MASSIVE TRANSFUSION PROTOCOL AND ROLE OF TRANSFUSION MEDICINE

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DISCLOSURE

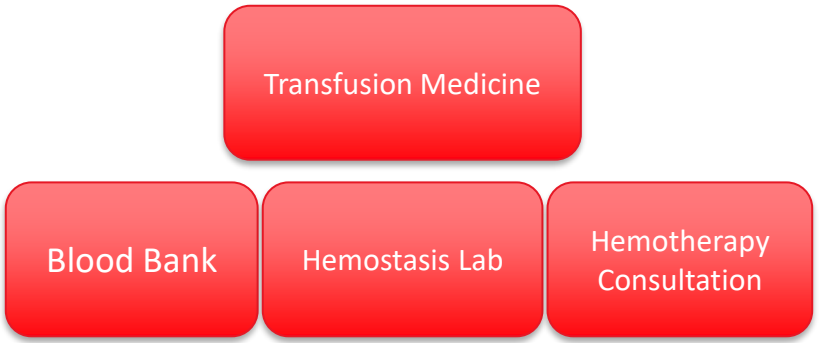
- No conflicts of interest

OBJECTIVES

- Describe the role of transfusion medicine service in Massive Transfusion
- Identify critical components of Massive Transfusion Protocol
- Discuss quality metrics and performance review

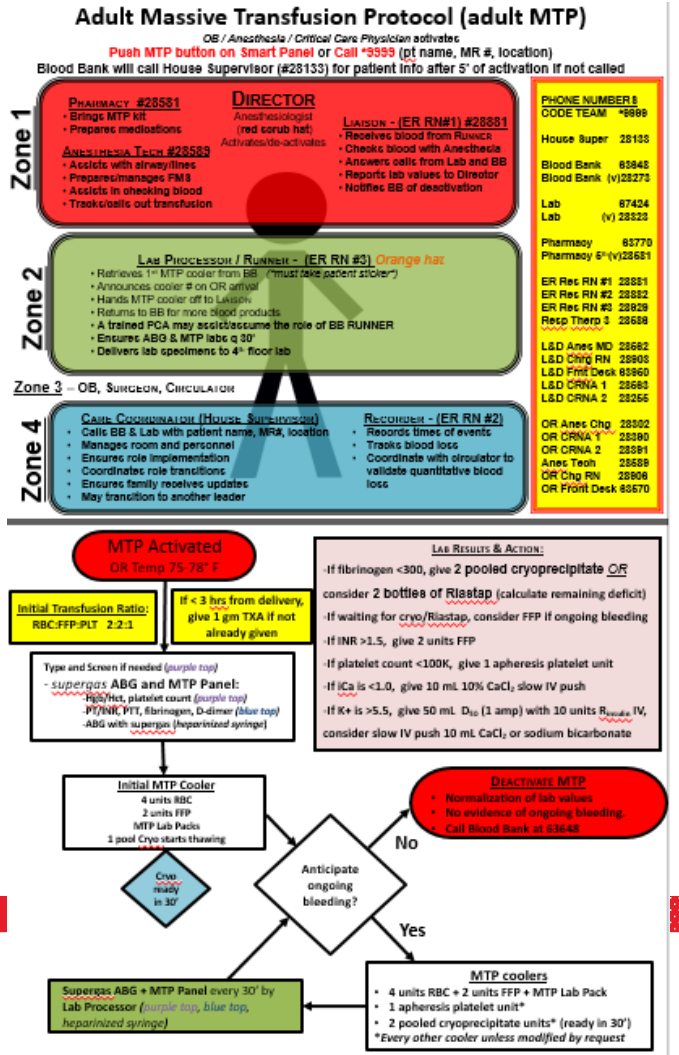
ROLE OF TRANSFUSION MEDICINE

- Timely management of massively bleeding patient requires significant coordination of resources
- Providing fast, safe and appropriate amount of blood products for resuscitation
- Providing timely coagulation studies to allow goal directed therapy
- Monitoring of the quality metrics as well as product wastage
- Availability of Transfusion Medicine specialist for consultation during massive transfusion



KEY COMPONENTS OF MTP PROTOCOL

- Information for easy and rapid activation
- Resource allocation and role assignment
- Blood Bank procedure for product preparation
- Uninterrupted delivery of products to the bedside
- Transfusion guidance
- Recommendations for adjunct product administration
- Testing guidance



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THERE IS ROOM FOR IMPROVEMENT NATIONWIDE

- Thirty-one survey responses from facilities across the United States
- 51.6% greater than 500 beds , 55.2% tertiary care, 85.7% designated as a trauma center, 75% teaching hospital
- Only 4 had 100% compliance
  - Uncrossmatched blood was identified with a special sticker or tag
  - O-negative blood was used for emergency release
  - The medical director was accessible on-site, on-call or both
  - Type and cross-match was collected as soon as possible

P-QU-6 | **Massive Transfusion Protocols for Obstetrical Hemorrhage: Current Recommendations and Practice**

