic and shock index. Reference lists of society guidance [8,9,10] were screened by hand for primary sources.

**Eligibility:** Studies were included if they reported the accuracy of blood loss assessment, the incidence or outcomes of postpartum haemorrhage in a defined population, or the effect of an intervention intended to improve detection or first-response treatment. Trials of individual bundle components are cited to establish that each element works, not as evidence about the bundle, and are identified as such.

**Data extraction and handling:** Design, setting, sample size, the definition of haemorrhage used and the reported estimate were extracted as published. The definition is reported alongside every incidence figure, because the 500 mL and 1000 mL thresholds and the method of measurement between them account for most of the variation in this literature. No pooling or re-analysis was performed. Figures 1 to 4 and Tables 1 and 2 reproduce published values only. This is a narrative synthesis and was not registered as a systematic review.

## Results

**The scale of the problem:** The WHO Multicountry Survey on Maternal and Newborn Health documented both the frequency of postpartum haemorrhage and the inconsistency of its management across 29 countries [11,12], and facility-based cohorts in high-burden settings report incidence and risk factors consistent with that picture [13]. Haemorrhage remains the leading direct cause of maternal death, and most haemorrhage deaths occur in the postpartum period rather than during labour [1].

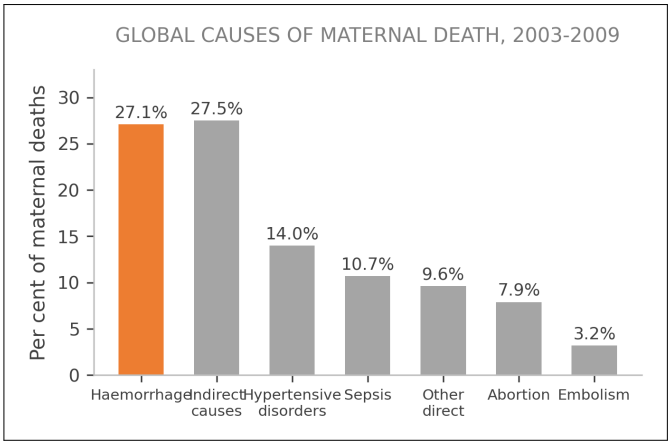


**Figure 3:** Global causes of maternal death, 2003 to 2009, as a percentage of all maternal deaths [1]

**Why estimation fails:** Visual assessment of blood loss is not merely imprecise; it is biased. Clinical reconstruction studies show systematic underestimation that worsens as volumes increase, which is exactly the wrong error to make [6]. Simulation work finds the same [15], and an integrative review concluded that accurate measurement is the step on which early detection depends [5]. Training with visual aids improves estimates without making them reliable [16], and gravimetric methods are cumbersome outside theatre [17]. A Cochrane review of methods for measuring blood loss after vaginal birth found the evidence for any one approach limited, while noting that direct collection outperforms estimation [18].

**What a calibrated drape is:** The device is a plastic sheet placed under the woman after delivery of the baby, funnelling blood into a graduated pouch so that the volume can be read rather than judged. It was described in low-resource obstetric settings some years before it was tested at scale [14,19], and its virtue is that it converts a subjective judgement into a number that triggers a protocol.

**The trial:** The E-MOTIVE trial randomised 78 secondary-level hospitals in Kenya, Nigeria, South Africa and Tanzania, enrolling 210,132 women having vaginal births. Intervention hospitals used a calibrated drape for detection together with the WHO first-response bundle of uterine massage, oxytocic drugs, tranexamic acid, intravenous fluids, examination and escalation, supported by simulation training, dedicated trolleys, local champions and audit feedback. The primary composite of severe postpartum haemorrhage, laparotomy for

bleeding or death from bleeding occurred in 1.6 per cent of the intervention group against 4.3 per cent under usual care (risk ratio 0.40, 95% CI 0.32 to 0.50) (Figure 1) [7].

