

1 **Paper 3: Lancet Series on postpartum haemorrhage**

2 **Diagnosis and treatment of postpartum haemorrhage: a race against time**

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48 **Summary**

49 Postpartum haemorrhage (PPH) is common, affecting an estimated 13% of women having
50 vaginal birth and 31% of women having caesarean birth. Successful management of PPH
51 requires early and accurate diagnosis and effective treatment. A systematic review found that
52 subjective visual estimation of blood loss misses 52% PPH diagnosis at vaginal birth (pooled
53 sensitivity 48%, 95% Confidence Interval (CI) 44% to 53%), and probably more at caesarean
54 birth. Thus, the WHO-FIGO-ICM guideline on PPH recommends objective quantification of
55 blood loss, for example, using a calibrated blood collection drape. Objective measurement of
56 blood loss, in combination with monitoring of vital signs has been shown to diagnose PPH
57 accurately and early, and improve clinical outcomes, when combined with a first-response
58 treatment bundle for PPH, and supported by a robust implementation strategy. First-response
59 PPH treatment at vaginal birth can be provided with the MOTIVE bundle, consisting of
60 uterine Massage, Oxytocic drugs, Tranexamic acid, Intravenous fluids, and Examination, for
61 all women who have lost ≥ 300 mL of blood and have an abnormal vital sign, or have lost
62 ≥ 500 mL regardless of the vital signs. If this first-response treatment fails to stop the
63 bleeding, the woman is said to have refractory PPH, which requires urgent management and
64 escalation of care to the most experienced provider or level of care available. Recommended
65 interventions for refractory PPH include additional or alternative uterotonic drugs, additional
66 tranexamic acid, uterine tamponade, and if access to an operating theatre and anaesthesia are
67 available, compression sutures, devascularisation surgery and hysterectomy. If access to an
68 operating theatre is not available, the woman should be transferred to a higher-level facility,
69 with temporising measures such a non-pneumatic antishock garment (NASG) in place.
70 Transfusion of blood and blood products can save lives and should be provided according to
71 a well-defined protocol. Refractory PPH can progress to life-threatening PPH, which we
72 define in Paper 1 of the Series as PPH associated with haemodynamic shock, collapse, or

acute organ failure, requiring immediate life-saving interventions. Life-threatening PPH should be managed by a multidisciplinary team providing aggressive resuscitation and targeted treatment. Saving the life of a woman with excessive postpartum bleeding is a race against time. The six delays to avoid are: (1) in the diagnosis (by using objective cumulative blood loss measurement and early trigger criteria), (2) in the first-response treatment (by authorising midwives to administer all components of a standardised bundle of interventions), (3) in the escalation (by using explicit escalation criteria and red flags), (4) in the use of temporising measures (e.g., NASG), (5) in the identification and targeted management of any specific cause(s) of bleeding, and (6) in the provision of blood and blood products. Quick actions to avoid these delays can make the difference between life and death for a woman with PPH.

Keywords

Postpartum haemorrhage; diagnosis, treatment; bundle; first-response; interventions

Introduction

Postpartum haemorrhage (PPH) cannot be accurately predicted or consistently prevented. Although several risk factors have been identified (see the first paper in the Lancet Series on PPH), existing prediction models have limited ability to accurately identify which women will develop PPH.^{1,2} There are several preventative steps for PPH (see second paper in the Lancet Series on PPH), but none can prevent a PPH with certainty. PPH, therefore, remains an unpredictable but a common occurrence in labour wards globally. An estimated 27 million women have a PPH every year, with 17 million at vaginal birth and 10 million at caesarean birth.³ As it is such a common complication, every labour ward and every operating theatre should always be ready to diagnose and treat PPH. Diagnosis of PPH is critical, as without

diagnosis, treatment will not be initiated. There has, however, been a serious neglect of research and guidance on PPH diagnosis, which may at least partly explain why visual estimation has established itself as the primary diagnostic method for detecting PPH in clinical practice. Across the world, PPH is commonly diagnosed by the healthcare provider looking under and around the woman (soaked sheets, pads and bed linen), visually inspecting the blood loss, and estimating the volume of blood lost. If the presumed blood loss is 500 mL or more, the woman is diagnosed with PPH and treated, but if it is thought to be less than 500 mL, there is no diagnosis or treatment. Leaving such a critical decision on who should and should not be treated to guesswork has perhaps been one of the most fundamental reasons for the lack of progress in PPH outcomes over the decades. A systematic review of test accuracy studies has shown that subjective visual estimation of blood loss misses the diagnosis in over half the women with PPH.⁴ To address this fundamental deficiency in PPH management, the WHO, in partnership with the International Federation of Gynecology and Obstetrics (FIGO) and the International Confederation of Midwives (ICM), has provided clear guidance on the diagnosis of PPH, addressing PPH definition, blood loss measurement methods, and trigger criteria for clinical action.⁵

As soon as a PPH is diagnosed, help should be summoned, and prompt and effective ‘first-response’ treatment needs to be provided. Such first-response treatment should ideally consist of all relevant effective treatments and be deliverable by all birth attendants, particularly midwives, without having to wait for a review by a doctor, as that can incur delays. It is the passing of time - the ticking clock - that kills women who bleed; quick and consistent delivery of a set of effective interventions by first-level healthcare providers can give women with excessive bleeding the best chance of avoiding refractory or life-threatening PPH, and the associated serious complications.⁶ Refractory PPH is defined as PPH that has not

123 responded to first-line treatment, and we define life-threatening PPH as PPH that is
124 associated with haemodynamic shock, collapse, or acute organ failure, necessitating life-
125 saving interventions from healthcare professionals. We address the diagnosis, as well as the
126 first-response, refractory and life-threatening PPH management in this third paper of the
127 Lancet Series on PPH. We identify the six time-critical steps in the pathway to serious
128 morbidity or death, which if implemented consistently, could produce dramatic
129 improvements in PPH outcomes. We conclude with health system issues that are important
130 for improving PPH outcomes.

