DOI: 10.21276/sjams.2016.4.10.15

Scholars Journal of Applied Medical Sciences (SJAMS) **ISSN 2320-6691 (Online)**
Sch. J. App. Med. Sci., 2016; 4(10A):3612-3623 **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Original Research Article

Role of Anaesthesiologist in Management of PPH

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Abstract: Obstetric haemorrhage is the one of the most common cause of maternal mortality worldwide accounting for 25-30%of all maternal deaths. Most of these deaths occur during labour, delivery or in the immediate postpartum period. The management of postpartum haemorrhage poses a threat to the developing as well as developed nations. Even today, in India most of the deliveries are unsupervised in the rural setting. One of the biggest shortcomings to the Millennium Development Goal 2015 of reducing the maternal mortality to 109/100,000 is dearth of specialists including anaesthesiologists at the level of primary care .Postpartum haemorrhage(PPH) is a life threatening situation. Simultaneous teamwork involving the obstetrician, anaesthesiologist ,haematologist, radiologist, operation theatre and labour room ,blood bank department is crucial for preventing mortality .Multiple tasks are to be performed by anaesthesiologists including resuscitation, monitoring vital signs, estimating blood loss, ordering and procuring blood and blood components ,activation of massive transfusion protocol, anaesthesia for various procedures to control bleeding including interventional radiology. The objective of this review is to familiarize the anaesthesiologist with the latest trends in transfusion practice and monitoring such as early use of fibrinogen concentrate based on point of care testing along with FIBTEM A5 has revolutionised the management of post-partum haemorrhage which is a must know for every anaesthesiologist. Finally a local protocol to be applicable in a tertiary care centre is outlined so that prompt measures can be taken so that mother's lives are not in jeopardy.
Keywords: Haemorrhage, Anaesthesiologist, Postpartum hemorrhage; Fibrinogen.

INTRODUCTION:

The World Health Organization (WHO) has described PPH as

- a blood loss of > 500 ml [1] in the first 24 hours after vaginal delivery as primary PPH or 1000 ml [2, 3] after caesarean section
- Severe obstetric haemorrhage [4] involves a blood loss of > 1500 ml, or a decrease in haemoglobin > 4 g/dl or a decrease in haematocrit by 10%, or requiring > 4 unit's blood transfusion.
- Major [4] haemorrhage as blood loss > 2500 ml,
- massive haemorrhage [5] as the loss of one blood volume or transfusion of at least 10 U of packed RBCs in 24 hours, loss of 50%blood volume in 3 hours ,or blood loss at a rate more than 150ml/min and is associated with significant morbidity [6].
- The latest UK Confidential Enquiry into Maternal Deaths reported substandard level of care either too little (IV fluid, oxytocic's, blood clotting factors) was given or too late(prostaglandins, resuscitation, blood components, decision for surgery, to get senior surgeon and anaesthetist involved) [6].
- Towards term, blood flow to the placenta is approximately 700 ml per minute. Unless the placenta is expelled and the uterus contracts, rapid blood loss will continue, leading to shock, acidosis and even coagulopathy The relative hemodilution and high cardiac output allows the large amount of blood loss in a pregnant female before the hypotension occurs and tachycardia is a late sign A healthy

pregnant woman will not show signs of shock upto a blood loss of 1000 mL [7, 8].

- Blood loss is always underestimated [9, 10]. The amount of blood loss is determined by visual estimation using stained maternity pads, surgical swabs, floor spills or suction bottles. There are various guidelines published to facilitate visual estimation of blood loss [10].
- A chart has been developed by Queen Charlotte's Hospital, London to calculate blood loss. It implies, when PPH is restricted to bed only blood loss is around 1000ml, when PPH is spilling on the floor blood loss is 2000ml and a full kidney dish is 500ml [11].

However, visual assessment of blood loss is grossly inaccurate and clinicians can underestimate blood loss by 50% [10] and inaccuracy increases as bleeding increases. Devices such as calibrated blood-collection drape also improve estimation [12]. Latest development is to utilize mobile phones to estimate blood loss using a built in algorithm; .There is an app for it [13].