T. Moon[1], A. Carpenter[2], J. Sadler[1]
[1]UNC, Chapel Hill, [2]Duke University Hospital System

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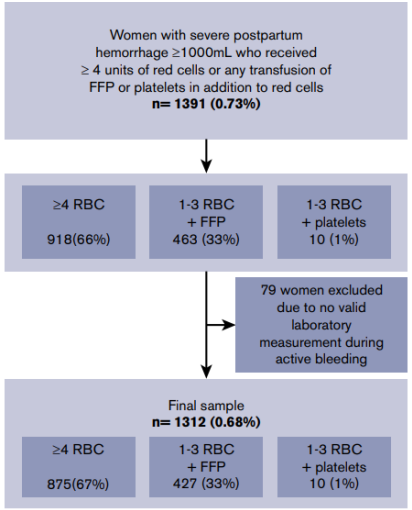
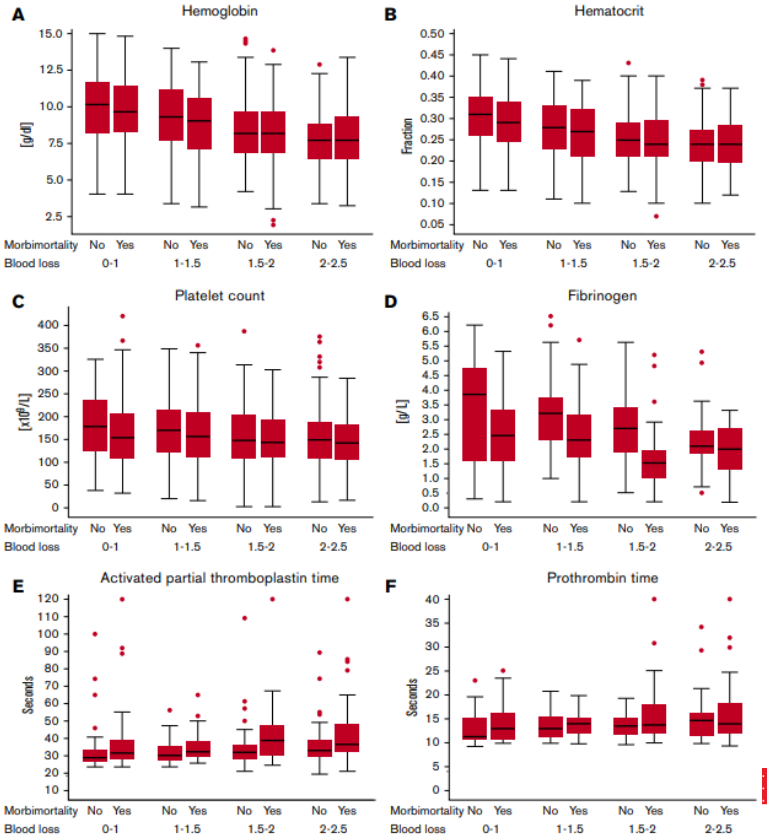
Moon et al, Transfusion 2023

COAGULOPATHY IN OBSTETRIC HEMORRHAGE

- Low fibrinogen and prolonged aPTT during the first 2 L of hemorrhage were associated with a subsequent composite adverse outcome
- Among women with and without the composite end point after 1.5 to 2 L of hemorrhage
  - Median fibrinogen 1.5 g/L (IQR, 1.0-1.9) vs 2.7 g/L (IQR, 1.9-3.4)
  - Median aPTT 32 s (IQR, 28-36) vs 39 s (IQR, 30-47)
  - PT and platelet count as assessed during the first 2 L of hemorrhage were not associated with morbidity or mortality





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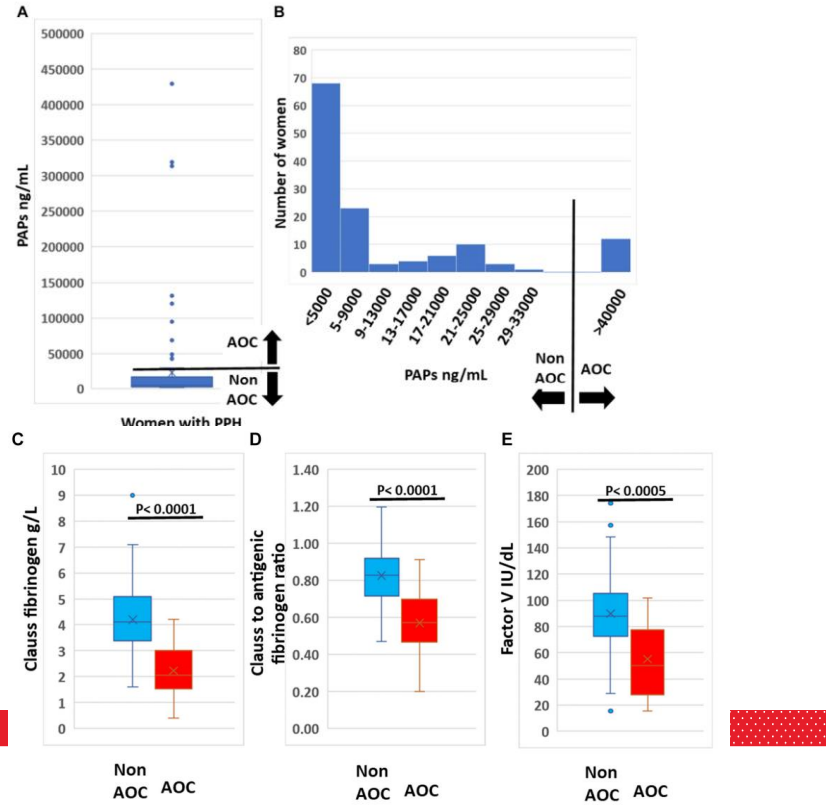
Gillissen et al, Bloodadvances, 2018. DOI 10.1182

ACUTE OBSTETRIC COAGULOPATHY(AOC)

- Clinically significant coagulopathy is rare during PPH
- At 1000 mL blood loss, fibrinogen was ≤2 g/L in 2.4%
  - 22.2% of cases with abruption
- Women with very large bleeds (>3000 mL) had evidence of a dilutional coagulopathy, although hemostatic impairment was uncommon
- Hyperfibrinolysis was observed in a small subgroup (1.06/1000 maternities)



Lloyd et al, J Thromb Haemost. 2023;21:862–879

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AOC

- Plasmin/antiplasmin (PAP) > 40 000 ng/mL
- Strongly Positive D-dimer
- Hypofibrinogenemia
- Dysfibrinogenemia
- Reduced factor V, factor VIII and factor IX
- Decreased factor XIII
- Increased activated protein C