Search strategy and consensus-building consultations

The recommendations are based on published systematic reviews of the current literature, appraisal of professional body guidelines and expert group discussions. For the systematic review published on prevalence of postpartum haemorrhage we searched PubMed, Web of Science, Embase, Google Scholar, Cochrane Database, ClinicalTrials.gov, and the ISRCTN registry databases (last search 11 August 2025).⁷ We also refer to the Cochrane network meta-analysis on the effectiveness of various combinations of diagnostic and treatment strategies for PPH⁴ and WHO's individual participant data meta-analysis on prognostic accuracy of clinical markers of postpartum bleeding in predicting maternal mortality or severe morbidity.⁸ For the review of professional body guidelines, we reviewed the latest WHO-FIGO-ICM consolidated guidelines for the prevention, diagnosis and treatment of postpartum haemorrhage⁵, their recommendations on the assessment of postpartum blood loss and use of a treatment bundle for postpartum haemorrhage⁹, and the Royal College of Obstetricians and Gynaecologists guidelines for blood transfusions.¹⁰ For expert group meetings, recommendations for this paper were formulated based on an international consensus meeting on PPH was held in March 2023, with a group of 27 key stakeholders from Argentina, Brazil, Kenya, Malawi, Nigeria, Norway, Pakistan, South

Africa, Sri Lanka, Tanzania, the UK and the USA. Agreements were reached through consensus. We also reviewed the international expert consensus on strategies for optimising early detection and obstetric first response management of postpartum haemorrhage at caesarean birth.¹¹

131

132 **Diagnosis of postpartum haemorrhage**

133 Diagnosis of PPH is challenging for at least three fundamental reasons: lack of consistency in
134 the definition of PPH; inaccurate measurement approaches; and unclear diagnostic criteria for
135 triggering treatment actions.

136

137 ***Definition of postpartum haemorrhage at vaginal birth and caesarean section***

138 Different definitions for PPH at vaginal birth and caesarean section have evolved over
139 time.^{12,13} PPH at vaginal birth is often defined on the basis of blood loss alone, with a blood
140 volume ≥ 500 mL denoting PPH.¹⁴ The mean blood loss at vaginal birth is 353 mL (SD 324 –
141 382 mL; 17 studies; 15 countries; 66,791 women)⁷ and the median blood loss is 220 mL (IQR
142 120 – 380 mL).⁶ A 500 mL blood loss threshold is, therefore, substantially higher than the
143 average blood loss at vaginal birth. A landmark WHO individual participant data (IPD) meta-
144 analysis found that a blood loss of ≥ 500 mL was strongly associated with poor clinical
145 outcomes, with a higher risk of the composite outcome of blood transfusion, hysterectomy,
146 intensive care unit admission or death, when compared with a blood loss of < 500 mL.⁸ Thus,
147 this long-established definition, with its origin in convention rather than evidence,
148 nevertheless has validity from a prognostic point of view. The deficiency in this definition
149 based on blood loss alone, however, is that whilst a healthy woman may tolerate a 500 mL
150 blood loss with ease, the same blood loss may be calamitous, for instance, to a woman with
151 malnutrition and severe anaemia. The 500 mL threshold may miss excessive blood loss in the

152 very women who are most likely to suffer serious adverse outcomes from bleeding. The
153 WHO recognised the need to refine the PPH definition and carried out a comprehensive
154 analysis of the distributional, prognostic and therapeutic evidence underpinning the existing
155 PPH definition, as well as an international consultation on the options for a PPH definition.
156 The evidence, the international experts consultation, and the deliberation of the WHO-FIGO-
157 ICM international PPH guideline panel resulted in an updated PPH definition that defined
158 PPH as a blood loss of ≥ 300 mL *plus* an abnormal vital sign, or a blood loss of ≥ 500 mL,
159 whichever occurred first, in the first 24 hours after birth. The abnormal vital signs were pulse
160 > 100 beats per minute, systolic blood pressure < 100 mmHg, diastolic blood pressure < 60
161 mmHg or shock index (pulse/systolic blood pressure) > 1 .

162
163 The definition of PPH at caesarean section was previously evaluated by a WHO global
164 experts group in 2022.¹¹ There were huge variations with guidelines citing blood loss
165 thresholds of 500 mL, 750 mL, 1000 mL, with some relying on blood loss alone, and others
166 on combinations of blood loss and vital signs.^{15,16} The international multi-stakeholder group
167 favoured a PPH definition that was broadly consistent between vaginal birth and caesarean
168 birth. Thus, the criteria suggested for triggering first response PPH treatment at caesarean
169 section were blood loss of ≥ 500 mL, or clinical signs of haemodynamic instability.¹¹ The
170 primary reason for this standardisation is that a blood loss of 500 mL has a prognostic
171 implication that is unlikely to be substantially different for different modes of childbirth. The
172 current common use of the 1000 mL threshold to define PPH at caesarean births may be
173 contributing to the caesarean-related PPH case fatality rate being more than twice as high as
174 the vaginal birth related PPH case fatality rate (see supplementary appendix, paper 1 of
175 Lancet Series on postpartum haemorrhage). The new and standardised definition of PPH at

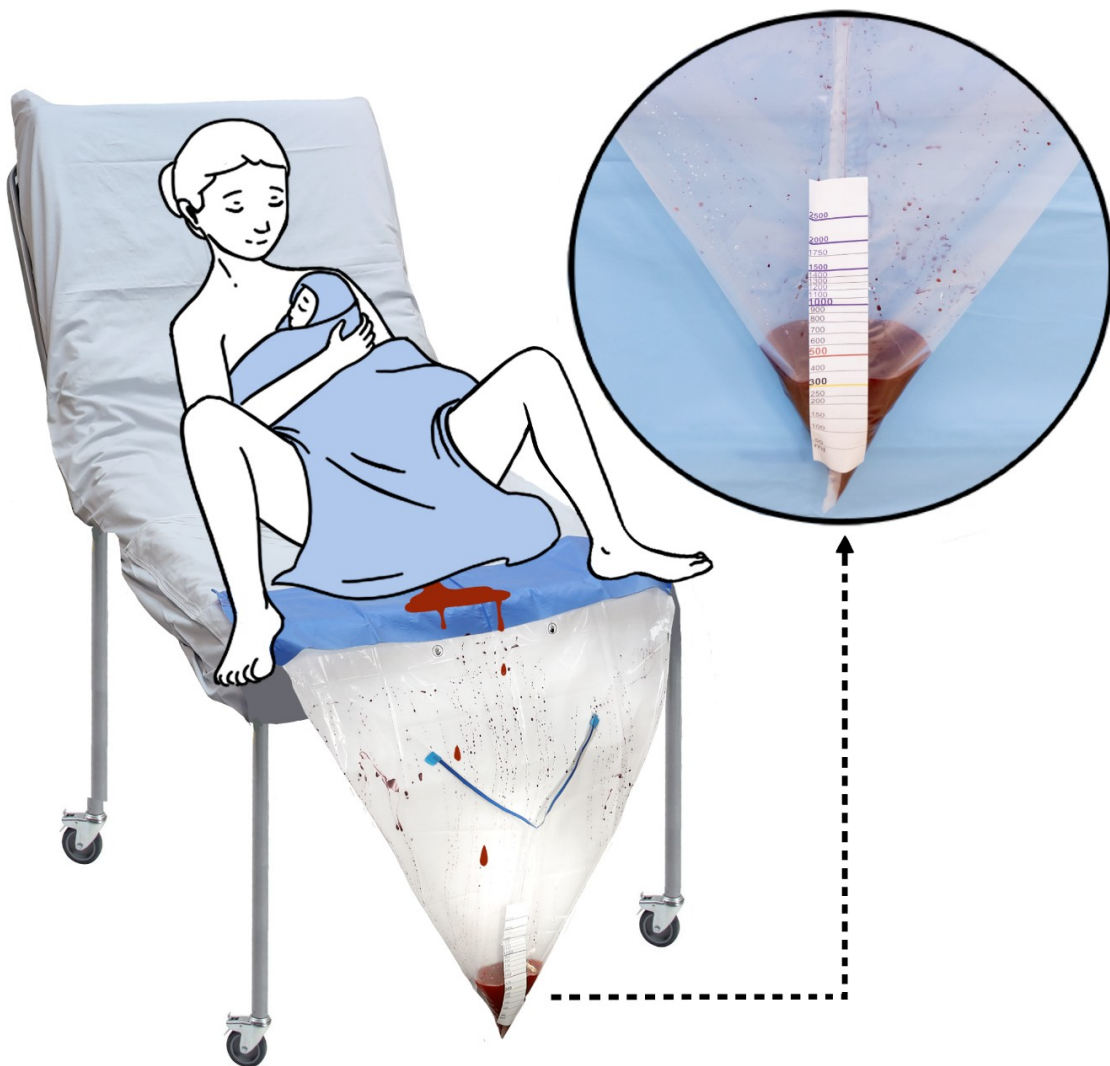
caesarean section is likely to lead to an earlier diagnosis of PPH at caesarean section, and thus an earlier commencement of first-response treatment, with anticipated better outcomes.