UK Confidential Enquiry into Maternal and Child Health (CEMACH) developed an 'Obstetric Early Warning Chart' to recognize and treat PPH at the earliest [14, 15]. The Royal College of obstetricians and gynaecologists RCOG recommends MEOWS (maternal obstetric early warning score) such as heart rate, arterial blood pressure, respiration mental status, urine output and capillary refill can be used to classify haemorrhagic shock into 4 different stages [16].

Table 1: classification of Haemorrhagic Shock

STAGES LOSS	BLOOD	% LOSS	SYMPTOMS
1	<1000ml	15%	asymptomatic
2	1000-1800ml	20-25%	tachycardia, orthostatic hypotension
3	1800-2200	30-35%	increasing tachycardia , tachypnoea, hypotension
4	>2200ml	>40%	shock, oliguria

The "RULE OF 30" is useful parameter to alert the obstetrician of warning signs. If the patient's systolic blood pressure drops by 30%, the heart rate rises by 30%, the respiratory rate increases to more than 30/minute, the haemoglobin (Hb) or haematocrit drops by 30%, and the urinary output decreases to <30 mL/hour, then the patient is likely to have lost 30% of her blood volume, and is in moderate shock, leading to severe shock.

The SHOCK INDEX [17] defined as the heart rate divided by the systolic blood pressure (normal up to 0.9 in obstetrics), has been shown , to be an accurate indicator of compensatory changes.in shock

DIFFERENCE BETWEEN OBSTETRIC AND NON OBSTETRIC HAEMORRHAGE is that

- Mothers have greater haemostatic reserve and
- they are in a prothrombotic state [18-20] especially due to
- Increased fibrinogen levels. At term fibrinogen levels are 5-7g/l
- besides, fibrinolysis increases
- there is –shortened PT &aPTT
- they have relative gestational thrombocytopenia

Reason for concern is because the parturient can undergo rapid deterioration from shock to coagulopathy, followed by multiorgan failure and death. Of deaths due to PPH, 90% occur in women who have none of the so-called classic risk factors. So regular implementation of preventive measures, rapid identification of patients and prompt measures to arrest the bleeding are vital for reducing maternal morbidity and mortality. A multidisciplinary approach involving obstetrician, anaesthesiologist haematologist, operation theatre ICU, and blood bank staff is pivotal for achieving a good outcome.

Table 2: Role of the Anaesthesiologist

1.Resuscitation
2.Assess vital signs ,airway, blood loss
3.Obtain venous access
4.Send lab investigations
5.Procure arterial and central venous access
6.Give fluid and blood products
7.Induction and maintenance of anaesthesia
8.Drug administration

The anaesthesiologist has been aptly called Captain of a sinking ship as while the obstetrician is busy performing procedures to arrest the cause of bleeding the other pair of hands i.e. the anaesthesiologist takes over to give optimum operating conditions to the obstetrician. The anaesthesiologist has more information on the hemodynamic picture and is the support system for the obstetrician.

ETIOLOGY of PPH is referred to as the 'Four T's [23].

1. Tone (70 %): Atonic uterus
2. Trauma (20%): Lacerations of the cervix, vagina and perineum
3. Tissue (10%): Retained products, placenta.
4. Thrombin (< 1%): Coagulation abnormalities

COMPLICATIONS of PPH are

- Acute renal injury [24].
- disseminated intravascular coagulation (DIC) [25]
- death,
- hysterectomy, and
- adult respiratory distress syndrome (ARDS) [26]

PREVENTION OF ATONIC PPH

- Active management of third stage of labour is strongly recommended.
- uterine massage,
- oxytocin administration reduces blood loss by 60%
- Oxytocin 5IU I/M at vaginal delivery and 5IU slow IV after caesarean section [27].

MANAGEMENT OF PPH

- Communication
- ,Resuscitation
- ,Monitoring
- Investigation and
- Measures to arrest bleeding have to be undertaken simultaneously

Senior obstetrician and senior anaesthesiologist must be involved early rather than late. After assessing the degree of haemorrhage resuscitation starts with ABCs

- Give 10-15L/min oxygen by face mask.
- Secure two large bore I V cannula 14-16 G (flow rate via a 14Gcannula is twice as fast as an 18G cannula)
- .Invasive arterial monitoring should be considered early in PPH
- Central venous access may be used but it should not delay resuscitation
- Send investigations viz full blood count
- group and cross match
- urea and electrolytes
- arterial blood gases
- coagulation profile, Prothrombin time, PT activated partial thromboplastin time, a PTT, fibrinogen, D dimer
- Rotational thrombo elastometry ROTEM ,FIBTEM A5and EXTEM if available

Commence rapid resuscitation with crystalloids to restore and maintain the circulating blood volume to prevent tissue and organ hypo‑perfusion. Organ cell damage does not occur until 100%blood volume is lost and equivalent fluid replacement is done.

