# ACUTE NORMOVOLEMIC HEMODILUTION PATIENTS UNDERGOING TOTAL ABDOMINAL HYSTERECTOMY-A RANDOMISED CONTROLLED TRIAL

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## CERTIFICATE

This is to certify that the dissertation titled "**ACUTE NORMOVOLEMIC HEMODILUTION PATIENTS UNDERGOING TOTAL ABDOMINAL HYSTERECTOMY-A RANDOMISED CONTROLLED TRIAL"** is a Bonafide original work done by **DR.SANTHOSH KUMAR N** during May 2017 - May 2020 in partial fulfilment of the requirements for M.D. (Anesthesiology) Branch X- Examination of The Tamilnadu Dr.M.G.R. Medical University to be held in May 2020.

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## DECLARATION

I **DR. SANTHOSH KUMAR N** solemnly declare that this dissertation, titled "**ACUTE NORMOVOLEMIC HEMODILUTION PATIENTS UNDERGOING TOTAL ABDOMINAL HYSTERECTOMY-A RANDOMISED CONTROLLED TRIAL"** is a Bonafide record of workdone by me in the Department of Anaesthesiology, Govt. Theni Medical College and Hospital, Theni under the guidance of **Prof.DR.M.BALASUBRAMANI, MD.,DA.,** Professor of Anaesthesiology, Govt. Theni Medical College & Hospital, Theni.

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Date: **DR.SANTHOSH KUMAR. N**

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## CONTENTS

# INTRODUCTION

The need for extensive surgical procedures which are often associated with major blood loss is on the rise and hence the need for intra-operative and post-operative replacement of blood continues to surge. Although blood and blood products are safer now than before, still there are many risks of allogenic blood transfusion such as transmission of blood-borne infections, haemolytic reactions and immunological complications ranging from subtle allergic reactions to anaphylactic shock and immunosuppression in some cases [1, 2]. Because of these reasons, several strategies to reduce or eliminate the need for homologous blood transfusion were introduced.

Messmer and Sunder-Plassman were the first to study a number of blood conservation strategies including autologous withdrawal of blood for re-infusion in the peri-operative period. Autologous transfusion can be done by pre-operative autologous blood donation (PABD) or acute normovolemic hemodilution (ANH) or intra-operative blood salvage [3].

Acute normovolemic hemodilution (ANH) is defined as the process of removing the whole blood from the patient immediately prior to the surgery and maintaining the normovolemia (circulating volume) by simultaneous replacement using suitable volume of acellular fluids such as crystalloids or colloids. It is performed shortly before or after the induction of anaesthesia. This can be considered in patients undergoing surgery in which substantial blood loss is anticipated [4]. Thus hemodiluted blood with fewer blood cells is

lost during surgery and once haemostasis is achieved at the end of the surgery, the saved blood is re-infused to the patient.

Acute normovolemic hemodilution (ANH) is convenient for the patient as a blood procurement technique as it is very simple to perform and the only technique which provides a fresh whole blood for use in the operating room. Moreover, acute normovolemic hemodilution is very cost-effective in comparison to autologous donation or intra-operative cell savage as the blood obtained from the patient needs no filtering, washing and storage in a blood bank [(5)].

As the blood is re-transfused immediately, there is no scope for biochemical changes in the blood associated with blood storage. Also, platelet function is preserved when compared to stored blood and similarly the risk of hypothermia associated with cold storage is avoided [(6)]. Furthermore, ANH eliminates the risk of transfusion related clerical error that could lead to transfusion of incompatible blood and its grave consequences. However, ANH remains to be underutilised because of the perception that it may prolong the time in the operating table and also it requires additional monitoring and personnel [(7)].

The hysterectomy is become a common obstetric surgery in India and one study reported a prevalence of roughly 17 per 1000 women according to District Level Household Survey (DLHS) data [(8)]. The need for blood transfusion is very common in women who undergo hysterectomy as the surgical procedure is associated with significant blood loss.

Acute normovolemic hemodilution being a safe, effective and economical alternative strategy that can be ideally used in patients who undergo hysterectomy alleviating the need for homologous blood transfusion and transfusion associated risks. Moreover, there is paucity of data regarding the use of ANH in hysterectomy especially in our country.

With this backdrop, this study was planned to study the safety, hemodynamic alterations associated with acute normovolemic hemodilution in comparison to conventional homologous blood transfusion among patients who were posted for hysterectomy in Government Theni medical college Hospital, Theni.

# REVIEW OF LITERATURE

## Historical review:

The first recorded successful but transmission happened in England in the year 1665 and it was done by physician Richard Lower as he transfused blood from other dogs to keep his dogs alive.

In 1795, an American physician by name Philip Physick claimed that he performed the first human blood transfusion but he did not publish his work.