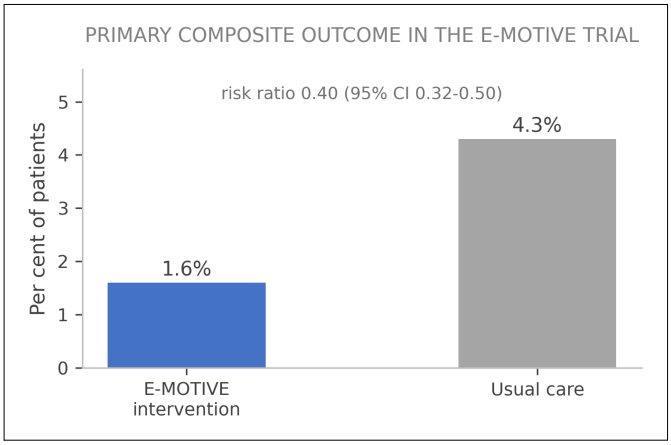


**Figure 1:** Composite of severe postpartum haemorrhage, laparotomy for bleeding or death from bleeding in the E-MOTIVE trial [7]

**What changed in between:** The mechanism is visible in the process outcomes. Postpartum haemorrhage was detected in 93.1 per cent of the intervention group against 51.1 per cent under usual care, and the first-response bundle was used in 91.2 per cent against 19.4 per cent (Figure 2) [7]. Half of the haemorrhages in the control hospitals were therefore never identified as such. Median measured blood loss was lower in the intervention group, and haemorrhage by the 500 mL definition was diagnosed in 8.5 per cent against 16.7 per cent. An economic evaluation conducted alongside the trial found the intervention cost-effective from a health system perspective [21].

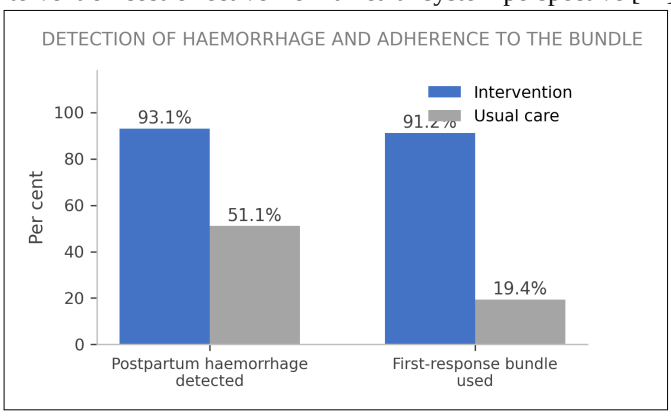


**Figure 2:** Detection of postpartum haemorrhage and use of the first-response bundle in the E-MOTIVE trial [7]

| Study | Design and cohort | Principal reported finding |
|---|---|---|
| Gallos et al. 2023 [7] | Cluster RCT, 210,132 women, 78 hospitals | Composite 1.6% vs 4.3%; RR 0.40 (95% CI 0.32-0.50) |
| Gallos et al. 2023 [7] | Same trial, process outcomes | Detection 93.1% vs 51.1%; bundle use 91.2% vs 19.4% |
| Say et al. 2014 [1] | WHO systematic analysis, 115 countries | Haemorrhage 27.1% of maternal deaths, the leading direct cause |
| WOMAN Trial 2017 [22] | RCT, 20,060 women with PPH | Death from bleeding 1.5% vs 1.9%; RR 0.81 (0.65-1.00) |
| Widmer et al. 2018 [23] | RCT, heat-stable carbetocin vs oxytocin | Non-inferior for prevention of blood loss of 500 mL or more |
| Gallos et al. 2018 [24] | Network meta-analysis of uterotonics | Ranks agents for prevention of postpartum haemorrhage |
| Main et al. 2017 [25] | Quality collaborative, Californian hospitals | Severe maternal morbidity from haemorrhage fell with a bundle |