In massive blood loss give crystalloid up to 2l,colloid 1.5l,4u packed red cells(PRBC,s),after 4u PRBC,s arrange for fresh frozen plasma(FFP)

Massive blood loss results in consumptive coagulopathy and this is difficult to distinguish from dilutional coagulopathy caused by transfusion with packed red cells and crystalloids [28]. Now, the accepted average ratio of colloid: crystalloid is 1:1.5 instead of 1:3 [29]. Crystalloids are preferred over colloids [30]. Thrombin generation is also decreased by dilution to a greater extent by crystalloid than by fresh frozen plasma [31].

Alexander *et al.;* [32] showed that whole blood was better than PRBCs in preventing acute tubular necrosis and other complications. Avoiding hypothermia, acidosis and hypocalcaemia will ensure optimal function of transfused coagulation factors, thereby preventing the lethal triad of coagulopathy. Simultaneously, the cause of the bleeding should be identified and controlled, by medical means, temporizing measures, mechanical measures or surgery.

If bleeding proves unresponsive to uterotonics, tranexamic acid (TXA) may be considered as an additional option [34], a synthetic derivative of lysine with antifibrinolytic properties, The WOMAN Trial for evaluating TXA for PPH treatment is underway [35]. WHO provides a weak recommendation for TXA where oxytocin and prostaglandins fail to control atonic PPH;however, RCOG reports that fibrinolytic inhibitors seldom have a place in PPH management .It is used for prevention of PPH in high risk cases [36].

TEMPORARY MEASURES

When medical measures fail the patient may be needed to be shifted to operation theatre for exploration and searching the etiology of bleeding. Temporary measures can be used to stop bleeding while patient is being shifted to operation theatre for definitive treatment of cause such as

- External aortic compression [37, 38].
- bimanual uterine compression and
- Non-pneumatic anti-shock garment (NASG) [39, 40].

External aortic compression reduces blood flow to the pelvic organs to a great extent at the same time preserving blood supply to surrounding organs. It can be applied with the fist of the hand above the umbilicus and slightly to left below the origin of renal arteries.

NASG can be applied to the lower extremities and abdomen whereby blood is shunted from here to central circulation it is made up of neoprene. It is useful in the low resource setting during transfer of patient to a higher referral centre.

Table 3: Pharmacological Methods for Managing PPH

DRUG	DOSE	SIDE EFFECTS
Oxytocin	Slow bolus of 5 U i/v followed by an infusion of 40 U over 4 hours is given routinely post cord clamping at all Caesarean sections. 2nd dose of 5 U i/v may be given	May cause tachycardia, hypotension and circulatory collapse
Ergometrine	250-500 mcg iv/im	Generalised vasoconstrictor effects Causes hypertension, nausea and vomiting. Use cautiously in pre-eclampsia and heart disease
Prostaglandins (CARBOPROST/MISOPROSTOL	Carboprost 250 mcg im- can be repeated every 15 minutes up to 8 doses Misoprostol 800 mcg pr (off licence)	Can cause severe bronchospasm, pulmonary and systemic hypertension, nausea, vomiting and diarrhoea Use with extreme caution in asthma
Tranexamic acid	1gm iv ,may repeat once again in24 hrs	

MECHANICAL PROCEDURES FOR PPH

Mechanical procedures used to treat atonic and non-atonic PPH include uterine massage, uterine packing and tamponade. Uterine balloons [41] such as the Sengs taken tube, Bakri [42] and Rüsch balloons are available. Use of tamponade in conjunction with B-lynch [43, 46] or other compression sutures is quite effective.