The first instance of autologous blood transfusion in humans happened in 1818 when Blundell reinfused the salvaged blood to a woman affected with postpartum haemorrhage and this happened much prior to the discovery of blood groups and even allotransfusion

In 1886, a case of intra operative blood salvage while performing lower Limb amputation was described by Duncan. Subsequently other methods were developed for the reinfusion of autologous blood removed many weeks prior to the surgery

The practice of autologous blood transfusion was first described by Grant in 1921. He experimented this procedure among patients who underwent surgery for cerebral tumours. In 1966, Symbas undertook a series of laboratory and clinical studies which led to the adoption of auto-transfusion protocol for the management of patients with acute traumatic hemothorax. Following this protocol management of 400 patients between 1966 and 1978 was done based on auto transmission

In 1968, the so-called “leapfrog method” was developed in which repeated donations within a 10 day period was done to store number of units of autologous blood meant to be used in the perioperative period. Later on, there was a paradigm shift towards removal of blood prior to surgery and the blood volume being replaced by infusion of colloids and crystalloids to produce an intentional normo-volemic hemodilution. This technique was initially used in heart surgeries accompanied with extracorporeal circulation and gradually extended to other surgical specialties.

In 1970, Messmer and Sunder astonishingly discovered that normo-volemic hemodilution increases the tissue perfusion and oxygenation through changes in properties of blood flow and reduction in blood viscosity.

After that normo-volemic hemodilution was introduced in 1973 across various surgical practices as an alternative to transmission of homologous blood and since then it has been used in various surgical fields as an effective blood salvage procedure.

**Acute normovolemic hemodilution (ANH): Evolution and concepts**

Strategies to reduce requirements for blood transfusion during surgery is considered the high priority in clinical care. The long-term sequel of blood transfusion like latent viral or transmission transmitted infections continue to be a concern to both patients and physicians [(9)].

Acute normovolemic hemodilution (ANH) is one of the important strategies used to reduce the need for blood transfusion. Existing approach to reducing blood transfusion during major surgery is divided into

A. Methods that decrease operative blood loss

B. Methods that provide autologous red cells.

A. The following are the methods that reduce blood loss [10]

1. Deliberate hypotension

2. Injection of local vasoconstrictive agents at the operative site

3. Systemic pharmacologic agents for reducing blood loss, such as aprotinin, aminocaproic acid, tranexamic acid and desmopressin.

B. Autologous red cells can be obtained either prior to or during the surgery. To obtain autologous blood, autologous preoperative donation through blood bank or acute normovolemic hemodilution are the techniques that are used prior to the surgery. Cell scavenging provides autologous red cells by scavenging blood from the operative field [11]. These strategies can be used in combination to reduce the need for allogeneic transfusion during the surgery.

Acute normovolemic hemodilution (ANH) reduces red cells lost during the surgery by decreasing the patient's red cell mass immediately prior to the surgery [12]. Controlled removal of whole blood is the first step in an ANH. The intravascular volume is maintained with non-red cell containing solutions during phlebotomy. During the surgery fewer red

cells are lost because the hematocrit is lower throughout the surgical procedure for the patients. The autologous blood is reinfused at the end of surgery.

If there is enough volume of cells stored prior to surgery and operative blood loss does not result in profound red cell losses, then acceptable hematocrit may be achieved without the use of allogenic transfusion. As the surgical blood loss is not appreciably changed by the use of hemodilution, fewer red cells will be lost due to patient's acute anemia.

**Critical Red cell mass:**

The major concept in applying hemodilution is to define "safe" lower limit for hematocrit. Comparatively healthy patients generally have good reserve of red cells. This reserve is the basic reason that the acute removal of blood in the preoperative period is a viable therapeutic option. There are two sources of cell loss, one associated with hemodilution and other is operative blood loss. Therefore, a relatively profound anemia is expected during the operative procedure. A good number of case reports indicate patients can survive with extremely low hematocrit but the anecdotal case reports cannot provide us the consistent "safe" lower limit of hematocrit [13].

The factors that define the lower limit of safety of Red cell mass are important considerations in implementing the hemodilution program. When cardiorespiratory compensatory mechanism is no longer effective to maintain the oxygen delivery, a critical red cell mass takes over. If the red cell mass goes below this critical level the anaerobic metabolism or tissue ischemia will occur. The myocardium and central

nervous system is the first tissue group where the critical red cell mass is reached. This is because under normal circumstances, greater portion of oxygen extraction occurs in the coronary or cerebral circulation. Especially myocardium is the highly sensitive to decreased oxygen availability because systemic compensatory responses to reduce red cell mass increase cardiac output. This raised cardiac output that leads to increased myocardial work leading to increased myocardial oxygen requirements [14].

When oxygen supply is limited due to anemia the increased cardiac energy expenditure puts additional demand on myocardial oxygen reserve. Hematocrit of less than 20% can affect the myocardial metabolism because of the decreased supply and heightened oxygen demand. If hematocrit is less than 15%, ischemia and myocardial infarction can occur even in healthy patients with normal coronary arteries. These changes are often seen in EKG changes with ST segment elevation. If the hematocrit is sustained at hematocrit levels less than 15%, centrilobular hepatic necrosis and acute renal failure in the liver and Kidneys, respectively will occur in this situation.