	Nonpregnant healthy controls (laboratory normal range or reference ranges)	Nonbleeding term pregnancy controls *N* = 37	Nonacute obstetric coagulopathy group Median (IQR) Range *N* = 118	Acute obstetric coagulopathy group Median (IQR) Range *N* = 12	*P* Non-AOC vs AOC
Factor V (IU/dL) Median (IQR), range	50–200	108 (99–118) 74–222	88 (73–105) 16–174	50 (32–77) 16–102	<.0005
D-dimer (ng/mL) Median (IQR), range	<350	599 (410–866) 239–2226	1702 (915–2726) 240–17 438	43915 (14 283–58 085) 10 607–64 145	<.0001
Plasminogen (IU/dL) Median (IQR), range	80–120	ND	103 (91–120) 37–173	82 (70–100) 54–124	<.05
Platelets ($\times 10^9$/L) Median (IQR), range	150–400	230 (181–279) 101–419	187 (150–251) 19–435	149 (109–172) 98–184	<.01
aPTT (s) Median (IQR), range	27–38.5	25.1 (23.4–26.0) 20–29.8	24.5 (22.2–26.4) 20–63.3	27.2 (24.8–29.6) 22.9–34.8	<.05
Clauss fibrinogen (g/L) Median (IQR), range	2.8 (2.5–3.3) 1.8–4.9	5.9 (4.4–5.6) 3.5–7.9	4.1 (3.4–5.0) 1.6–9.0	2.1 (1.6–3.0) 0.4–4.2	<.0001
Fibtem A5 (mm) Median (IQR), range	ND	23 (21–26) 6.0–33	20 (16–24) 7–37	11.5 (8–14) 0–21	<.0001
Fibrinogen ELISA (g/L) Median (IQR), range	3.5 (3.2–4.1) 2.0–7.2	6.4 (5.8–7.4) 4.7–8.5	5.0 (4.3–5.9) 1.8–10.1	4.0 (3–4.5) 2–5.6	<.005
Fibrinogen Clauss/ELISA ratio Median (IQR), range	0.80 (0.76–0.87) 0.66–0.96	0.76 (0.72–0.84) 0.57–10.4	0.83 (0.72–0.92) 0.47–1.20	0.57 (0.48–0.68) 0.21–0.91	<.0001
VWF/FVIII ratio Median (IQR), range	ND	1.38 (1.05–1.88) 0.59–2.58	1.29 (1.05–1.69) 0.28–5.60	3.57 (2.26–5.29) 1.34–8.54	<.0001
Factor IX (IU/dL) Median (IQR), range	50–150	173 (159–188) 74–267	158 (133–178) 56–275	122 (111–158) 68–277	<.05
Factor XIII (IU/dL)	64–136	54 (43–81) 22–98	54 (43–65) 15–136	45 (34–51) 19–60	<.01
Highest activated protein C (IU/dL) during bleeding Median (IQR), range	2.4 (2.0–3.3) 1.6–4.2[1] *N* = 70	11 (9.7–12.3) 3.1–17.5 *N* = 21	19.6 (15.2–34.9) 2.4–172 *N* = 54	88.7 (46.4–121) 38–993 *N* = 6	.0007

Lloyd et al, J Thromb Haemost. 2023;21:862–879

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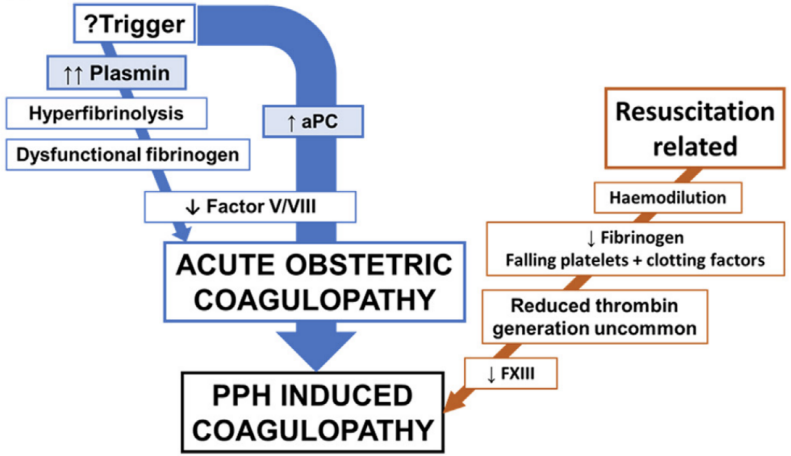
MECHANISM INVOLVED IN COAGULOPATHY ASSOCIATED WITH OBSTETRIC HEMORRHAGE

- PPH-associated coagulopathy has been described as a form of disseminated intravascular coagulation (DIC) where hemostatic changes are predominantly due to consumption of coagulation factors
- Increased pro-coagulant factors, including fibrinogen, FVIII, and von Willebrand factor (VWF), and reduced anticoagulants, such as protein S
- Fibrinogen falls to critically low levels earlier than other coagulation factors during PPH
- Prolongation of prothrombin time (PT) or activated partial thromboplastin time (APTT) is rare during PPH until bleeding exceeds 3 L
- Rarely severe coagulopathy may contribute to bleeding, classically in the setting of amniotic fluid embolism and placental abruption



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Bell et al, J Thromb Haemost. 2023;21:2064–2077

FIBRINOGEN

- Women with severe PPH had
  - Lower fibrinogen, factor V, antithrombin activity, protein C antigen, prolonged prothrombin time
  - Higher D-dimer and TAT complexes
- Multivariate analysis showed Fibrinogen as the only marker associated with the occurrence of severe PPH
- The risk for severe PPH was 2.63-fold higher for each 1 g/L decrease of fibrinogen
- Positive predictive value of a fibrinogen concentration of ≤2 g/L was 100%
- Negative predictive value of concentration >4g/L was 79%

ORIGINAL ARTICLE

The decrease of fibrinogen is an early predictor of the severity of postpartum hemorrhage

B. CHARBIT,*† L. MANDELBROT,‡ E. SAMAIN,§ G. BARON,¶ B. HADDAOUI,‡‡‡ H. KEITA,‡¶ O. SIBONY,** D. MAHIEU-CAPUTO,¶ M. F. HURTAUD-ROUX,** M. G. HUISSE,¶‡‡ M. H. DENNINGER,†‡‡ and D. DE PROST‡††‡‡ FOR THE PPH STUDY GROUP

*AP-HP, Hôpital Saint-Antoine, Clinical Investigation Center, Paris; †AP-HP, Hôpital Beaujon, Clichy; ‡AP-HP, Hôpital Louis Mourier, Colombes; §Hôpital Jean Minjoz, Besançon; ¶AP-HP, Hôpital Bichat, Paris; **AP-HP, Hôpital Robert Debré, Paris; ††INSERM U698, Paris; and ‡‡AP-HP, CIB PhenoGen, Paris, France

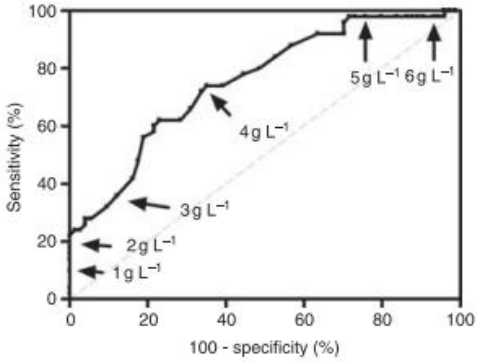

Fig. 3. ROC curve of fibrinogen plasma concentration at H0 for the diagnosis of severe postpartum hemorrhage.