Arterial balloon occlusion and UAE (uterine artery embolization) arerecommended prior to surgical intervention [44, 45]. These procedures are performed by experienced interventional radiology personnel. Prophylactic occlusion for diagnosed placenta accretes is done by placement of balloons in the internal iliac or uterine arteries, which are inflated in the event of PPH [47]. If bleeding continues even after inflation, embolization can be performed via the balloon catheters, by placement of microparticles, polyvinyl alcohol, gel foam or coils, which occlude blood flow to the uterine arteries [46, 48, 49]. Complications such as uterine necrosis, thromboembolic events or fistula have been reported.

SURGICAL MEASURES

Failed medical and mechanical approaches to management of PPH warrant surgical exploration. The surgeon must decide which of the following procedure is warranted

- a dilation and curettage,
- manual removal of placenta,
- suturing of lacerations
- laparotomy and/or
- The uterine or the internal iliac arteries can be ligated bilaterally to temporarily decrease blood perfusion to the uterus [50].
- Uterine artery ligation is now preferred as it is simpler and has a higher success rate.
- Subtotal hysterectomy.

ANAESTHETIC MANAGEMENT

- General Aneasthesia with endotracheal intubation is technique of choice.
- 100%oxygen is given.
- avoid volatile anaesthetic agents and nitrous oxide
- Low dose ketamine, midazolam, fentanyl are used for awareness
- .Active warming devices and rapid infusion devices should be used.
- Uterine inversion may result from forceful placental cord traction. Tocolytics, halogenated anesthetics or nitroglycerine may be given to relax the uterus in uterine inversion.

American college of obstetricians and gynaecologists (ACOG) have classified patients presenting with PPH into 4 stages

Table 4: Acog Classification of PPH and Management

STAGE	BLOOD LOSS	VITALS AND LABS	MANAGEMENT
1	.>500MLat vag delivery >1000ml at caesarean	normal	Record vitals, o2saturation every 5 min, insert iv access , foley scatheter, type and x match 2 U PRBC,S
2	UPTO 1500ML	normal	2nd iv access, send coagulation profile and fibrinogen, warming blanket, intra uterine balloon, give 2 PRBC,s thaw 2FFP,call anaesthetist, shift to OT
3.	>1500ML	abnormal vitals and labs, oliguria	Activate MASSIVE TRANSFUSION PROTOCOL (4UPRBC,S,4UFFP,1apheresis platelet pack alternating with 2pools cryoprecipitate) immediate interventions and hemostasis
4	CV COLLAPSE HYPOVOLEMIC SHOCK	abnormal	Aggressive blood and factor replacement ,perform hysterectomy

MECHANISM of Disseminated intravascular coagulation (DIC) in PPH

The tissue factor (extrinsic) pathway initiates thrombingeneration which triggers the intrinsic elements to generate the thrombin burst. Thrombin stimulates the conversion of fibrinogen to fibrin. As bleeding continues, these newly formed clots are fibrinogen-poor, and thrombin percolates from them and gain access to the systemic circulation where it binds to antithrombin. The decrease in antithrombin is exacerbated by infusions of crystalloids [31].The direct consequence of circulating thrombin, unopposed by antithrombin, is disseminated intravascular coagulation. Fibrinogen levels fall in massive blood loss [31, 32].

The clot observation test for DIC provides a simple measure of fibrinogen. A volume of 5 mL of the patient's blood is placed into a clean, red-topped tube and watched for clotting. Normally, blood will clot within 8–10 minutes and will remain intact. If the fibrinogen concentration is low, generally less than 150 mg/dL, the blood in the tube will not clot, or if it does, it will undergo partial or complete dissolution in 30–60 minutes.

DIC management involves treatment of hypo fibrinoginemia with cryoprecipitate, fibrinogen concentrate or fresh frozen plasma transfusion to maintain fibrinogen levels above (100–200mg/dl) [33].