Hemodilution to relatively low hematocrit is better tolerated during surgeries because the period of anemia is brief and oxygen requirements are reduced by anaesthesia. This is a main reason that hematocrit values of less than 20% are recorded often in a hemodiluted patient during the intraoperative period. If the blood loss is replaced with crystalloid and replacement is withheld until 20% of hematocrit is observed, then more than half of the total blood volume can be removed by a combination of operative blood loss and hemodilution much prior to replacing the red cells [15].

**Factors determining efficiency of hemodilution:**

**1. Red cell mass:** Persons with greater red cell masses can donate more blood. Red cell mass is based on:

A. Initial hematocrit: patients with higher hematocrit will be able to provide more red cell mass prior to the surgery. The patients beginning hematocrit and blood volume are the important factors in estimating the amount of blood that must be removed prior to surgery.

B. Blood Volume: Blood volume increases weight. The "ideal" 70-Kg male has approximately a 5-1 volume on a weight basis. For example, a 55-kg adolescent female's blood volume would be approximately 3,500ml (55kg*60-65 ml/kg).

**2. Magnitude of hemodilution:** If the hematocrit is lower after hemodilution, very less red cell loss occurs because of surgical blood loss. This is the reason behind the fact that if more blood is removed before the surgery, there is greater potential in reducing red cell losses. Anyhow, at the same time this hemodilution may lead to profound hemodynamic consequences. For example, a profound hemodilution (4 units of whole blood in a 70-kg healthy patient) requires the administration of large volumes of non-red-cell-containing solutions to maintain normovolemia. We can also try hemodilution with 2 units of blood with more safety but may not be as effective in reducing red cell losses. This balance between the magnitude of hemodilution employed and theoretic red cell losses can be calculated by predicting changes in red cell mass with different levels of hemodilution [(16)].

If a 70-kg patient with the hematocrit of 40% has 4 units of blood removed prior to surgery, surgery begins after normovolemia is re-established in a patient who has a Hematocrit of approximately 25%. Intra-operative hematocrit reaches a nadir of less than 20% if the operative blood loss is 1500 ml. The lower limit of hematocrit will approximately be 34% if the same patient had 4 units of stored blood following the operative blood loss of 1500 ml. If the same patient had only 2 units of stored blood, then lower limit of hematocrit will approximately be 24%. Following replacement of the two units, then hematocrit will be restored to 31%. In contrast if no hemodilution is used during the procedure, hematocrit with operative blood loss would be approximately 28%

3. **Intra operative blood loss:** The most obvious main determinant of red cell loss is blood loss during surgery

4. **Intra operative management**: If normovolemia is not effectively re-established following removal of the autologous blood, then the procedure offers no benefit with regards to red cell losses. Operative blood loss would occur at the highest preoperative hematocrit level if there is an absence of hemodilution. The timing of cell replacement is also another factor that affects the effectiveness of ANH. After the operative blood loss, when the blood stored is replaced then the patient will experience the least red cell losses. From a safety aspect, occasionally blood removed prior to the surgery may need to be transfused to treat severe anemia during the surgery [(17)].

**Special considerations during hemodilution**

From the haemostasis management perspective, patients experience to sources of blood loss. One's blood loss associated with hemodilution and another is operative blood loss for which larger volumes of crystalloid or college solutions will be required during the intra operative period. The changes in intravascular volume should be closely monitored during the procedure to assure intravascular volume is maintained optimally throughout the procedure [(9)].

If the Patient is hypovolemic (i.e. Hemo-concentrated) more red cells will be lost and hemodilution will be less effective in achieving a higher postoperative hematocrit. Post-operative edema is a frequent consequence of the need to maintain normovolemia with crystalloid and colloid solutions. The less Intraoperative hematocrit of <20% are often noticed during hemodilution and hence during this phase, additional cardiovascular monitoring should be done [(11)].

The purpose of this monitoring is to assess the impact of lower hematocrit on systemic functions. Invasive hemodynamic monitoring also establishes vascular access and also helps to frequently measure blood biochemistry and ph. Serial hematocrit and arterial blood gases helps in accurate blood loss estimation and to evaluate fluid replacement and provide information about adequacy of oxygen delivery. The myocardial ischemia is the first sign of inadequate oxygen delivery as a result of anemia. This is revealed by persistent tachycardia and electrocardiogram findings. The decrease in blood viscosity associated with hemodilution often decreases blood pressure and hence profound hemodilution should

not be combined with other techniques such as deliberate hypotension as this will also decrease tissue oxygen delivery [12].