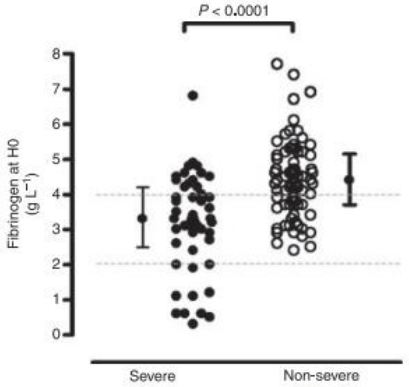

Fig. 2. Individual fibrinogen plasma concentrations at H0 in women with severe (●) or non-severe (○) postpartum hemorrhage. Mean ± SD values are reported for both groups.

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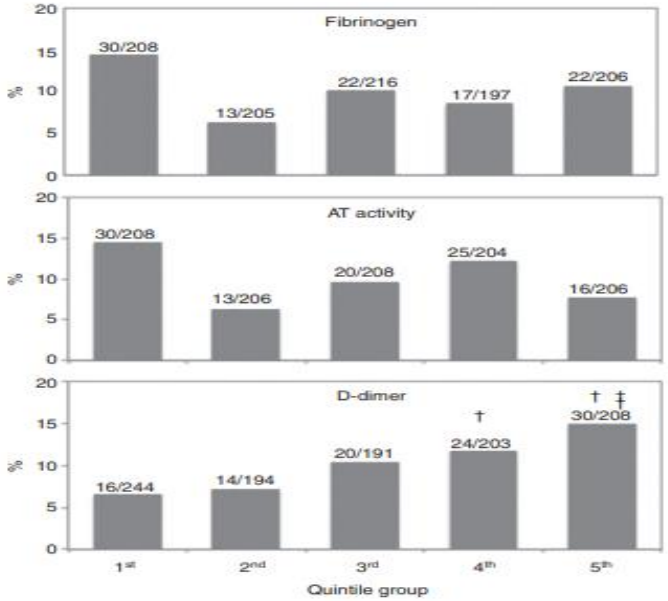
Charbit et al, J Thromb Haemost. 2007 Feb;5(2):266-73

D-DIMER

Naho Endo-Kawamura, Mana Obata-Yasuoka*, Hiroya Yagi, Rena Ohara, Yuko Nagai, Miyuki Mayumi, Kanako Abe and Hiromi Hamada

Higher D-dimer level in the early third trimester predicts the occurrence of postpartum hemorrhage

- Three blood variables were identified as independent risk factors for PPH at week 35-37
  - Fibrinogen level < 4.0 g/L (OR [95% CI], 1.96)
  - D-dimer level > 2.7 μg/mL (2.03 [1.29–3.19])
  - Antithrombin activity < 85% (1.84 [1.05–3.21])



Endo-Kawamura et al, J Perinat Med. 2016 Jul 1;44(5):551-6

FACTOR XIII

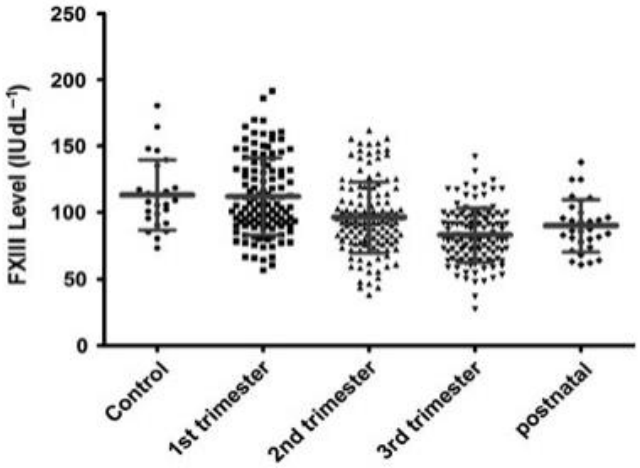
- Factor XIII (FXIII), fibrin stabilizing factor, circulates in plasma as a heterodimer composed of two catalytic A–subunits and two carrier B–subunits
- Samples from 376 women with normal pregnancy
- Significant reduction in the mean FXIII activity during the second and third trimester
- References ranges
  - First Trimester 55–169 IU/dL
  - Second Trimester 45–147 IU/dL
  - Third trimester 42–125 IU/dL
  - Postpartum period 61–137 IU/dL

ORIGINAL ARTICLE *Rare bleeding disorders*

Changes in factor XIII level during pregnancy

L. T. SHARIEF,*† A. S. LAWRIE,‡ I. J. MACKIE,‡ C. SMITH,§ F. PEYVANDI¶** and R. A. KADIR†

*Institute of Women's Health, University College London; †Obstetrics and Gynaecology Department, Haemophilia centre and Thrombosis Unit, Royal Free Hospital NHS Foundation Trust; ‡Haemostasis Research Unit, Department of Haematology, University College London; §Institute of Epidemiology & Health, University College London, London, UK; ¶Angelo Bianchi Bonomi Hemophilia and Thrombosis, Centre Fondazione IRCCS Ca' Granda, Ospedale Maggiore Policlinico; and **Angelo Bianchi Bonomi Hemophilia and Thrombosis Center, Università degli Studi di Milano, Milan, Italy



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Sharief et al, Haemophilia. 2014 Mar;20(2):e144-8

GOAL DIRECTED THERAPY

Green-top Guideline No. 47
May 2015

Royal College of Obstetricians & Gynaecologists

- **FFP** at a dose of **12–15 ml/kg** should be administered **for every 6 units of red cells** during major obstetric hemorrhage. Subsequent FFP transfusion should be guided by the results of clotting tests if they are available in a timely manner, aiming to maintain prothrombin time (PT) and activated partial thromboplastin time (APTT) ratios at less than 1.5 x normal.
- **Cryoprecipitate** at a standard dose of **two 5-unit pools** should be administered early in major obstetric hemorrhage. Subsequent cryoprecipitate transfusion should be guided by fibrinogen results, aiming to keep levels above 1.5 g/l.