Table 5: Indications for Blood Product Replacement

TRANSFUSION TRIGGERS	TRANSFUSION TARGETS
HB<7GM% -give PRBC,s	HB>8-10GM%
HCT<24%- give PRBC,s	HCT>30%
PT/Aptt>1.5times -give FFP	PT/Aptt<1.5times
PLATELETS<75,000/cmm-give PLATELET Ssingle doner pack increases 5000,one apheresis pack increases25-30,000/cmm	PLATELETS >75,OOO/cmm
FIBRINOGEN<2gm/L give fibrinogen concentrate 30-60mg/kgor,cryoprecipitate2pools of 10-12ueach	FIBRINOGEN>3gm/L
FIBTEM A5<12- give FFP, fibrinogen concentrate or cryoprecipitate,	FIBTEM A5>16

TRANSFUSION THERAPY IN PPH-

Each obstetric unit must have access to on-site blood banking and O neg blood 24/7 Atleast 4 units O-ve blood should be available in blood bank of hospitals managing obstetric emergencies.

- Grouping and cross matching takes 45 minutes. Whereas
- group and type specific blood is available within 10 minutes

- Group O-ve is immediately available. It should be used in emergency as the chances of a clinically significant red cell antibody being missed in a patient with a negative antibody screen (false negative) are 1-4/10,000 [51].

Fluid replacement is done after 1l bloodloss, packed red cells are given after 2l loss and coagulation factors are replaced after 5Lloss. It has been observed that patients receiving <10 units of PRBCs rarely need component replacement, All blood components are screened (checked) by two people to confirm that products are correctly transfused

Recent studies quote that platelets as well as clotting factors are depleted at the same time during massive haemorrhage thereby explaining the role of shock packs having platelets, packed red cells and plasma in fixed proportions(1:1:1). RCOG Green top Guideline No 52 recommends a ratio of PRBC, fresh frozen plasma and Platelet of 6: 4:1 in cases of massive haemorrhage [53, 54].

The management with shock-packs of platelets, PRBC,s, fresh frozen plasma does not take into account that , the mother's fibrinogen level will be greater than that in the FFP administered, and therefore unmonitored usage will lead to dilution and possibly contribute to pulmonary complications . Pre-emptive thawing of blood products, if done in advance just in case the need arises can lead to wastage if discarded or transfused into patient when not required.

It has been found that the fibrinogen value fell progressively as blood loss increased, and reaches unfavourably low levels before other coagulation factors [57]. Charbit *et al.;* found that a fibrinogen level below 2 g/l, had a 100% chance for progression to severe PPH, whilst a fibrinogen level above 4 g/l was safe level [22]. Gayat *et al.;* showed that a fibrinogen level below 2 g/l, was a strong indicator of the need for an invasive procedure [58]. In a PPH trial study a fibrinogen of <2.9 g/l had a positive predictive value (PPV) of 39% for progression to PPH whilst a fibrinogen above 2.9 g/l had a negative predictive value (NPV) of 94% [59]. In other studies, a low fibrinogen level, taken early during a PPH, was predictive of the need for invasive procedures or infusion of RBC and FFP, [21, 22, 58]. A fibrinogen of 1 g.l_1 is too low for adequate haemostasis during ongoing obstetric bleeding, and that a minimum level of at 2g l_1 may be taken as cut-off. Results from several trials showed that a fibrinogen < 3 g.l_1 and especially < 2 g.l_1, in the early phase of the PPH, is associated with progression to severe PPH whilst a fibrinogen > 4 g.l_1 is not [21, 22, 52, 57, 58, 60]. A survey has shown that standard laboratory tests (prothrombin time and activated partial thromboplastin time) did not correlate well with the blood loss in obstetrics [57, 60]. Besides they are time consuming taking about 45 minutes. They assess only limited aspects of coagulation in a study most PPH patients, had normal PT/ aPTT values until blood loss reached 5000 ml [57, 60]. Therefore, there is increasing evidence for the use of point of- care(POC) monitoring in obstetric haemorrhage, such as TEG® (thromboelastography) and ROTEM® (thromboelastometry).These are whole blood rapid bedside ,near patient tests that are completed with the formation of fibrin strands. They test not only coagulation but also clot strength, stability and lysis ROTEM provides information on the cause of bleeding, broadcasts whole blood coagulation property, informs about fibrinolysis, platelets and fibrinogen [66]. The improved design of ROTEM allows it to be easily shifted to the operation theatre or labour room [64]. ROTEM tests are started by re-calcification and accelerated by adding an activator of the intrinsic (eg. INTEM and HEPTEM) or extrinsic (eg. EXTEM, FIBTEM and APTEM) coagulation pathway [65]. In EXTEM: coagulation is activated by a small amount of tissue factor to monitor the coagulation process via the extrinsic pathway. It gives an approximation of platelet count whereas in FIBTEM coagulation is activated as in EXTEM to monitor the clot firmness after blocking platelet contribution to the clot firmness. FIBTEM is always interpreted along with EXTEM. In FIBTEM platelet inhibitor cytochalasin D is added, which allows an assessment of the role of fibrinogen on clot stability. Therefore, the resulting clot is only dependent on the fibrin formation and fibrin polymerisation .Thus it gives an estimate about fibrinogen levels. ROTEM-guided therapy can reduce blood product use and therefore the unnecessary complications of transfusion. The FIBTEM assay gives results after 5 min (A5) and at the time of maximum clot firmness (MCF) [60, 61, 62, 63, 67, 68]. It has been observed that A5 and MCF give identical information and as the A5 is available on average 19 min earlier than MCF; it allows earlier intervention during major PPH and hence is preferred [67].