**Comparison of hemodilution and autologous donations**:

The two techniques frequently compared to acute normovolemic hemodilution are autologous free donation of blood and intra operative red cell scavenging. These techniques are based on common strategy of providing autologous blood source in the pre-operative period [18]. Theoretical comparison of autologous donation, ANH and no replacement is provided in the following table.

| Treatment groups | Pre-Op | Hemodilution (withdrawal) | Postoperative 1500ml blood loss | Hemodilution Replace | 500ml postoperative blood loss |
|---|---|---|---|---|---|
| No treatment | 40% | - | 30% | 32% | 26% |
| Hemodiluted (2 united) | 40% | 32% | 24% | | 30% |
| Autologous (2units) | 36% | - | 26% | | 32% |

*Table showing theoretical hematocrit changes expected prior to, and following surgery in the groups of patients. (The patients were assumed to be 70 kg with a starting hematocrit of 40% and patients experience 1500ml of blood loss during surgery and another 500 ml of blood loss in the post-operative period)*

Autologous donation was endorsed enthusiastically 20 years ago but the decreasing risk of allogenic blood transfusions has to lead to the revaluation of this approach. Different studies have concluded autologous donation may not be cost effective strategy, primarily because of lowered infection risk of current volunteer donor blood pool [19].

The main limitations of autologous donation related to cost efficiency and participation by patients. The following are the factors in surgical patients that influence the efficacy of autologous donation

- Frequency of patient participation,
- Whether autologous donors avoid allogenic blood use
- Proportion of autologous blood that is reinfused used during the perioperative period.

Because the blood donation happens weeks prior to surgery, autologous donation offers some advantages to ANH. Unlike in ANH, autologous donors will not require the larger volumes of intravascular volume replacement to re-establish normovolemia [20].

The basic reason that blood replacement is necessary is the postoperative loss of red cells into drains or the surgical wound. Unlike ANH or cell scavenging techniques that are primarily an intra operative method to reinfuse autologous blood, pre-donated autologous blood can usually be stored till the postoperative blood [21]. On the other hand, the use of a blood bank exposes autologous donors to the numerous sources of iatrogenic errors associated with collecting, labeling, storing and checking a patient's autologous blood.

These clerical errors are the often serious complications associated with the use of a blood bank [22].

The major advantage of ANH is that the technique can be used intraoperatively, without the need for long-term blood storage and testing. Normovolemia should be maintained throughout the intra operative period so that hemodilution can reduce red cell losses [23].

## ACUTE NORMOVOLEMIC HAEMODILUTION (ANH):

### Indications of ANH: [11, 24-28]

1. Surgery associated with substantial blood loss (750-1500ml).
2. Surgical procedures where a benefit from ANH was demonstrated.
    a. Radical prostatectomy
    b. Cardiothoracic surgery
    c. Elderly Patients without cardiac disease
    d. Hip and knee arthroplasty
    e. Vascular surgery (AAA repair and other vascular procedures)
    f. Spine surgery
    g. Liver resections

3. Patient request for transfusion free management for religious/personal reasons (Jehovah's Witness)

For ANH to be maximally efficacious, surgical blood loss should be more than 70% of the patient's blood volume [29]. When the blood loss exceeds 90% of the patients' blood volume ANH alone may not be able to prevent exposure to allogeneic blood, but it may reduce the number of allogeneic units transfused. [30]

**Advantages of ANH [31-32]:**

1. It decreases the risk of transfusion reaction due to wrong blood administration or error.

2. It is the least costly method of autologous blood procurement

3. Provides fresh autologous blood product compared to stored blood. It has functional platelets, normal levels of clotting factors and 2, 3, DPG and no biochemical alterations associated with storage.

4. Reduces or eliminates the need for allogeneic blood transfusion1.

5. The blood does not require testing.

6.Eliminates the risk of infection transmission associated with volunteer donor blood( transmission risks : HIV – less than 1 in 1,000,000 per unit; Hepatitis C – less than 1 in 1,000,000 per unit;

7. Can be used in presence of malignancy or infection (peritonitis etc)

8.Can be used for emergent operations where preoperative autologous donation is not possible.

**Contraindications** [29-31]**:**

1.Impaired renal function, (unable to excrete fluid load)

2.Anaemia (Hb under 9 g/ml). (Patients with iron deficiency anaemia can be treated with per oral or with IV iron and erythropoietin prior to surgery according to established guidelines)

3.Clinically evident limitation of cardiac function, untreated hypertension

4.Clotting disorders

5.Significant pulmonary disease

6.Bacteraemia

7.When increased cardiac output is undesirable (e.g. coronary artery disease, aortic stenosis)

**Consent process:**

Release of liability form for refusal of blood transfusion is a mandate form for the patients who have religious or spiritual reasons for refusing blood components. This is to ensure that the patients are informed of the risk of refusal and also specifically what blood components, if any, the patient is willing to accept. This form has to be signed by the Patient, Patients clinician and legal representative as well.

**Practical Applications protocol** [32]**:**

Personnel should be immediately available who are conversant with the technique of ANH, its complications and the compensatory mechanisms it involves.