Quantification of blood loss

A Cochrane systematic review of studies of PPH diagnosis found subjective visual estimation of blood loss missed 52% of women with PPH (pooled sensitivity 48%; 95% confidence interval (CI) 44% to 53%; moderate certainty; 4 studies; 196,305 women).⁴ Missing more than half the PPH in our labour wards should be a global scandal, but subjective visual estimation is a commonly accepted practice worldwide. Neither training nor experience seems to improve the diagnostic performance of the subjective visual estimation approach.¹⁷ Objective blood loss assessment methods, such as using calibrated blood collection drapes, on the other hand, are highly accurate in assessing cumulative blood loss and diagnosing PPH.⁴ The same Cochrane review that assessed the accuracy of subjective visual method also assessed the accuracy of calibrated blood collection drapes for diagnosing PPH, and found this objective method missed only 7% of women with PPH (pooled sensitivity 93%; 95% CI; 92-93%; 2 studies; 53,762 women).⁴ The WHO-FIGO-ICM guideline on PPH, therefore, recommends all women should have cumulative blood loss objectively quantified.⁹ There should no longer be a place for visual estimation of blood loss in modern maternity practice. Calibrated blood collection drapes measure cumulative blood loss accurately⁴, are easy to use¹⁸, and can be part of a cost-effective strategy¹⁹ (Figure 1). They can be used after all vaginal births, including assisted births. The drape should be applied under the woman's buttocks right after the birth of the baby so as to exclude any amniotic fluid, but before the delivery of the placenta. It should be kept for at least 1 hour after childbirth²⁰, and if there is any ongoing bleeding at the 1-hour time-point, it should be kept in place for another hour. The drape can be tied around the woman's waist to allow her to adjust her position and move

around if she wishes. Cumulative blood loss levels and vital signs should be checked at least every 15 minutes during this period.²⁰ Almost all PPHs occur within 90 minutes of childbirth²⁰ and thus, this schedule will capture the vast majority of women with PPH.

Figure 1. Calibrated blood collection drape



malife calibrated blood collection drape (courtesy of Kimal, UK)²¹

Am

Intraoperative cumulative blood loss assessment at caesarean section requires a gravimetric approach for swabs and linen, and a volumetric approach for blood collected in suction

211 canisters. The dry weights of mops, swabs and linen used at caesarean section should be
212 known so that these can be deducted from the weight of blood-soaked materials to accurately
213 calculate the cumulative blood loss. The fluid collected in suction canisters should have the
214 volume of amniotic fluid and any irrigation fluid deducted to obtain the correct volume of
215 cumulative blood loss. The operating team should be vigilant for vaginal loss concealed by
216 surgical drapes. The blood loss and vital signs measurements must occur in real-time during
217 the operation so that the surgeon and the anaesthetist can detect excessive blood loss early,
218 and respond immediately. A colorimetric blood loss assessment technology, that scans and
219 processes images of blood-soaked swabs and suction canisters in real-time during the
220 caesarean section, is currently being evaluated. Such a technology could simplify operating
221 room workflow, provide automated ongoing readouts of blood loss intra-operatively, and
222 have built-in alerts to warn of women with excessive blood loss. Postoperative phase blood
223 loss assessment is more complex as the bleeding is often concealed; a WHO global experts
224 group, therefore, suggested that postoperative PPH could be detected primarily by frequently
225 monitoring the woman's vital signs and other clinical signs of internal bleeding,
226 supplemented by cumulative objective blood loss assessment of any revealed blood loss.¹¹