**Table 1:** Principal studies reviewed, with the finding as reported by the original investigators

**The components have their own evidence:** Each element of the bundle rests on separate trials. Active management of the third stage is long established [26]. Among uterotonics, network meta-analysis ranks the available agents [24], and heat-stable carbetocin was non-inferior to oxytocin without requiring a cold chain, which matters where refrigeration is unreliable [23,27]. For tranexamic acid, the WOMAN trial randomised 20,060 women with postpartum haemorrhage and found death from bleeding reduced from 1.9 to 1.5 per cent (risk ratio 0.81, 95% CI 0.65 to 1.00), with the benefit confined to treatment within three hours of birth, where death from bleeding fell from 1.7 to 1.2 per cent (Figure 4) [22,28]. Given prophylactically after vaginal birth it reduced measured loss modestly [29], and after caesarean it reduced a composite haemorrhage outcome [30].

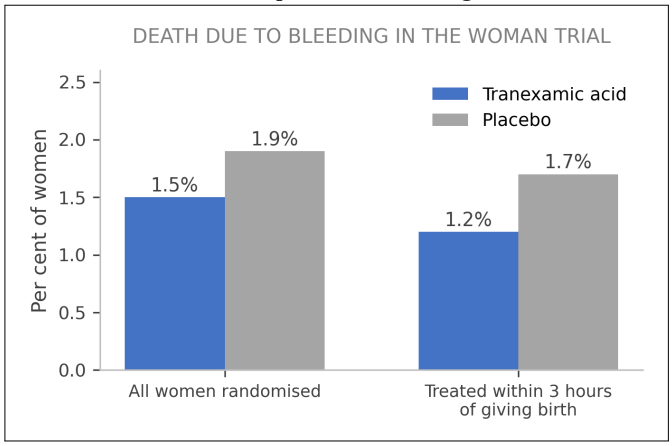


**Figure 4:** Death due to bleeding in the WOMAN trial, overall and among women treated within three hours of giving birth [22]

**Bundles outside the trial setting:** The same logic has been applied in high-income systems. A Californian quality collaborative reported reduced severe maternal morbidity from haemorrhage following implementation of a standardised bundle [25], and comprehensive protocols have been associated with reduced blood product use [31]. Reviews of maternal deaths from haemorrhage repeatedly identify delayed recognition and delayed escalation as the preventable elements [32,33]. Where

definitive care is distant, adjuncts such as the non-pneumatic anti-shock garment have been used to buy transfer time [34], and near-miss analyses show how narrow the margin often is [35].

**Detecting deterioration, not just volume:** Volume is not the only signal. The shock index, the ratio of heart rate to systolic pressure, predicts adverse outcome in postpartum haemorrhage better than either component alone and requires no equipment beyond what every labour ward has [36,37]. It complements rather than replaces measured loss, since a woman may compensate for some time before her volume deficit declares itself.

| Element | What it addresses | Evidence |
|---|---|---|
| Calibrated drape | Systematic underestimation by eye | Detection 93.1% vs 51.1% within the trial [7,6] |
| Uterine massage | Atony, the commonest cause | Standard first response; part of the WHO bundle [10] |
| Oxytocic drugs | Uterine tone | Network meta-analysis; carbetocin needs no cold chain [23,24] |
| Tranexamic acid | Fibrinolysis; time-critical | Death from bleeding 1.2% vs 1.7% if given within 3h [22] |
| Intravenous fluids | Hypovolaemia while cause is addressed | Bundle component; supported by guidance [8,9] |
| Examination and escalation | Retained tissue, trauma, delay in referral | Delayed escalation repeatedly identified in death reviews [32,33] |

**Table 2:** Components of the first-response bundle and the failure each is intended to correct

## Discussion

The E-MOTIVE result is large, and its size is the first thing that should prompt caution rather than enthusiasm. A risk ratio of 0.40 for a composite that includes death is not what incremental improvements in obstetric care usually deliver. The explanation is visible in the process data: this was not a comparison of two treatments but a comparison between treating and not recognising. Half the haemorrhages in the control hospitals went undetected, and four in five women there did not receive the bundle [7]. The intervention was tested against a baseline with very substantial room to improve.