- Blood should be withdrawn using a strict aseptic technique.
- Use separate IV lines to withdraw blood and infuse the replacement fluid.
- Appropriate monitoring equipment must be available and used as per departmental policy
- Blood is withdrawn after induction or anaesthesia and before the start of surgery
- A CVP or external jugular line is the fastest way to withdraw blood.
- If using a Cordis to withdraw blood, make sure that the volume replacement is fast enough
- To avoid damage to cellular components, it is recommended to use 14-16 IVs to withdraw blood. 18G is the minimum acceptable in adults patients
- Use Separate IV lines to withdraw blood and infuse the replacement fluid
- Use fluid warmer as up to 9 litres of fluid may be administered over less than an hour. ANH takes about 20-35 minutes
- Use of arterial line for blood collection is not recommended as it loses the ability to monitor arterial pressure (and the wave – form for swings produced by respiration), and there is a risk of occluding the arterial catheter.

- Collect blood in standard transfusion bags containing anticoagulant (citrate-phosphate-dextrose-adenosine)
- Gently agitate the bag often to make sure proper mixing of the blood and anticoagulant
- After collection is complete then clamp the collecting tubing and apply a knot
- A weighing scale may be used (if unavailable)-note the weight of the bag with the CPDA and collect blood until an additional 450gms weight.
- 6% Hydroxyethyl starch and 5% albumin were used in a 1:1 ratio
- High FiO2 in the perioperative period is essential to improve the oxygen delivery
- The first 450-500 ml of blood can be withdrawn without starting fluid replacement, After the replace blood with fluid in the ratio of 1ml blood: 3 ml lactated Ringers or normal saline.
- Label the bags and number them as per instructions in “labeling the blood”.

**Labeling the Blood:**

- Keep the blood along with the patient in theatre
- Very important to number the units as filled, if more than one is withdrawn
- Patient name, number, date and time
- Write “FOR AUTOLOGOUS USE ONLY” on the label

- THE BLOOD IS ONLY FOR REINFUSION IN THEATRE, IT MUST NOT LEAVE THE THEATRE (discard any blood unused at the end of surgery).

**Blood Storage** [33]**:**

•Blood may be kept at room temperature for up to 4 hours after which time it should be stored at a preferred temperature of 60C (see below for exceptions)

•Blood bags should be agitated periodically while filling, to ensure mixing of the blood with the anticoagulant. Each bag should contain no more than 450ml and no less than 300ml of blood to ensure the proper ratio of blood to anticoagulant (ratio of 10:1)

•Store the blood in theatre with the patient. It is suggested that a little of the anticoagulant in the blood bag is introduced into the line from which the blood is withdrawn to prevent clotting.

•The first one to two units withdrawn are rich with inactivated clotting factors. Accordingly, based on blood loss and overall condition of the patient, the anaesthetist will determine at the end of the case whether to reinfuse those units first or last

•After initial agitation during collection, there is no need to rock or agitate the blood while it is being 'stored' in theatre if correct collection bags have been used.

**Volume of blood to withdraw:**

•Hemoglobin levels should be determined following removal of blood (after haemodilution of the patient, and at regular intervals during the surgical procedure)

•Euvolaemia is one of the cornerstones of proper performance of ANH. Hence the amount of fluid to be replaced to maintain euvolemia will depend upon the patient's age, sex, medical condition, hemodynamic status and the amount of blood removed

•Key monitoring guideline is the presence of tachycardia which indicates the patient's threshold for phlebotomy has been reached. We should stop blood withdrawal with onset of tachycardia

•The volume of blood removed will depend upon the patient's initial Hb, estimated blood volume to be lost during the surgery and the hemodynamic status of the patient (34)

- Usually between 2-4 units (approx. 400-500 mls/bag)
- Maximum recommended volume 2000mls
- Theatre target = Until patient reaches phlebotomy threshold or equivalent to expected blood loss and quantity that would be normally needed in allogeneic infusions or haematocrit of 20%

  Formula for calculation for volume of blood to withdraw:

  $$Vol = \{EBV \times (Hi - Hf)\} / Havg$$

  Hi = initial Haematocrit .Hf = Target Haematocrit

  Havg = average haematocrit = (Hi+Hf)/2

  EBV = estimated blood volume (can use body weight x 65 ml for women and 70ml for men)

- Once the time of major blood loss is over, or earlier if clinically indicated, the blood is slowly transfused back to the patient in the conventional manner.
- The units are usually transfused in the reverse order of collection. The first unit removed , which has the highest Hb level and the most platelets is transfused last.
- It is assumed that all units removed are returned.

• When using adult blood bags for pediatric cases, it is necessary to withdraw an amount of citrate from the bag proportional to the amount that's been collected. The reason for this collection is to keep the whole blood citrate ratio approximately equal to 10:1.

**Obstetrical Patients:**

1. All the above policies and procedures for ANH must be followed without any exceptions for this patient population

2.ANH is also called as an alternative to allogeneic blood transfusion and must be used in cases where there is substantial blood loss anticipated (i.e placenta previa, placenta accreta, etc) and in cases where patients have developed antibodies to blood

3. Patients undergoing both regional anaesthesia and ANH should be given special importance regarding their intravascular volume and fluid status.