GOAL DIRECTED THERAPY

ACOG PRACTICE BULLETIN SUMMARY

Clinical Management Guidelines for Obstetrician–Gynecologists

NUMBER 183, OCTOBER 2017

(Replaces Practice Bulletin Number 76, October 2006)

The American College of Obstetricians and Gynecologists
WOMEN'S HEALTH CARE PHYSICIANS

- When a massive transfusion protocol is needed, fixed ratios (6:4:1 ratio) of packed red blood cells, fresh frozen plasma, and platelets should be used.

TRANSFUSION RATIO

- Starting with Fixed-ratio, followed by goal directed therapy once the lab results are obtained
- Actual cumulative product infusion differed from the initially recommended ratio
- **Goal directed therapy** is safe and effective however, rarely results in fixed ratio of products

Table 2 Estimated blood loss, crystalloid and blood products administered during MTP

	Median (Q1, Q3)	Mean ± SD
IVF (mL)	3,200 (2,500, 4,350)	3,683 ± 1,869
EBL (mL)	1,650 (1,100, 2,237)	1,945 ± 1,225
RBC transfused, units	5 (3, 9)	6.5 ± 5.2
FFP + Cryo transfused, units	11.5 (2, 22)	14.8 ± 16.4
PLT transfused, units	6 (0, 12)	8.3 ± 9.7
FFP + Cryo/RBC	1.56 (0.67, 3)	2.5 ± 3.51
PLT/RBC	1 (0, 1.5)	1.1 ± 1.41

Table 5 Laboratory values for blood count, coagulation indices, and electrolytes before, during, and after massive transfusion protocol

Hemoglobin (g/dL)	10.5 ± 1.8	9.8 ± 1.7[a]	10.3 ± 1.6
Hematocrit (%)	31.0 ± 5.0	28.0 ± 4.9[a]	30.6 ± 4.4
Platelets (×1,000/μL)	169 ± 56	161 ± 57[a]	216 ± 83
Prothrombin time (s)	14.5 ± 2.5	14.8 ± 2.1[b]	13.8 ± 1.8
INR	1.2 ± 0.2	1.2 ± 0.2[b]	1.1 ± 0.1
Partial thromboplastin time (s)	32.6 ± 10.0	31.4 ± 5.7[b]	30.5 ± 3.3
Fibrinogen (mg/dL)	384 ± 153	362 ± 113[a]	446 ± 117

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Salmanian et al, Am J Perinatol 2023;40:95–98

TRANSFUSION RATIO

Identified studies detailing massive transfusion protocols during obstetric haemorrhage.

	Year	Cases	Protocol
Bonnet MP et al. [9]	2011	38	FFP/RBC ratio exceeds 1 at 12 h following the onset of obstetric haemorrhage.
Matsunaga S et al. [10]	2012	196	Medically necessary FFP/RCC ratio is 1.3 in obstetric haemorrhage.
Gutierrez MC et al. [12]	2012	26	MTP was defined as a combination of 6 units of O-negative RBC, 4 units of FFP (liquid AB plasma or thawed type-specific plasma), and 1 apheresis platelet (PLT) unit.
Green L et al. [11]	2016	181	FFP/RBC ratio $\geq$ 1 required during massive obstetrics haemorrhage.
Tanaka H et al. [13]	2016	52	Transfusion of FFP/RBC ratio $\geq$ 1 reduces mortality during amniotic fluid embolism with coagulopathy.

- FFP/RBC ratio of $\geq$1 has been observed in obstetric population to maintain adequate coagulation parameters
- Post-embolism survival following transfusion with a FFP/RBC ratio $\geq$1 (odds ratio: 28.32; 95% confidence interval)

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H. Tanaka et al., Taiw Jour of Obst & Gyn, 2017, 715e718

TRANEXAMIC ACID

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

WOMAN Trial Collaborators*

Lancet 2017; 389: 2105–16

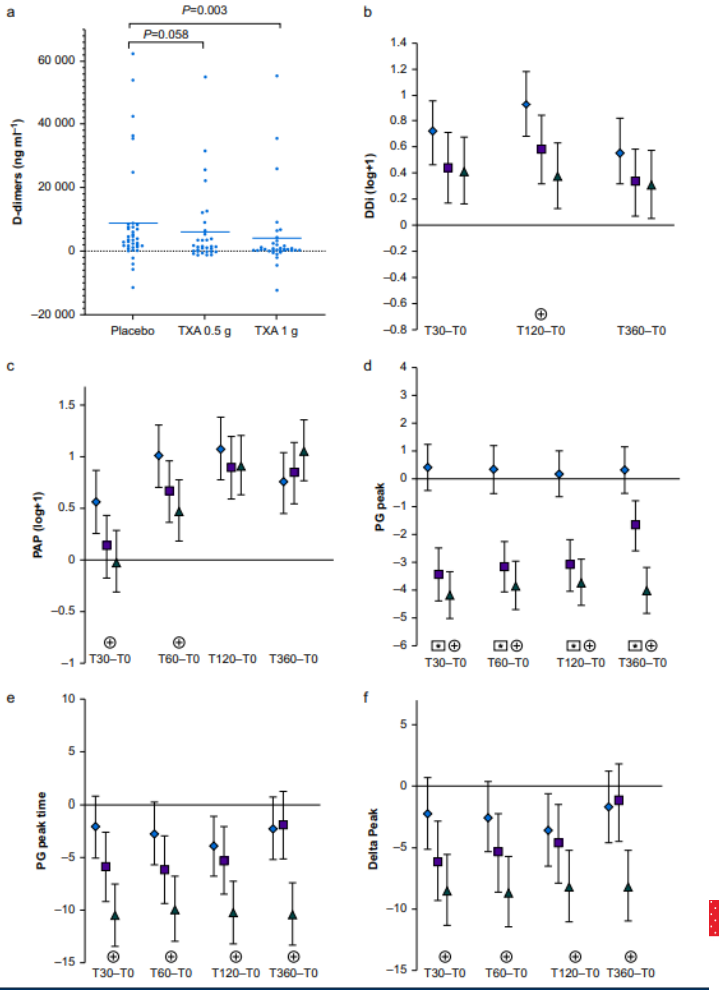
- 20,060 women were enrolled and randomly assigned to 1 g intravenous tranexamic acid or matching placebo
- A significant **reduction of mortality** (1.5% versus 1.9%, P=.045 for tranexamic acid compared to placebo, respectively)
- When the treatment was **given within 3 hours of birth**, the mortality rates from obstetric hemorrhage were 1.2% versus 1.7% comparing tranexamic acid to placebo (P=0.008)
- No increase in risk of thrombosis