Table 6: Fibtem A5 and Approximate Fibrinogen Equivalent [63]

FIBTEM A5	FIBRINOGEN LEVEL
23	4g/l
15	3g/l
10	2g/l
6	1g/l

This faster useful information, differentiate between surgical and hemostatic bleeding .Someone who is still bleeding do we need to re-open or give blood products Multiple studies now support that ROTEM is easier to use in the perioperative and emergency setting; is able to detect underlying cause of bleeding and other factors like acidosis, hypo- or hyperthermia adding to coagulopathy. Furthermore it can also be used to predict the effect of costly therapy such as rfVIIa

WHO recommends that institutions have a formal protocol in place for PPH management? Maternal blood loss > 1.5 litres or FIBTEM A5<12 [69], or more than 10 units blood transfusion required should activate a MASSIVE TRANSFUSION PROTOCOL (MTP) [55, 56]. Within the protocol there must be clear determination of individual responsibilities.

Early escalation to senior level should be encouraged. Immediately order 4 units packed red cells. If FIBTEM A5 is between 12-16 then FFPis defrosted and made available [69, 70, 77].

Table 7: Recommended Fibtem A5 Algorithm [69, 72]

FIBTEM A5<7 AND EXTEM<47	FIBTEM A5 7-12 AND EXTEM<47	FIBTEM A5>12 AND EXTEM>47
Fibrinogen concentrate or cryoprecipitate	If active bleeding, fibrinogen concentrate or cryoprecipitate	No products required

Recheck FIBTEM A5 levels after I hour. The goal is to achieve a fibrinogen level of 2.2gm/l which corresponds to a FIBTEM A5 assay of 12. Fibrinogen level is rectified to lower end of normal to minimise the risk of thrombosis [69].

OPTIONS for fibrinogen replacement to increase fibrinogen level by 1gm/l [60, 78].

- fresh frozen plasma,-30ml/kg
- cryoprecipitate -3ml/kg
- fibrinogen concentrate.-60mg/kg

FRESH FROZEN PLASMA

- Early empirical FFP might be justified in cases of placental abruption and amniotic fluid embolism where significant consumption is likely, or when very large volumes of blood loss are expected such as uterine rupture or placenta accrete.
- However if FIBTEM is available FFPis recommended if FIBTEM A5 is less than 12(equivalent to a fibrinogen of 2.2gm %.)
- Another transfusion trigger is PTT/PT ratios of 1.59 normal. Asking for FFP/cryoprecipitate from the laboratory, thawing it, issuing it and transporting it usually takes around 1 hour even with an efficient system hence fibrinogen concentrate is a quicker alternative.