**Fluid Replacement and Coagulation Abnormalities in ANH:**

1. The anaesthesia team must anticipate the rare possibility that a coagulopathy may occur for the cases where moderate to severe hemodilution is planned (750 ml-1500 ml or more)

2. The type of replacement fluid should take the above into consideration. In vivo and in vitro studies have shown that moderate to severe hemodilution with hydroxyethyl starches as the replacement fluid may cause an alteration in platelet function, or in negative effect on blood coagulation factors in addition to the effects of hemodilution in the haemostatic function (35).This does not necessarily translate into abnormal clinical bleeding. Surgery itself, without ANH can induce a significant increase in markers for activation of the coagulation system and fibrinolysis (11). In addition, severe hemodilution secondary to blood loss replaced with crystalloids or colloids (without ANH) can also lead to coagulopathy)

3. Measures to prevent coagulation abnormalities [36]

- This is to prevent a dilutional coagulopathy that may rarely develop as a result of moderate to severe ANH, and the process of ongoing dilution from blood loss and replacement of this blood loss with intravenous fluid
- Fractionation of the blood removed and then returning approximately ½ of the fractionated fluid, both platelet rich plasma (PRP) and platelet poor plasma (PPP) while the ANH process is still ongoing.

- Fractionation and returning a portion of the platelet poor plasma and platelet rich plasma limits the need for excessive use of intravenous fluids, thus preventing a dilutional coagulopathy
- Limit the amount of hydroxyethyl starches used as the replacement fluid (1000cc-2500cc) during ANH
- Studies have shown that using amounts greater than 20 ml/kg does not increase the risk of bleeding in cases with major blood loss
- Studies have also shown that the use if hydroxyethyl starches as replacement fluids during moderate to severe ANH may cause platelet adhesion abnormalities and a decrease in factor VIII:C
- There is no current algorithm to predict which patients are likely to develop a coagulopathy from ANH. Severe blood loss with ingoing dilution may be the best predictor.

4. Below are goal directed steps to minimize the negative effects of severe hemodilution with or without the use of hydroxyethyl starches.

- Use the thromboelastography, a goal directed guide to the coagulation status if the anaesthesia team removes>1500ml of blood during ANH
- Post ANH thromboelastography (+/- the return of ½ the PRP and PPP)
- Baseline thromboelastography

- Give goal directed therapy depending on the thromboelastography results. Follow thromboelastography every few hours or if there is a concern that the patient appears clinically “oozy”.
- Remember that the PRP and PPP can be used to correct thromboelastography abnormalities
- Switch to crystalloids or minimize the use of hydroxyethyl starches (1-2 litres) in the face of ongoing blood loss and concern about platelet abnormalities
- Return remaining PPR and PPP
- Prophylactic DDAVP in cases where hydroxyethyl starch was used.

**Special Consideration for Jehovah’s witnesses** [37]

In common the Jehovah’s Witness patients request that their blood not be withdrawn and “stored”. Some request that blood withdrawn be kept in continuity with their circulatory system. Witness patients who agree ANH have individual requirements about how the procedure is performed. In such cases, after the blood is withdrawn into a CPD bag, a multi-infusion port is suggested for withdrawing more than one bag of blood so that all units can be kept attached to the patient. Confirmation that this is acceptable to the patient beforehand.

**Other research articles:**

Naqash IA et al [38] conducted a prospective randomised study as an evaluation of acute normovolemic hemodilution as a potential method in reducing the blood loss and auto-transfusion among neurosurgical patients who underwent surgical excision of intracranial meningioma. About 40 patients were categorised into two groups such as control group receiving conventional homologous blood intraoperatively while the group II (ANH) group received acute normovolemic hemodilution till the target hematocrit of 30% after induction of anaesthesia.

The mean amount of blood withdrawn in ANH group was 802.5 ± 208 ml and this was simultaneously replaced with an equal volume of 6% hydroxyethyl starch to maintain normovolemia intraoperatively. There was no significant variation in the mean hemoglobin level between the two groups whereas hematocrit values decreased significantly in both the groups at various stages of intraoperative period. The amount of surgical blood loss in group I/ Control group was 835.29 ± 684.37 in comparison to 865 ± 409.7 ml in group 2. This difference in amount of surgical blood loss was statistically insignificant but there was a statistically significant difference in the mean volume of blood transfused between two groups as group 1/ control-group required higher volume of homologous blood in comparison to ANH group. They concluded that acute normovolemic hemodilution up to the target hematocrit of 30% is a safe and effective alternative in reducing the need for homologous blood transfusion among patients undergoing surgical excision of intracranial meningioma.

Monk T.G et al [11] did a study on acute normovolemic hemodilution to determine the cost-effectiveness and as an alternative to preoperative autologous blood donation among the patients undergoing radical retro pubic prostatectomy. The main primary objective of this study was to compare the cost and benefits of these two autologous blood collection techniques. 32 patients were used for radical prostatectomy who has undergone ANH to a target hematocrit level of 28%. To maintain the hematocrit level >25% the blood was transfused in the preoperative period. The following are the comparison factors that's done in this study. Hematocrit levels, transfusion outcomes and costs, and postoperative outcomes for these patients (hemodilution group) were compared with a matched patient cohort who preoperatively donated 3 units of blood for autologous use in prostatectomy surgery (non-hemodilution group, n=30).