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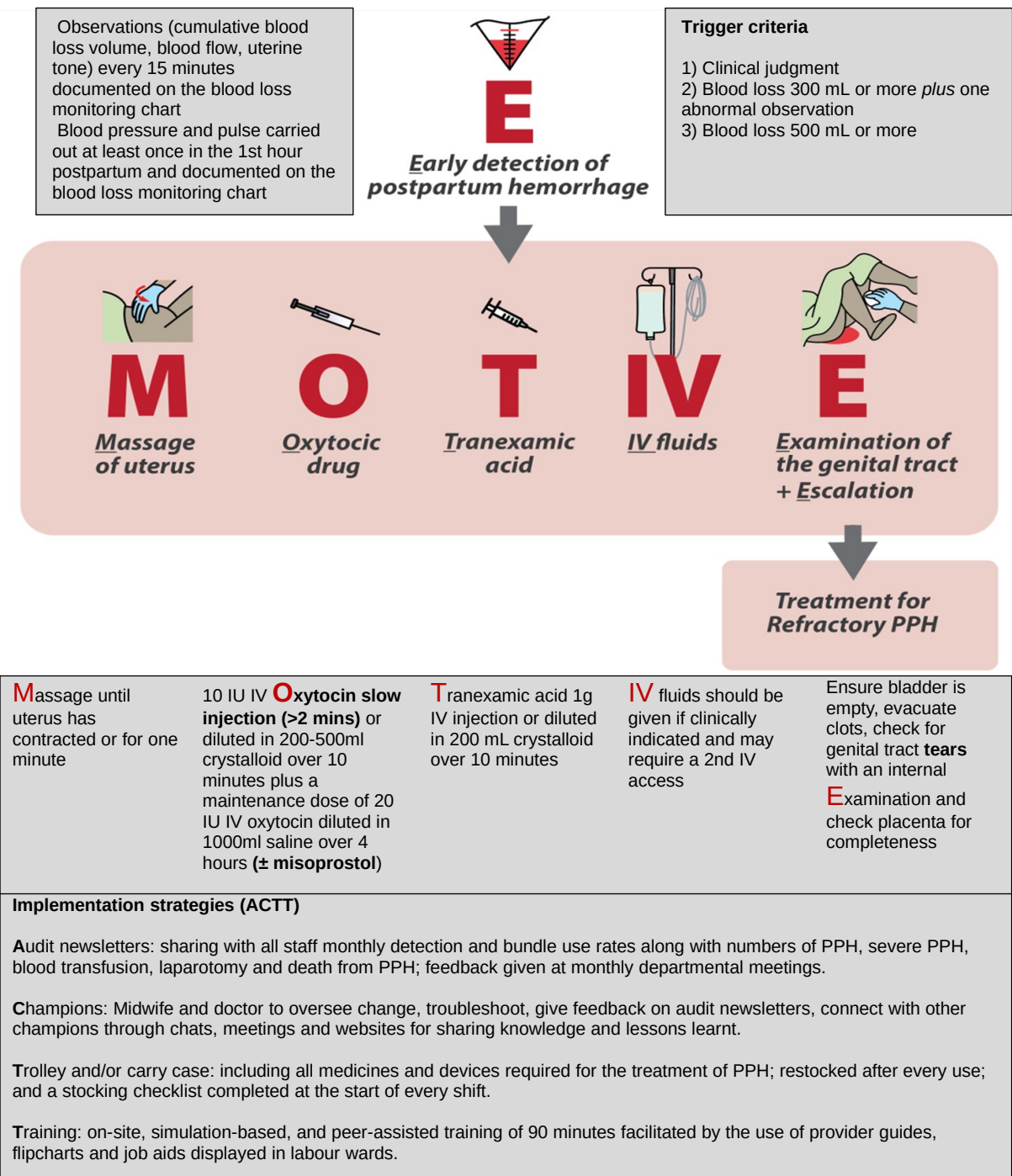
228 **First-response treatment of postpartum haemorrhage**

229 Early diagnosis and prompt treatment are essential to avert morbidity and mortality from
230 PPH. The updated WHO definition of PPH enables early diagnosis of PPH. However, if early
231 diagnosis is not linked to prompt and effective treatment, better outcomes cannot be
232 expected. The E-MOTIVE intervention combined an early diagnosis strategy with a bundle
233 of effective interventions, supported with a robust implementation approach, to address PPH
234 at vaginal birth.⁶ The first "E" in E-MOTIVE refers to Early and accurate diagnosis of PPH
235 using a calibrated blood collection drape. The first-response treatment is initiated on one of

three criteria: (1) clinical judgment that the bleeding is excessive (clinical prompt), (2) an objectively measured blood loss of ≥ 300 mL *plus* abnormal vital signs or atonic uterus (early treatment prompt), and (3) a blood loss of ≥ 500 mL (safety net prompt). The first-response treatment is a bundle of interventions called “MOTIVE”⁵: uterine **M**assage, **O**xytocic drugs, **T**ranexamic acid, **I**ntra**V**enous fluids, and **E**xamination of the genital tract (Figure 2). This comprehensive bundle works in multiple ways: uterine massage promotes uterine tone and expels any clots in the uterus that may be hindering uterine contraction. Oxytocic drugs stimulate uterine contraction and address uterine atony, while tranexamic acid antagonises fibrinolysis. Intravenous fluids re-expand plasma volume, and examination helps to identify the source of bleeding and provide targeted treatment. The bundle of interventions addresses multiple PPH causes which may be acting at the same time. The term ‘bundle’ is used loosely by many to mean a collection of interventions; however, bundle is a technical term²² defined by the Health Foundation and the US Institute for Healthcare Improvement as a set of evidence-based interventions for a defined patient population and care setting that needs to be implemented together; i.e., each care bundle component should be applied to every patient, every time. So, for instance, an algorithm is not a care bundle, as all elements of an algorithm are not applied to every woman, but only some elements are applied conditionally, if the women meet certain criteria. Neither is a package of quality improvement initiatives that consists of a host of preventive and treatment elements, where preventive elements may be applied to all women, but treatment elements only to those who meet certain diagnostic criteria. MOTIVE is a classic treatment bundle in that all elements are mandated: uterine massage, oxytocic drugs, tranexamic acid, intravenous fluids, and examination should be provided to every woman, every time, as long as the trigger criteria for treatment have been met.

261 **Figure 2. E-MOTIVE Treatment Bundle for vaginal births**

262



263

264 Source: E-MOTIVE trial report (Gallos et al.⁶)

265 The E-MOTIVE intervention may be conceptually sound, but does it work in practice? A

266 large multi-country cluster-randomised controlled study was conducted to test the E-

267 MOTIVE intervention, supported with an implementation strategy that consisted of inter-

268 professional onsite training and drills, PPH trolleys or carry cases (Figure 3), local champions

269 to promote and support the intervention and an audit and feedback system. The trial found E-
 270 MOTIVE resulted in a 60% reduction in the primary composite outcome of blood loss ≥ 1000
 271 mL, laparotomy for PPH or maternal death from PPH (RR 0.40; 95% CI: 0.32 to 0.50).⁶
 272 Blood transfusion rate for bleeding was 29% lower with the E-MOTIVE intervention (RR
 273 0.71; 95% CI: 0.55 to 0.90). Although the study was not powered for mortality outcome, the
 274 available data suggested a reduction in mortality (RR 0.73; 95% CI: 0.40 to 1.31). E-
 275 MOTIVE was also found to be feasible, acceptable, and cost-effective.^{18,19} The WHO,
 276 therefore, recommends objective quantification of blood loss with a calibrated blood
 277 collection drape and bundled treatment of PPH as the strategy for early diagnosis and first-
 278 response treatment of PPH at vaginal birth.⁵

279

280 **Figure 3. An example postpartum haemorrhage carry case with a checklist of contents**