That has a direct implication for generalisability. In a setting where quantitative blood loss measurement is already routine and bundle adherence already high, the headroom is smaller and the effect will be smaller with it. The trial establishes what is achievable where detection is currently poor; it does not establish what a drape adds to a well-run unit.

The second caution concerns attribution. The drape was one part of a package that included simulation-based training, dedicated equipment trolleys, named local champions and monthly audit feedback [7]. Any of those could carry a substantial share of the effect, and the design cannot apportion it. This is a reasonable way to test a service change and an unreasonable way to evaluate a device. Anyone reading the result as evidence that a plastic drape saves lives has read it too quickly; the drape makes a number visible, and the number triggers a response that someone has been trained, equipped and audited to deliver.

What survives both caveats is the mechanism. Every element of the response has its own trial evidence, tranexamic acid most sharply of all, where benefit is confined to administration within three hours of birth [22,28]. A treatment whose effect depends on timing cannot work if diagnosis is late, and diagnosis is late when loss is judged by eye. Measurement is upstream of everything else in the pathway, which is why improving it moves outcomes that individual drug trials struggle to move.

## Study limitations

The limitations belong to the underlying literature. The principal trial was conducted in four African countries at secondary level, and its baseline detection and adherence rates should not be assumed elsewhere [7]. It was not powered for maternal death, and the mortality component of the composite is small. Blinding was impossible, and detection itself was an outcome, so ascertainment differed between arms by design. Definitions of haemorrhage vary between the 500 mL and 1000 mL thresholds and between estimated and measured loss, which makes incidence figures across studies difficult to compare [2,19]. Trials of individual components were conducted in different populations from the bundle trial and cannot simply be added together [22,23,24]. Caesarean births were excluded from the principal trial. And cost-effectiveness depends heavily on the unit price of the drape, which is a commercial rather than a clinical variable [21].

## Conclusion

Postpartum haemorrhage kills through delay more than through severity. The evidence reviewed here shows that the first delay is diagnostic, that it follows from estimating blood loss rather than measuring it, and that a graduated drape closes it: detection rose from half to almost all, bundle use from a fifth to nine in ten, and the composite of severe haemorrhage, laparotomy and death from bleeding fell by 60 per cent. The honest summary is that a package including a drape achieved this, not that a drape did. But the sequence the package interrupts is well understood, and each treatment it delivers loses effect with every hour it is postponed. Making the loss visible is the cheapest available step, and on current evidence it is the one that determines whether the rest of the response happens at all.

## Acknowledgements

The authors thank the investigators whose trials and multicountry surveys are drawn together in this article, and the midwives who collected the trial data on which the principal findings rest.

## Funding

No dedicated funding from public, commercial or charitable sources supported the preparation of this review.

## Conflict of Interest

The authors declare no competing interests.

## Ethics Statement

This article reviews previously published studies only. No new patient data were collected and no participants were recruited, so ethical approval was not required.

## References

1. Say L, Chou D, Gemmill A, Tuncalp O, Moller AB, Daniels J, et al. "Global causes of maternal death: a WHO systematic analysis". Lancet Glob Health 2(2014):e323-e333.

2. Carroli G, Cuesta C, Abalos E, Gulmezoglu AM. "Epidemiology of postpartum haemorrhage: a systematic review". Best Pract Res Clin Obstet Gynaecol 22(2008):999-1012.

3. Knight M, Callaghan WM, Berg C, Alexander S, Bouvier-Colle MH, Ford JB, et al. "Trends in postpartum hemorrhage in high resource countries: a review and recommendations from the International Postpartum Hemorrhage Collaborative Group". BMC Pregnancy Childbirth 9(2009):55.

4. Kramer MS, Berg C, Abenhaim H, Dahhou M, Rouleau J, Mehrabadi A, et al. "Incidence, risk factors, and temporal trends in severe postpartum hemorrhage". Am J Obstet Gynecol 209(2013):449.e1-449.e7.

5. Hancock A, Weeks AD, Lavender DT. "Is accurate and reliable blood loss estimation the crucial step in early detection of postpartum haemorrhage: an integrative review of the literature". BMC Pregnancy Childbirth 15(2015):230.