Lancet. 2017 May 27;389(10084):2105-2116.

Tranexamic acid dose–response relationship for antifibrinolysis in postpartum haemorrhage during Caesarean delivery: TRACES, a double-blind, placebo-controlled, multicentre, dose-ranging biomarker study

Anne-Sophie Ducloy-Bouthors[1,2,*], Sixtine Gilliot[2], Maeva Kyheng[3,4], David Faraoni[5], Alexandre Turbelin[1], Hawa Keita-Meyer[6], Agnès Rigouzzo[7], Gabriela Moyanotidou[8], Benjamin Constant[9], Francoise Broisin[10], Agnès L. Gouez[11], Rémi Favier[12], Edith Peynaud[13], Louise Ghesquiere[14], Gilles Lebuffe[2,15], Alain Duhamel[3,4], Delphine Allorge[16], Sophie Susen[17], Benjamin Hennart[16], Emmanuelle Jeanpierre[17], Pascal Odou[2], and the TRACES working group[†]

- Comparing TXA 0.5g vs 1g vs placebo
- Hyper fibrinolysis was evidenced by a mean increase over baseline of 93% for D-dimer level at 120 min and 56% for the plasmin-antiplasmin level at 30 min
- 1 g was associated with smaller increases over baseline D-dimers: 38% (13-63) [P=0.003 vs placebo]; plasmin-antiplasmin: -2% (-32 to 28) [P=0.009 vs placebo]
- **Tranexamic acid 0.5 g was less potent**, with non-significant reductions, D-dimers: 58% (32-84]) [P=0.06 vs placebo]; plasmin antiplasmin: 13% (18-43) [P=0.051]
- Both tranexamic acid doses reduced the plasmin peak



British Journal of Anesthesia, 129 (6): 937e945 (2022)

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EARLY ADMINISTRATION OF CRYOPRECIPITATE

- Multicenter randomized pilot trial
- Administration of cryo within 90 min vs control group
- **Less blood transfusions** (excluding intervention cryoprecipitate) in the intervention group at both 24 h (4.1 vs. 5.1 units, mean difference -1, 95%CI -2.3–0.4) and at discharge (4.2 vs. 5.2 units, mean difference -1, 95%CI: -2.4–0.4)
- **Fewer surgical procedures** in the intervention group had (46% vs. 59%, OR 0.6, 95%CI 0.3–1.1) and fewer ICU admissions (5% vs. 13%, OR 0.4, 95%CI 0.1–1.1)

Early cryoprecipitate transfusion versus standard care in severe postpartum haemorrhage: a pilot cluster-randomised trial

L. Green,[1,2] **J. Daru,**[3] **F. J. Gonzalez Carreras,**[4] **D. Lanz,**[5] **M. C. Pardo,**[6] **T. Pérez,**[7] **S. Philip,**[8] **T. Tanqueray,**[9] **K. S. Khan,**[10,11] and collaborators*

	Intervention n = 110	Control n = 70	Total n = 180	Mean difference/ OR (95% CI)[a]
Estimated blood loss, ml	2326 (985)	2688 (1315)	2467 (1135)	−362 (−701 to −23)
Blood transfusion requirements from PPH to discharge				
RBC; units	2.5 (1.9)	3.2 (2.3)	2.8 (2.1)	−0.7 (−1.3 to −0.1)
FFP; units	0.8 (1.7)	1.1 (1.6)	0.9 (1.6)	−0.2 (−0.7–0.3)
Platelets; units	0.1 (0.5)	0.2 (0.6)	0.2 (0.6)	−0.1 (−0.3–0.1)
Cryo; units[c]	0.7 (1)	0.7 (1.3)	0.7 (1.1)	0 (−0.3–0.3)
Total; units[c]	4.2 (4.1)	5.2 (5.2)	4.6 (4.6)	−1 (−2.4–0.4)

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Anaesthesia 2022, 77, 175–184

EARLY ADMINISTRATION OF FIBRINOGEN CONCENTRATE

- Multicenter, RCT, 437 patients
- Failure as composite primary efficacy endpoint: at least 4 g/dl of hemoglobin decrease and/or transfusion of at least two units of packed red blood cells within 48 hours following investigational medicinal product administration
- Blood loss and plasma fibrinogen were similar in both groups
- Failure rates were 40.0% and 42.4% in the fibrinogen and placebo groups, respectively (odds ratio [OR] = 0.99) after adjustment for center and baseline plasma fibrinogen; (95% CI 0.66–1.47; P = 0.96)

Early and systematic administration of fibrinogen concentrate in postpartum haemorrhage following vaginal delivery: the FIDEL randomised controlled trial

AS Ducloy-Bouthors,[a,b] FJ Mercier,[c,*] JM Grouin,[d] F Bayoumeu,[e] J Corouge,[a] A Le Gouez,[c] T Rackelboom,[f] F Broisin,[g] F Vial,[h] A Luzi,[i] O Capronnier,[j] C Huissoud,[g,k,*] A Mignon,[f,*] the FIDEL working group[†]