PPH carry case	ITEM*	Number of items
	Large Bore IV cannula	x 2
	Tourniquet	x 2
	Alcohol swabs	x 6
	10ml sterile water for injection	x 4
	Medical tape/plaster	x 2
	TXA 500mg/5mL vials OR 1gm/10mL vials	x 10
	21G needles (GREEN)	x 6
	23G needles (BLUE)	x 6
	5mL syringes	x 6
	10mL syringes	x 8
	Additive stickers for IV fluids	x 3
	1000mL IV fluids (NaCl or Ringer's Lactate)	x 1
	500mL IV fluids (NaCl or Ringer's Lactate)	x 2
	Giving set	x 2
	SMALL packet sterile swabs	x 2
	MEDIUM packet sterile swabs	x 2
	Catheter bag	x 1
	Foley's catheter	x 1
	Size SMALL sterile gloves	x 2
	Size MEDIUM sterile gloves	x 2
	Size LARGE sterile gloves	x 2
	Lignocaine 1% 10mL	x 1
	Plastic apron	x 1
	Cradle device - fully charged	x 1

*Oxytocin ampoules in fridge

281

282

283 The E-MOTIVE intervention is likely to require adaptations for the caesarean birth context.
284 Healthcare providers would need to rely on objective measurement of blood loss, using either
285 a combined gravimetric and volumetric approach, or a colorimetric system should it be
286 validated to be diagnostically more accurate than traditional methods. The first response
287 treatment is likely to involve a bundle of interventions, consisting of mechanical compression
288 of the uterus, additional uterotonic drugs, tranexamic acid, intravenous fluids, targeted
289 surgical sutures, and examination to identify and address the source of bleeding. An
290 evaluation of an adapted E-MOTIVE intervention for the caesarean birth context, called the
291 E-MASTER intervention, has recently commenced.

292

293 Post-operative bleeding after caesarean section can be internal into the abdomen, and thus
294 concealed and difficult to diagnose. Diagnosis in the post-operative phase relies on frequent
295 observations of the vital signs and other clinical signs of internal bleeding, supplemented by
296 cumulative objective assessment of any revealed blood loss. If internal bleeding is suspected,
297 bedside ultrasound scan can help with the diagnosis of excess blood in the abdomen.¹¹

298

299 PPH is a common complication and women giving birth in any setting should be attended by
300 health workers who can diagnose PPH accurately and early, as well as administer first
301 response bundle treatment and make timely referral for advanced care, if the bundle fails to
302 stop the bleeding. However, many births still occur outside of formal health facilities or in
303 low level facilities with limited resources, both of which may be attended by non-skilled
304 providers. The use of calibrated drapes for objective quantification of blood loss may not be
305 possible in this context, but alternatives such as calibrated bedpans or standardized absorbent
306 cloth mats could offer a practical method for early diagnosis of excessive bleeding.

307 If misoprostol has not been used for prevention, it could be administered as a first-line
308 uterotonic treatment.^{5,23,24} Misoprostol is heat-stable, easy to administer orally, sublingually or
309 rectally and does not require refrigeration, making it an option for community births. It is
310 important, however, that early referral to a higher-level facility must be initiated as soon as
311 PPH is suspected or diagnosed so that the full first-response bundle can be administered and,
312 if the first-response bundle fails, refractory PPH treatments can be provided. Referral
313 pathways should be clearly defined and supported by community education, clear referral
314 criteria, transport plans, and communication systems.

315

316 **Treatment of refractory or life-threatening postpartum haemorrhage**

317 Refractory PPH is diagnosed if a woman continues to bleed despite first-response treatment.

318 An analysis of 29,539 vaginal births from 23 hospitals in 10 countries found 16.2%

319 (497/3,061) of women with PPH progressed to have refractory PPH.²⁵ Life-threatening PPH

320 is diagnosed if a woman's bleeding results in shock, collapse, or acute organ failure; it is the

321 last mile before death.³ Red flags for life-threatening PPH include drowsiness, confusion,

322 dyspnoea, oliguria, bruising, blood loss ≥ 1500 mL²⁶, pulse >110 beats per minute⁸, systolic

323 blood pressure <90 mmHg⁸, shock index ≥ 1.7 ²⁷⁻²⁹, haemoglobin <7 g/dL^{30,31}, fibrinogen <2 g/

324 L^{32,33}, PT-INR ≥ 1.5 ^{31,34}, and lactate >2.6 mmol/L.³⁵

325

326 Management of refractory PPH, and particularly if it has progressed to become life-

327 threatening, starts with taking urgent steps to support Circulation, Airway, Breathing (CAB).

328 The woman should lie flat and facial oxygen should be provided. We propose a structured

329 way to approach refractory PPH at vaginal birth as shown in Figure 4. It consists of three

330 overlapping phases: Assess & Act, Stabilise, and Operate. The 'Assess & Act' phase has two

331 bundles, one for the top-end operator (usually the anaesthetist, anaesthetic nurse, obstetrician

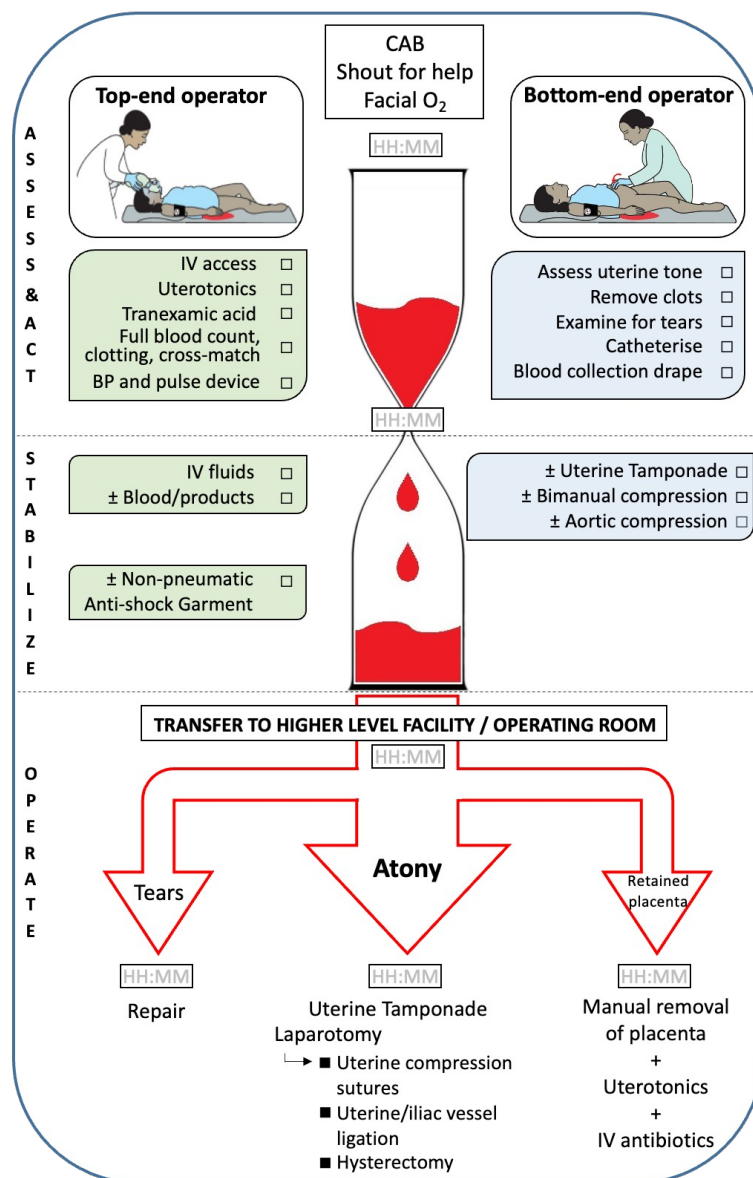
or midwife) and one for the bottom-end operator (usually the obstetrician or midwife). Each bundle operator has five elements to act on in a contemporaneous fashion: the top-end operator will need to secure intravenous access, provide (additional) uterotonics and (additional) tranexamic acid, obtain blood for blood count, clotting and cross-matching, and apply a vital signs monitoring device; the bottom-end operator will need to re-assess uterine tone, remove any clots in the vagina and cervix, re-examine the genital tract for any trauma, catheterise the woman, and apply a blood collection drape under the buttocks to measure ongoing blood loss, if a drape is not already in place.