6. Bose P, Regan F, Paterson-Brown S. "Improving the accuracy of estimated blood loss at obstetric haemorrhage using clinical reconstructions". BJOG 113(2006):919-924.

7. Gallos I, Devall A, Martin J, Middleton L, Beeson L, Galadanci H, et al. "Randomized trial of early detection and treatment of postpartum hemorrhage". N Engl J Med 389(2023):11-21.

8. Escobar MF, Nassar AH, Theron G, Barnea ER, Nicholson W, Ramasauskaite D, et al. "FIGO recommendations on the management of postpartum hemorrhage 2022". Int J Gynaecol Obstet 157(2022):3-50.

9. Mavrides E, Allard S, Chandraharan E, Collins P, Green L, Hunt BJ, et al. "Prevention and management of postpartum haemorrhage: Green-top Guideline No. 52". BJOG 124(2017):e106-e149.

10. Althabe F, Therrien MNS, Pingray V, Hermida J, Gulmezoglu AM, Armbruster D, et al. "Postpartum hemorrhage care bundles to improve adherence to guidelines: a WHO technical consultation". Int J Gynaecol Obstet 148(2020):290-299.

11. Sheldon WR, Blum J, Vogel JP, Souza JP, Gulmezoglu AM, Winikoff B. "Postpartum haemorrhage management, risks, and maternal outcomes: findings from the World Health Organization Multicountry Survey on Maternal and Newborn Health". BJOG 121(2014):5-13.

12. Souza JP, Gulmezoglu AM, Vogel J, Carroli G, Lumbiganon P, Qureshi Z, et al. "Moving beyond essential interventions for reduction of maternal mortality (the WHO Multicountry Survey on Maternal and Newborn Health): a cross-sectional study". Lancet 381(2013):1747-1755.

13. Ononge S, Mirembe F, Wandabwa J, Campbell OMR. "Incidence and risk factors for postpartum haemorrhage in Uganda". Reprod Health 13(2016):38.

14. Patel A, Goudar SS, Geller SE, Kodkany BS, Edlavitch SA, Wagh K, et al. "Drape estimation vs. visual assessment for estimating postpartum hemorrhage". Int J Gynaecol Obstet 93(2006):220-224.

15. Toledo P, McCarthy RJ, Hewlett BJ, Fitzgerald PC, Wong CA. "The accuracy of blood loss estimation after simulated vaginal delivery". Anesth Analg 105(2007):1736-1740.

16. Zuckerwise LC, Pettker CM, Illuzzi J, Raab CR, Lipkind HS. "Use of a novel visual aid to improve estimation of obstetric blood loss". Obstet Gynecol 123(2014):982-986.

17. Lilley G, Burkett-St-Laurent D, Precious E, Bruynseels D, Kaye A, Sanders J, et al. "Measurement of blood loss during postpartum haemorrhage". Int J Obstet Anesth 24(2015):8-14.

18. Diaz V, Abalos E, Carroli G. "Methods for blood loss estimation after vaginal birth". Cochrane Database Syst Rev 9(2018):CD010980.

19. Prata N, Mbaruku G, Campbell M, Potts M, Vahidnia F. "Controlling postpartum hemorrhage after home births in Tanzania". Int J Gynaecol Obstet 90(2005):51-55.

20. Weeks A. "The prevention and treatment of postpartum haemorrhage: what do we know, and where do we go to next?". BJOG 122(2015):202-210.

21. Williams EV, Goranitis I, Oppong R, Perry SJ, Devall AJ, Martin JT, et al. "A cost-effectiveness analysis of early detection and bundled treatment of postpartum hemorrhage alongside the E-MOTIVE trial". Nat Med (2024).

22. WOMAN Trial Collaborators. "Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage

(WOMAN): an international, randomised, double-blind, placebo-controlled trial". Lancet 389(2017):2105-2116.