Outcome	Fibrinogen $n = 220$	Placebo $n = 210$	OR (95%CI)	*P*-value
Primary outcome				
Failure, *n* (%)	88 (40.0%)	89 (42.4%)	0.99 (0.66–1.47)	0.96*
Secondary outcomes				
RBC transfusion ≥2 Units from H0 to D2, *n* (%)	51 (23.4%)	52 (25.0%)	1.00 (0.63–1.60)	0.98*
RBC transfusion ≥4 Units from H0 to D2, *n* (%)	6 (2.7%)	5 (2.4%)		0.87**
Number of RBC units per transfused patient from H0 to D2, mean ± SD	2.7 ± 1.2	3.1 ± 2.5		0.99***
Hb loss ≥4 g/dl from reference level to D2, *n* (%)	42 (19.1%)	41 (19.5%)	1.02 (0.62;1.67)	0.95*
Hb loss ≥3 g/dl from reference level to D2, *n* (%)	102 (46.4%)	98 (46.9%)		0.91**
Hb loss ≥4 g/dl from H0 to D2, *n* (%)	16 (7.3%)	17 (8.3%)		0.69**
Hb level < 9 g/dl from reference level to D2, *n* (%)	112 (50.9%)	117 (56.0%)		0.29**
Total blood loss (from baseline to D2), mean ± SD, ml	1555 ± 849	1723 ± 1193		0.21***
Additional blood loss (from H0 to D2), mean ± SD, ml	304.7 ± 386.2	319.7 ± 417.1		0.33***
Intrauterine balloon, *n* (%)	63 (28.6%)	61 (29.0%)		0.93**
At least one rescue procedure, *n* (%)	65 (29.5%)	64 (30.5%)		0.83**
At least one invasive haemostatic procedure, *n* (%), including:	8 (3.6%)	10 (4.8%)		0.56**
Arterial embolisation	6 (2.7%)	10 (4.8%)		0.27**
Arterial ligation	0 (0%)	0 (0%)		—
Hysterectomy	0 (0%)	1 (0.5%)		0.49****
Intensive care or resuscitation, *n* (%)	62 (28.2%)	54 (25.7%)		0.56**
Length of stay in intensive care or resuscitation unit, mean ± SD, day	0.7 ± 0.6	0.7 ± 0.9		0.84***
SOFA score of patients admitted to intensive care or resuscitation unit, median [min; max]	0 [0;4]	0 [0;6]		0.32***
Death, *n* (%)	0 (0%)	0 (0%)		—

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BJOG 2021;128:1814–1823

WHOLE BLOOD

- 610 patients required at least 1 unit of RBCs within 24 h of delivery
- 12.0% (n = 73) met criteria for massive transfusion
- Mean transfusion requirement of 8.6 units of PRBC, 6.6 units of FFP, 1.0 units of PLT, and 5 units of pooled Cryoprecipitate
- 93.9% of patients were RhD-positive (n = 573)
  - This population would be eligible for receiving LTOWB
- 3.28% (n = 20) of patients possessed a passive anti-D due to prior Rh immunoglobulin (RhIg) administration
- 2.0% had allo-antibodies

MAJOR HEMORRHAGE

TRANSFUSION

Risk factors for massive transfusion in obstetrical hemorrhage and consideration of a whole blood program

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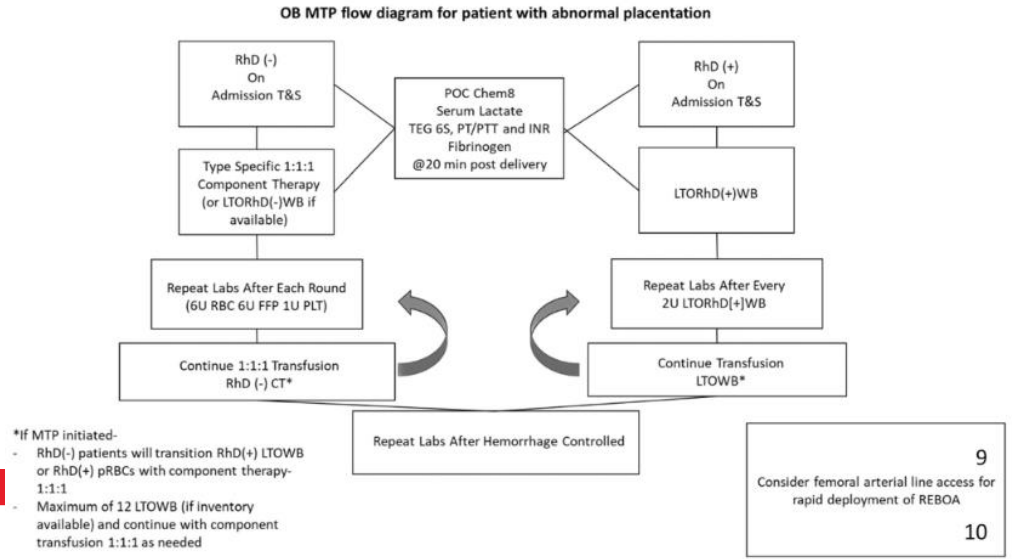

Transfusion. 2023;63:S112–S119.

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LABORATORY MONITORING

- 20,349 patients, ROTEM monitoring
- Patients in the PCVT group received
  - **Fewer transfusions of RBCs** (P=0.0001), **FFP** (P b 0.0001), **and platelets** (P= 0.0001)
  - **Estimated blood loss was also significantly lower in the PCVT group** (median [IQR] 2000 [1600–2500] vs 3000 [2000–4000] mL, P b 0.001)
  - **The incidence of puerperal hysterectomy** (25% [7/28] vs 53.5% [31/58], P = 0.013) and **postoperative ICU admission** (3.6% [1/28] vs 43.1% [25/58], P b 0.001) were significantly lower in the PCVT group

Point-of-care viscoelastic testing improves the outcome of pregnancies complicated by severe postpartum hemorrhage

Denis Snegovskikh, M.D. [a,*], Dmitri Souza, M.D.,Ph.D. [b], Zachary Walton, M.D., Ph.D. [a], Feng Dai, Ph.D. [c], Rachel Rachler [d], Angelique Garay [e], Victoria V. Snegovskikh, M.D. [f], Ferne R. Braveman, M.D. [e], Errol R. Norwitz, M.D., Ph.D. [g]

Table 2
Postoperative outcomes of the study population[a].