The ‘Stabilise’ phase requires the operators to resuscitate the woman with IV fluids, blood and blood products, and the use of one or more of the temporising approaches for minimising blood loss while preparations are made for further treatment. Temporising measures include bimanual compression of the uterus, uterine tamponade, external aortic compression, or the use of a non-pneumatic anti-shock garment (NASG). If the woman is to be transported to another hospital, the use of a NASG is recommended. Coagulopathy should be considered in all cases of refractory PPH.^{36,37} Coagulopathy is associated with poor maternal outcomes since obstetric interventions will fail if haemostasis is impaired. Coagulopathy may occur as a consequence of massive blood loss (and dilution of coagulation factors) or earlier in a bleed in certain pathologies such as abruption or amniotic fluid embolism.

The third phase ‘Operate’ generally requires the woman to be transferred promptly to an operating room, whilst resuscitation continues. In the operating room, under anaesthesia, a thorough genital tract examination will need to be performed to determine the cause of bleeding. Further management can then be tailored to the cause(s) (Figure 4). Operative management may include manual removal of the placenta, repair of genital tract trauma,

uterine tamponade, brace sutures, devascularisation surgery or a hysterectomy. Uterine artery embolization may be an option in some well-resourced settings with the availability of an interventional radiologist. Timely action is a critical determinant of outcome; thus, all these actions will need to be completed quickly, and important time points should be noted on the ‘timeline spine’ (Figure 5). Clear protocols, co-ordinated teamwork and an enabling environment are essential.

Figure 4. A structured approach for managing refractory postpartum haemorrhage



CAB: Circulation, Airway and Breathing; O₂: Oxygen; IV: intravenous; HH:MM – hour: minutes

367

368 Management of refractory PPH at caesarean section follows the same principles as
369 management at vaginal birth, i.e., assessment, stabilisation and definitive treatment, all done
370 swiftly. Cumulative blood loss assessment should use an objective method, for example a
371 combined gravimetric and volumetric approach or a validated colorimetric system. Vital
372 signs should be monitored continuously by the anaesthetist or anaesthetic nurse. Identifying
373 the source of bleeding, particularly uterine angle tears or placental bed bleeding, and any
374 evidence of coagulopathy are both essential for targeted treatment. Effective stabilisation can
375 be achieved with bimanual compression, uterine tamponade, or a uterine tourniquet (by tying
376 a foley catheter around the lower uterus³⁸). If the woman needs to be transported to another
377 facility, the uterine tourniquet can be left in situ with the abdomen closed, and the patient
378 further stabilised with an anti-shock garment during transport. Definitive treatment will
379 involve repairing tears, brace sutures, devascularisation surgery or hysterectomy.

380

381 Management of life-threatening PPH requires the immediate attendance of the emergency
382 team, which should include senior obstetricians and anaesthetists. The immediate priority is
383 to assess and resuscitate the woman through steps to manage CAB (circulation, airway and
384 breathing), to control the bleeding, and to provide transfusion of blood and blood products, as
385 necessary. Specific management will be guided by the presentation and cause, but swift
386 temporising with uterine tourniquet, and early recourse to hysterectomy may be needed to
387 preserve the woman's life. Postoperative care is likely to require an intensive care setting.

388

389 **Transfusion of blood and blood products**

390 The circulating blood volume in a pregnant woman is between 4.7 to 7.5 litres depending on
391 the body mass index.³⁹ The loss of blood during PPH can be so rapid that it is not unusual for

392 a woman to lose one, two or more litres of blood within minutes. Intravenous fluids can re-
393 expand plasma volume, but blood transfusion is often needed to replace the lost blood and
394 prevent serious morbidity and mortality. All birth facilities should, therefore, strive to have
395 access to a blood bank or have an on-site blood storage unit to hold emergency Group-O
396 Rhesus D-negative blood in stock.

397

398 Criteria for blood and blood product transfusion incorporate clinical assessment and
399 haematological tests (which may be performed in the laboratory or at the bedside). Women
400 with acute haemorrhage can have a normal haemoglobin concentration (Hb) until the blood
401 becomes diluted with infused fluids, and thus relying on single blood results to guide
402 transfusion decisions can be misleading. Blood transfusion should be considered if a woman
403 is deemed to have sustained severe PPH (≥ 1000 mL blood loss), or is haemodynamically
404 unstable, with the therapeutic aim of elevating Hb to at least over 70g/L.⁵ Blood loss can
405 result in dilution of coagulation factors, and thus blood products may also be needed.⁴⁰

406 Concentrated fibrinogen (cryoprecipitate or fibrinogen concentrate) should be transfused if
407 Clauss fibrinogen level is < 2 g/L to maintain levels > 2 g/L.¹⁰ Transfusion of fibrinogen,
408 without testing the fibrinogen level, in moderate to severe (> 1500 mL blood loss) PPH has not
409 been shown to improve outcomes.⁴¹⁻⁴³ In cases of acute obstetric coagulopathy (for example,
410 with abruption or amniotic fluid embolism), hypofibrinogenemia occurring early in a bleed is
411 likely due to fibrin and fibrinogen destruction and inhibition³⁶, rather than by dilution of
412 clotting factors from massive blood loss. Concentrated fibrinogen replacement will be
413 required at an earlier stage to restore haemostasis and avoid ongoing bleeding with the
414 development of mixed coagulopathy (acute obstetric coagulopathy and dilutional
415 coagulopathy). Platelet transfusion should be considered on clinical grounds or if the platelet
416 count is $< 75 \times 10^9$ /L; the therapeutic aim is to achieve a platelet count of over 50×10^9 /L.⁴⁴

417 Fresh frozen plasma (FFP) should be used on clinical grounds, if 4 units of blood have been
418 transfused, or to maintain prothrombin time (PT) and activated partial prothromboplastin time
419 (APTT) < 1.5 times the non-pregnant reference ranges Transfusion of blood and blood
420 products should be guided by clear protocols that are readily available on labour wards and
421 operating theatres. The need for blood and blood products should be anticipated, and early
422 requests should be made, as there can often be delays in provision.