23. Widmer M, Piaggio G, Nguyen TMH, Osoti A, Owa OO, Misra S, et al. "Heat-stable carbetocin versus oxytocin to prevent hemorrhage after vaginal birth". N Engl J Med 379(2018):743-752.

24. Gallos ID, Papadopoulou A, Man R, Athanasopoulos N, Tobias A, Price MJ, et al. "Uterotonic agents for preventing postpartum haemorrhage: a network meta-analysis". Cochrane Database Syst Rev 12(2018):CD011689.

25. Main EK, Cape V, Abreo A, Vasher J, Woods A, Carpenter A, et al. "Reduction of severe maternal morbidity from hemorrhage using a state perinatal quality collaborative". Am J Obstet Gynecol 216(2017):298.e1-298.e11.

26. Begley CM, Gyte GML, Devane D, McGuire W, Weeks A, Biesty LM. "Active versus expectant management for women in the third stage of labour". Cochrane Database Syst Rev 2(2019):CD007412.

27. Vogel JP, Williams M, Gallos I, Althabe F, Oladapo OT. "WHO recommendations on uterotonics for postpartum haemorrhage prevention: what works, and which one?". BMJ Glob Health 4(2019):e001466.

28. Shakur H, Beaumont D, Pavord S, Gayet-Ageron A, Ker K, Mousa HA. "Antifibrinolytic drugs for treating primary postpartum haemorrhage". Cochrane Database Syst Rev 2(2018):CD012964.

29. Sentilhes L, Winer N, Azria E, Senat MV, Le Ray C, Vardon D, et al. "Tranexamic acid for the prevention of blood loss after vaginal delivery". N Engl J Med 379(2018):731-742.

30. Sentilhes L, Senat MV, Le Lous M, Winer N, Rozenberg P, Kayem G, et al. "Tranexamic acid for the prevention of blood loss after cesarean delivery". N Engl J Med 384(2021):1623-1634.

31. Shields LE, Wiesner S, Fulton J, Pelletreau B. "Comprehensive maternal hemorrhage protocols reduce the use of blood products and improve patient safety". Am J Obstet Gynecol 212(2015):272-280.

32. Della Torre M, Kilpatrick SJ, Hibbard JU, Simonson L, Scott S, Koch A, et al. "Assessing preventability for obstetric hemorrhage". Am J Perinatol 28(2011):753-760.

33. Bonnet MP, Deneux-Tharaux C, Bouvier-Colle MH. "Critical care and transfusion management in maternal deaths from postpartum haemorrhage". Eur J Obstet Gynecol Reprod Biol 158(2011):183-188.

34. Miller S, Fathalla MMF, Ojengbede OA, Camlin C, Mourad-Youssif M, Morhason-Bello IO, et al. "Obstetric hemorrhage and shock management: using the low technology non-pneumatic anti-shock garment in Nigerian and Egyptian tertiary care facilities". BMC Pregnancy Childbirth 10(2010):64.

35. Sotunsa JO, Adeniyi AA, Imaralu JO, Fawole B, Adegbola O, Aimakhu CO, et al. "Maternal near-miss and death among women with postpartum haemorrhage: a secondary analysis of the Nigeria Near-miss and Maternal Death Survey". BJOG 126(2019):19-25.

36. Nathan HL, El Ayadi A, Hezelgrave NL, Seed P, Butrick E, Miller S, et al. "Shock index: an effective predictor of outcome in postpartum haemorrhage?". BJOG 122(2015):268-275.

37. El Ayadi AM, Nathan HL, Seed PT, Butrick EA, Hezelgrave NL, Shennan AH, et al. "Vital sign prediction of adverse maternal outcomes in women with hypovolemic shock: the role of shock index". PLoS One 11(2016):e0148729.

**Citation:** Haddad A, Bergstrom L, Mendes F. "Early Detection of Postpartum Haemorrhage Using a Calibrated Blood-Collection Drape: A Narrative Review of the Bundled Response in Secondary-Level Hospitals." J Clin Case Stud (2023): 001-006 doi: 10.5281/zenodo.22227613