As a result, 32 patients underwent ANH to a hematocrit level of 28±1.7 %, and 1740±346 ml (3.5± 0.7 units) of blood were collected. Three (10%) of the patients in each cohort had allogeneic blood exposure. The total transfusion cost were 73% higher for the non-hemodilution group patients than for the hemodilution group patients ($330± $100 vs.$ 191 ± $55, $p<0.001$). There is no much differences in the post-operative outcomes. This study finally concluded that an integrated blood conservation program utilizing acute normovolemic hemodilution and a defined transfusion trigger can decrease the requirement for preoperative donation of blood for autologous use in radical prostatectomy. Comparatively the point-of-care autologous blood procurement is more cost-effective than preadmission donation of autologous blood units.

Santaso J T et al [39] performed a study to determine the effect of hemodilution on tissue perfusion and blood coagulation during radical hysterectomy. The purpose of this study was to evaluate the safety of hemodilution on global and splanchnic perfusion and blood coagulation during radical hysterectomy. 16 patients with cervical carcinoma was used for this study. A pulmonary artery and a gastric tonometry catheter were placed on all 16 patients. This is fixed to obtain the Global perfusion indices, splanchnic perfusion index, and coagulation tests. The blood was removed till the hemoglobin level of 8-9- 9g/dl was reached. After hemodilution, at the end of surgery, and after the re-transfusion of blood three more measurements were taken. To determine the statistical significance the one-way analysis of variance was done. As a result, 16 patients with cervical carcinoma has 1.0± 0.3 L (mean ± SD) of blood removed and had a blood loss of 0.8 ± 0.7 L. Hemodiluted preoperative hemoglobin was 8.7 ± 1g/dl. All of the global perfusion indices, except for arterial pH and oxygen consumption, decreased after hemodilution and recovered with the re-transfusion of blood ($P \geq 0.1$). One patient had a major complication of pulmonary edema. They concluded that hemodilution during radical hysterectomy does not appear to compromise tissue perfusion or coagulation.

Rehm M et al [40] did a study about the changes in intravascular Volume during acute normovolemic hemodilution and intraoperative retransfusion in patients with radical hysterectomy. In this study, in 15 patients undergone radical hysterectomy, preoperative ANH to a hematocrit of 24% was experimented using 5% albumin solution. For volume substitution intraoperatively saline 0.9% solution was used, and intraoperative re-

transfusion was started at a hematocrit of 20%.Before and after ANH and re-transfusion and preoperatively the plasma volume (indocyanine green dilution technique), hematocrit and plasma protein concentration were measured. In the same stage of before and after ANH the Red cell volume (labelling erythrocytes with fluorescein) was determined. The results have shown the mean normal plasma volume (1,514 ± 143ml/m2) and reduced red cell volumes (707 ± 79ml/m2) were measured preoperatively. Blood (1150 ± 196ml) was removed and replaced with 1.333 ± 204 ml of colloid. Blood volume before and after ANH was same and amounted to 3,740 ml. The plasma volume didn't increase until the re-transfusion despite infusing 3,389 ± 1.021 ml of crystalloid (corrected for urine output) to compensate for an targeted surgical blood loss of 727 ± 726 ml. Postoperatively, after re-transfusion of all autologous blood, blood volume was 255 ± 424 ml which was higher than pre-operatively before ANH. Instead mean calculated blood loss of 1,256 ± 892 ml, only one patient received allogeneic blood.

They concluded that during ANH, normovolemia was appropriately maintained. After surgical blood loss of 1,256 ± 892 ml, crystalloid and colloid supplies of 5,572 ± 1462 ml and 1,667 ± 548 ml, respectively and complete intraoperative re-transfusions of autologous blood was given to every patient and also the mean blood volume was 250 ml higher than preoperatively before ANH.

## OBJECTIVES OF THE STUDY

- To study the safety, hemodynamic alterations associated with acute normovolemic hemodilution (ANH) among patients who were posted for elective hysterectomy in Government Theni medical college Hospital, Theni.
- To compare the hemodynamic alterations between patients receiving acute normovolemic hemodilution (ANH) and patients receiving conventional homologous blood transfusion during elective hysterectomy in Government Theni medical college Hospital, Theni.

# METHODOLOGY

## STUDY AREA:

The study was conducted in the operating theatre under Department of Anaesthesiology with patients posted for hysterectomy from Department of Gynaecology, Government Theni medical college Hospital, Theni

## STUDY PERIOD:

The timeline of this study is as follows:

- Protocol preparation, submission of protocol to institutional ethical committee: August 2017 to October 2018
- Preparation of Proforma and other logistics and support personnel: November 2017 to February 2018
- Data collection: March 2018 to April 2019
- Data Entry and Data analysis: September 2018 to September 2019
- Finalization of thesis and submission: September 2019 to October 2019

## STUDY POPULATION:

The study population included 60 patients posted for elective total abdominal hysterectomy from Department of Gynaecology, Government Theni medical college Hospital, Theni during the study period.