423

424 Intraoperative cell salvage, where the blood lost during an operation is collected, processed
425 and auto-transfused, may have a role in the management of women at high risk of PPH,
426 particularly in places where access to blood is limited, as well as in women who refuse
427 allogenic blood transfusion.⁴⁵

428

429 **Time-critical steps: racing against time**

430

431 The "three delays" model is a well-established framework for exploring and addressing
432 maternal morbidity and mortality.⁴⁶ The first delay is in deciding to seek care, the second
433 delay is in identifying and reaching a health facility, and the third delay is in receiving
434 effective care once at the facility. Whilst our focus in this paper has been on addressing the
435 third delay, an effective strategy will need to address the first and second delays too. Such a
436 strategy could include increasing community engagement and birth preparedness, promoting
437 regular antenatal care, improving transportation options for women in difficult-to-reach areas,
438 and strengthening referral pathways.

439

440 We identify six delays to avoid in the context of PPH care, once the woman is in a health
441 facility. These are: (1) in the diagnosis (by using objective blood loss devices and clear

criteria for treatment), (2) in the first-response treatment (by using a bundle of interventions), (3) in the escalation (by using explicit escalation criteria and red flags), (4) in the use of temporising measures (e.g., uterine tamponade; NASG), and (5) in identifying the specific cause of bleeding for targeted treatment (i.e., atony, trauma, retained tissue, abnormal placentation or clotting abnormality), and (6) in the provision of blood and blood products. Many of these steps can be delivered concurrently to save time. Every minute of delay avoided in these steps could mean the difference between life and death for a haemorrhaging woman.

Formula One teams can change the tires in a racing car in about 2·5 seconds. They achieve this speed through exceptional teamwork, where every team member knows exactly what their role is, extensive practice, particularly through synchronised action drills, precise communication, and specialised tools that are kept together in a readily accessible place. Some teams are so well-practiced that they can change the tires in complete darkness. The principles used by Formula One teams, namely teamwork, practice drills, clear communication, and the use of effective tools kept in a readily accessible place (Figure 3), are exactly relevant to maternity teams that wish to secure a positive outcome for the women under their care. Over the past decade, there have been efforts to improve teamwork, communication and efficiency in obstetric emergency care to improve outcomes.^{47,48} However, further improvements are needed. Modern maternity care needs to move away from using visual estimation guesswork to diagnose PPH. We need to use clear trigger criteria for action, and once a decision to act is made, the full first-response bundle should be used, with all components at least started within the 15 minutes ‘golden period’.⁴⁹ This 15 minute target has been shown to be achievable.^{18,49} If first-response treatment does not work, swift escalation to senior team members is essential; the common escalation criteria are

uncontrollable bleeding, measured blood loss ≥ 1000 mL, haemodynamic shock, extensive genital tract trauma or the presence of any red flags (see refractory PPH section above).⁶ Lower-level facilities should have clear referral pathways to higher-level facilities. Search for causes of PPH should include persistent uterine atony, retained tissues, placenta accreta, clotting abnormalities, genital tract trauma, uterine rupture and uterine inversion; targeted prompt treatment will be needed to address these causes. Visible and consultative leadership, clear protocols including referral pathways to higher-level facilities, effective onsite inter-professional training, simulation-based drills, effective audit and feedback systems, particularly targeting near-misses, and quality improvement programmes are the cornerstone of a healthcare system that is ready to respond to PPH at any time. Effective regulations that ensure midwives' scope of practice includes early identification of PPH and immediate provision of all components of first-response treatment, without waiting for the approval of doctors, are needed. Quality-assured medicines and commodities for PPH prevention and treatment should be reliably forecasted and procured through national procurement and distribution plans.

Women may need supportive care after a PPH. A severe PPH is a life-threatening experience that can leave a woman with anxiety^{50,51} and psychological trauma⁵². Screening for psychological consequences and providing appropriate postnatal support should be the standard of care. Women who have experienced PPH are at risk of impaired breastfeeding and bonding with the newborn, anaemia, infection, sepsis and thrombosis. A postnatal Hb at discharge from hospital and between 4 – 6 weeks after childbirth can help identify women who need oral or intravenous iron therapy.

Discussion

Evidence from women who have died of PPH shows substandard clinical care is often a root cause. Substandard care presents itself in three main ways: missed or delayed PPH diagnosis, slow and fragmented delivery of treatment interventions, and agonisingly late escalation of care. Weak and under-resourced health systems create the conditions for substandard care. In this Series, we have provided evidence-based approaches to improve diagnosis and treatment. There has been a tremendous global effort to promote facility-based births, but being in a facility is of limited use to the 52% of women⁴ with PPH who would have their PPH diagnosis missed by the current diagnostic approach that relies on subjective visual estimation of blood loss. There is now high-quality evidence from the large, multi-country cluster-randomised E-MOTIVE trial to guide policy and practice, showing a strategy that includes objective blood loss assessment with a calibrated blood collection drape, combined with a first response bundle of effective treatments and robust implementation strategy, results in substantial improvements in health outcomes.⁶ Every woman having a vaginal birth should have her blood loss accurately assessed with a calibrated drape or an alternative device, and those having a caesarean section should have their blood loss objectively quantified, with the combination of gravimetric and volumetric approaches or novel techniques such as the colorimetric quantification of blood loss.