	PCVT ($n = 28$)	Non-PCVT ($n = 58$)	*P*-value
Hematocrit on postoperative day 1 (%)	24.7 (23.0–26.6)	27.8 (24.5–30.0)	0.004
Hysterectomy, yes	7 (25.0%)	31 (53.5%)	0.013
Estimated blood loss (mL)	2000 (1600–2500)	3000 (2000–4000)	<0.001
Crystalloids (mL)	3500 (3100–4500)	3500 (3000–4100)	0.88
Hextend (mL)	0 (0–250)	0 (0–500)	0.45
Red blood cells (units)			<0.001
- 0	11 (39.3%)	3 (5.2%)	
- 1	7 (25.0%)	3 (5.2%)	
- ≥2	10 (35.7%)	52 (89.6%)	
Fresh frozen plasma (units)			<0.001
- 0	25 (89.3%)	16 (27.6%)	
- ≥1	3 (10.7%)	42 (72.4%)	
Albumin (units)			0.09
- 0	28 (100%)	51 (87.9%)	
- 500 to 1000	0 (0%)	7 (12.1%)	
Cryoprecipitate (units)			0.78
- 0	22 (78.6%)	47 (81.0%)	
- ≥5	6 (21.4%)	11 (19%)	
Platelets (units)			<0.001
- 0	28 (100%)	32 (55.2%)	
- ≥5	0 (0%)	26 (44.8%)	
Length of hospitalization after delivery (days)	4 (3–4)	5 (4–6)	<0.001
ICU admission	1 (3.6%)	25 (43.1%)	<0.001

[a] Data are expressed as n (%), median (interquartile range).

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Snegovskikh et al. , Journal of Clinical Anesthesia 44 (2018) 50–56

REVIEW OF CLINICAL PERFORMANCE

- Ultimate goal is to improve patient outcomes
- Standardization of the review process
- Providing education and feedback to the clinicians
- Currently there are no mandated quality metrics available for obstetric massive transfusion monitoring

The trauma center should review cases of massive transfusion with the following complications:

- Coagulopathy
- Thrombotic complications
- ARDS
- Other transfusion reactions, including TACO (transfusion-associated volume overload), TRALI (transfusion-related acute lung injury), and hemolytic transfusion reaction
- Over-transfusion of RBC
- Death

QUALITY METRICS

- Documentation
- Timing of activation and deactivation
- Product wastage
- Compliance
  - Laboratory monitoring
  - Transfusion protocol
- Review of missed opportunities

Metric	Goal
Documentation	100%
Time of Activation to First RBC Infusion	30 minutes
Time of Activation to First FFP Infusion	45 minutes
Time of Activation to Time of MTP Pack Issued	10 minutes
Product Wastage RBC	<1%
Product Wastage Plasma	<5%
Product Wastage Platelet	<5%
Product Wastage Cryoprecipitate	<35%
Lab Collection after MTP Activation	100%
Time of MTP Activation to Time of Collection of first Labs	< 30 minutes
Time from MTP lab collection to result	< 45 minutes
Transfusion ratio	<2
Time of Deactivation to Time of Blood Bank Notification	<1 hour

SUMMARY

- Post partum hemorrhage is a leading cause of maternal mortality and morbidity
- Severe coagulopathy is rare but can be associated with poor outcomes
- Standardized resuscitation strategies can improve outcomes
- Multidisciplinary approach is crucial for developing effective strategies and protocol development

THANK YOU

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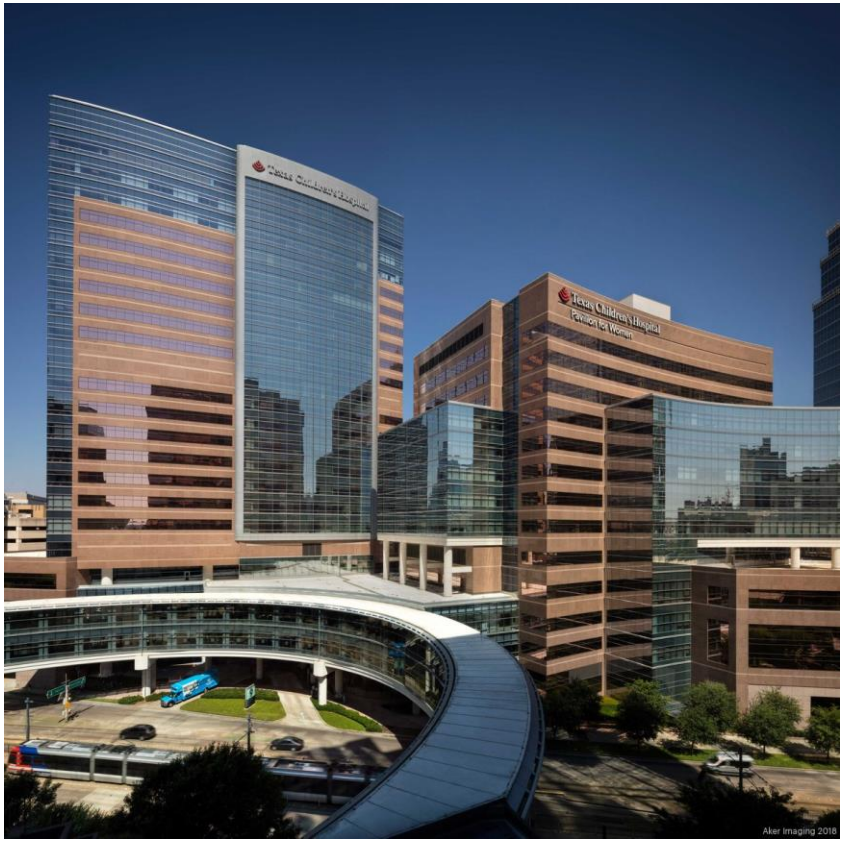

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