FIBRINOGEN CONCENTRATE

- Fibrinogen concentrate is a plasma derived purified fibrinogen preparation does not contain other coagulation factors, it is pathogen inactivated [71-74].
- Fibrinogen concentrate (RiaSTAP® manufactured by CSL Behring, Marburg, Germany) [71] can be used to quickly to restore fibrinogen to the normal range [75].
- Subjective data suggest that fibrinogen concentrate may be useful option in managing severe hypofibrinogenaemia associated with massive PPH [73-75].
- The dose will be calculated as: dose (g) = (23-actual Fibtem A5) × ideal body weight for height/140 [76] upto a maximum of 8gms.
- Fibrinogen concentrate is stable at room temperature unlike cryoprecipitate, which must be kept frozen and then thawed prior to administration [71-74].
- Fibrinogen concentrate can be reconstituted and given immediately after FIBTEM A5assay that takes only 10 minutes [69].
- The first RCT using fibrinogen concentrate focusing specifically PPH is on-going [70].
- Use of fibrinogen concentrate, led to a significant reduction in use of transfused red cells, FFP, cryoprecipitate, platelets and transfusion associated circulatory overload, intensive care unit admission, and a non-significant reduction in hysterectomy [69, 71]. These data support the use of near patient testing during PPH, and provide evidence for use of fibrinogen concentrate (FIBTEM < 12 mm and/or fibrinogen of 2.2g.l_1).
- A recent investigation found that if fibrinogen was measured by point-of-care TEG® instead of the standard laboratory method, the use of fibrinogen concentrate would be increased and less fresh frozen plasma (FFP) would be given [73].

CRYOPRECIPITATE

- Cryoprecipitate is recommended to maintain the fibrinogen level above 1–1.5 g.l_1 if FFP has not been successful. Also has factor VIII,XIII,VWF ,fibronectin

- Recommendations regarding ABO compatibility are variable
- Thawing takes about 10 minutes.
- One pool contains 8-12 units of cryoprecipitate
- Each unit contains 150mg of fibrinogen.
- One pool of cryoprecipitate raises the fibrinogen level by about 0.5 g
- Cryoprecipitate, the cold concentrated form of FFP, contains approximately 10 times the fibrinogen as FFP. Therefore, while FFP may be useful for volume expansion , cryoprecipitate is the product of choice for the restoration of fibrinogen levels

.

PLATELETS

- Current recommendations advocate that the platelet count should be kept >7 5 x 109.l_1 ,
- When more than 10 units of blood have been transfused platelets should be replaced_
- When EXTEM levels are low but FIBTEM is normal platelets should be transfused [69].
- One apheresis pack of platelets leads to an increase in platelet count by 25,000-30,000
- Platelets should be group and type specific

RECOMBINANT FVII a.

- rFVIIa binds directly to the activated platelet and makes up for deficiencies of factor VIIIa and IXa
- It is recommended when 1.5 times blood volume has been lost.
- The dose is 90 μg/kg intravenously over 3-5 minutes, repeatable once. An adequate haematocrit, a platelet count > 50 x 109/l, fibrinogen > 1 g/l, pH > 7.2, and temperature> 34 ^{0C} are required [54, 82]. Such conditions are difficult to fulfil during massive obstetric haemorrhage.
- rFVIIa has a major role in PPH patients with bleeding not responding to pharmacologic management and uterus sparing surgical techniques [79, 80,81].
- rFVIIa use is disputable due to chances of increased thromboembolic events

CELL SALVAGE

- It can be used in those who refuse transfusion like Jehovah, s witness [83].
- It can be set up preoperatively by the perfusionist in the operation theatre as in placenta accreta
- Blood is collected by double suction pump, is washed anticoagulated, filtered, centrifuged and then reinfused back onto the patient via 40um filter.
- The chances of amniotic fluid embolism are thought to be rare if leucocyte depletion filters are used [84, 85].
- There is low chance of rhesus immunization, infection.
- 75-85%of shed blood is returned back into the circulation
- The reinfused blood has a haematocrit of 60-70%consisting of red cells
- Coagulation factors are still needed.

Royal College of Obstetricians and Gynaecologists suggests that PPH > 1 l or blood transfusion is an indication for further thrombo prophylaxis [23].

EARLY ONSET and detection of hypo fibrinoginemia, role of point-of-care monitoring of coagulation abnormalities, FIBTEM A5 assay giving an estimate of fibrinogen levels within 10 min and the use of fibrinogen concentrate have created a drastic change in current management protocols of PPH. This along with simulation drills and a checklist approach and staying prepared to handle obstetric emergencies may improve PPH management. Above all this, a multidisciplinary team work with all participants working proactively is the key to success in the treatment of PPH.

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