Measurement of blood loss is of no value, unless it is clearly linked to thresholds and prompts to initiate action. The updated evidence-based WHO-FIGO-ICM definition of PPH provides clear thresholds for first-response treatment. The new definition challenges the exclusive use of the conventional 500 mL blood loss threshold for defining PPH, as such a threshold can leave behind the most vulnerable women, e.g., women with malnutrition and severe anaemia who may decompensate well before they lose 500 mL of blood. The addition of blood loss ≥ 300 mL plus an abnormal vital sign as part the PPH definition can capture these women,

and enable earlier recognition and treatment of PPH, giving women a better chance of surviving a PPH. The updated WHO-FIGO-ICM PPH definition prioritises prognostic sensitivity over prognostic specificity, enabling the provision of PPH treatment to previously overlooked women.⁸

First-response treatment for PPH should be with a treatment bundle, in which all treatment elements are delivered quickly. We have detailed the E-MOTIVE bundle for PPH at vaginal birth and proposed possible adaptations for PPH at caesarean birth. If first-response treatment does not work, escalation of care should be prompt. Refractory and life-threatening PPH management requires expert help, and thus calling for senior staff early is a critical intervention in its own right, but is often poorly done; explicit criteria for escalation, as provided in this paper, can help minimise delays in calling for help. Blood and blood products can keep a woman alive while definitive treatment to stop the bleeding is provided; the need for blood should be anticipated early, and solutions should be in place to meet the need. Provision of effective care will require clear communication, leadership and teamwork. Respectful care should be the standard, with ongoing and compassionate communication with the woman even in the midst of an acute and stressful emergency.

The recommendations in this Series are based on the best available evidence. We have published several systematic reviews, and updated several existing ones, in the lead-up to the publication of this Series. Furthermore, we have benefited from the extensive literature reviews carried out as part of evidence preparation for the consolidated PPH guidelines jointly issued by the WHO, FIGO and ICM.⁵ Where evidence was scant, or of unreliable quality, the recommendations are based on international consensus, elicited through various global workshops and consultations. Such consensus-based recommendations will need to be

re-examined as relevant research evidence becomes available. There is limited evidence on the prevention, diagnosis and treatment of PPH at caesarean births and home births. Much of the evidence presented in the Series comes from studies of PPH at vaginal births in health facilities. There is an urgent need to generate high quality evidence to guide PPH care at caesarean births and home births. For example, methods for objectively measuring blood loss at caesarean section, such as the colorimetric method, and at home birth, such as the use of standardized cloth mats that absorb a certain amount of blood per square unit of the material, need evaluation. Coagulopathy leads to failure of obstetric interventions and therefore research investigating mechanisms, identification (including point of care testing) and treatment of obstetric coagulopathy in all healthcare settings is needed to improve care. Urgent research is needed on broader health system issues, such as the procurement and distribution of essential drugs and equipment, financing models that reduce out-of-pocket costs, the provision of solar-backed power supply for refrigerators (to store oxytocin) and operating theatres, and drone delivery of blood and essential drugs to remote areas.⁵³

Specific treatment research priorities include investigating optimal tranexamic acid regimens, use of carbetocin for treatment of PPH, and comparative effectiveness of different uterine tamponade devices. The PPH Roadmap further highlights the need for implementation research into identifying barriers and facilitators affecting the adoption and use of evidence-based recommendations, developing the most effective implementation and advocacy strategies and strategies for improving access to PPH commodities while engaging the private sector for innovating around the development of medicines, diagnostics and devices.⁵⁴

Panel

Series Key Messages

- Address modifiable risk factors for PPH, particularly anaemia and unindicated caesarean operations
- Provide routine prophylaxis for PPH with cold-chain maintained oxytocin or carbetocin
- Consider dual prophylaxis with oxytocin and misoprostol for women at high risk of PPH
- Apply the reappraised definition of PPH to avoid missed cases
- Use objective methods of blood loss assessment, such as calibrated drapes, to accurately diagnose PPH
- Use first response treatment bundles to avoid the delays of sequential treatments, and treat multiple concurrent causes of PPH
- Use red flags to identify women diagnosed with PPH who may deteriorate beyond first response treatment
- Maintain urgency across the spectrum of prevention, diagnosis and treatment of PPH to avoid missed opportunities

564

565 The recommendations from this Series focus on maintaining urgency across prevention,
566 diagnosis and treatment of PPH. Opportunities to modify risk factors for PPH such as
567 anaemia, start before a woman becomes pregnant. Once she is pregnant other risk factors
568 such as lack of antenatal care can be addressed. Routine prophylaxis with either cold chain-
569 maintained oxytocin, or carbetocin should be provided for all women giving birth. If women
570 are identified as being at high risk of PPH, dual prophylaxis with oxytocin plus misoprostol
571 should be considered. Objective methods of blood loss assessment, such as with a calibrated
572 drape, should be used to diagnose PPH using the reappraised definition of PPH. If PPH is
573 diagnosed, first response treatment bundles should be used to avoid the delays of sequential
574 treatments. If women with PPH who have had first response treatment, continue to bleed, red
575 flags should be monitored to identify those who are likely to suffer severe adverse outcomes.

576

577 The principles outlined in this Series represent achievable goals that could transform PPH
578 outcomes globally. The essential knowledge and tools to substantially reduce PPH-related

morbidity and mortality now exist; the primary challenge lies in translating this evidence into consistent clinical practice across diverse healthcare settings. The required transformation extends beyond merely enhancing individual clinical skills to encompass systemic and systematic changes in healthcare delivery and organisational culture. Success will demand sustained commitment from policy makers, healthcare leaders, adequate resource allocation, and continuous quality improvement efforts. The ultimate goal, the elimination of preventable maternal deaths from PPH through the consistent application of evidence-based practices worldwide, is within our collective grasp.

Contributors

AC drafted the structure of the paper and the first draft of text, tables, and figures. Figure 1 was produced in conjunction with Kimal, UK. KNS was responsible for the production of Figures 2 and 3. AD was responsible for the production of Figure 4. All co-authors revised the manuscript at least once, contributed to the literature review, and provided important intellectual input. Authors listed on individual papers within the Series contributed only to those specific papers and not to others. All authors had the opportunity to review each completed paper, and agree to the inclusion of the paper they co-authored in this Series.

Declaration of interests

SB has received industry support from Werfen and Haemonetics to provide devices and consumables free of charge to participating sites in the OBS UK trial and participated on two annual PPH Advisory Board Meetings in 2024 and 2025. SM has received funding to her academic institution from the Marin Community Foundation and LifeWrap-NASG International. AW has received payment as an expert witness in an ongoing General Medical Council trial of retained placenta. AW is the co-inventor of a PPH device, with the patent

held by his academic institution and a royalty sharing scheme should any royalties arise. IDG and OTO were members of the WHO Steering Group that coordinated the development of the WHO-FIGO-ICM Consolidated guidelines for the prevention, diagnosis, and treatment of postpartum haemorrhage. OTO is the Project Coordinator for the REACH trial: Research to Expand Access to Heat-stable Carbetocin for the Treatment of Postpartum Haemorrhage, which received main funding support from Unitaid, complementary funding support from MSD for Mothers, in-kind contributions from HRP (salary costs) and in-kind donation of heat-stable carbetocin for PPH prophylaxis and as IMP to trial participating sites by Ferring Pharmaceuticals. The other authors declare no competing interests.

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