Study design: Institution based experimental study.

The 60 subjects were divided randomly into either of the following two groups based on odd-even method as follows:

Group I: Control group: 30 patients posted for elective hysterectomy received homologous blood transfusion.

Group II: Hemodilution Group: 30 patients posted for elective hysterectomy received acute normovolemic hemodilution as per procedure described below.

**Inclusion criteria:**

- Patients of any age above 18 years posted for elective total abdominal hysterectomy
- Pre-operative Hemoglobin >10grams%
- Pre-operative hematocrit >30%

**Exclusion criteria:**

- Presence of cardiac, pulmonary, renal or liver disease
- Uncontrolled hypertension
- Coagulation disorders
- Hypoalbuminemia
- Presence of infection
- Patients not willing to provide consent to participation in the study

**Pre-operative Work-up:**

All patients were subjected to routine Pre-operative screening tests such as

Blood: Hb%

PCV

Total count

Differential Count

Platelet count

ESR

Urea

Sugar (fasting and Post-prandial)

Serum: Creatinine

Electrolytes : Na, K

Proteins

Screening for Hep.B,C and HIV

Urine: protein,

Sugar

Microscopy

Coagulation profile

ECG

Chest X-ray PA View

Other relevant gynecological tests.

GROSS Formula for calculation of blood volume for withdrawal:

Vol = {EBV x (Hi – Hf)}/ Havg

Hi = initial Haematocrit .

Hf = Target Haematocrit

Havg = average haematocrit = (Hi+Hf)/2

EBV = estimated blood volume (can use body weight x 65 ml for women. It is about7% of the patient's body weight

Premedication: All patients were given T.Diazepam 5mg, Tab. Metaclopromide 10 mg, Tab. Ranitidine 150 mg the night before surgery

Baseline parameters:

**The following are noted:**

- Pulse rate
- Blood Pressure: Systolic and Diastolic
- Oxygen saturation
- ECG
- Urine output after bladder catheterization.

All patients received 5 litres of oxygen per minute through a ventimask in the pre-induction period.

Two 16 gauge intra-venous cannula were started under aseptic conditions, one for infusion of cyrstalloids such as NS and RL. The other one is used a port to

withdraw blood through connecting it to blood bags. In some patients withdrawal of blood was facilitated with the help of automated blood pressure cuff.

**Collection of blood:**

- Blood was collected from antecubital vein of the upper arm which is in opposite side of the arm receiving replacement fluids
- Volume of blood collected was based on Gross Formula as discussed earlier and hemodilution was performed until Hematocrit reached a target of 30%
- For each ml of blood withdrawn, 3 ml of crystalloid was replaced simultaneously through a cannula placed in the opposite side of the cannula used for withdrawal of blood
- The volume of blood withdrawn was replaced with crystalloids.
- The blood bags were weighed to show the reading increments of every 25 grams and the volume of blood collected was calculated as 1 ml of blood is equal to 1.06 grams approximately
- Manual rocking of the bags was done frequently during the withdrawal of blood to allow the blood to mix uniformly with the anticoagulant
- Each bag was labelled after collection of necessary volume of blood in the sequential order of collection containing patients' details such as name, age, IP number, date and time of collection and then the bags were kept inside the theatre itself by the side of the patient

- All the vital signs were continuously monitored during the process of blood withdrawal
- The technique used was general anaesthesia with controlled ventilation which was standardized for all the patients
- Patients were pre-medicated with Inj.Glycopyrrolate 10 mcg/kg and Inj.Midazolam 0.025mg/kg intravenously stat. Pre-oxygenation with 100% O2 for 3 minutes was given. The induction of anaesthesia was done with 2.5% injection Thiopentone sodium 5 mg / kg and intubated with injection Suxamethonium 2mg / kg IV. All the patients were intubated oro-tracheally with appropriate size endotracheal tube and maintenance of anaesthesia was done with nitrous oxide and Oxygen and 0.5 -1% sevoflurane. Injection Vecuronium 0.1mg / kg was mainly used to facilitate intermittent positive pressure ventilation. The reversal of anaesthesia was done at the end of surgery using Injection Neostigmine 50 mcg / kg and Inj.Glycopyrrolate 10 mcg / kg slow intravenous and extubated after full recovery from anaesthesia
- Volume replacement was done using crystalloids such as ringer lactate, normal saline depending on the volume of blood loss during the surgery and normo-volemia was maintained throughout the intraoperative period
- The blood which was withdrawn was reinfused after achieving normal homeostasis at the end of the surgery especially after a major blood loss has ceased or if intraoperative hemoglobin level was less than 8 gms%

- Frequently the blood samples were collected to estimate haemoglobin, PCV, bleeding time, clotting time, RBC count especially after every unit of blood withdrawal and also before transmission and after transfusion of the collected blood
- After ensuring complete recovery of the patients, they were placed in the postoperative Intensive Care Unit for 24 hours and then shifted to the post-operative wards
- All patients were followed up until discharge.

**Ethical Considerations:**

The Ethical approval for this study was obtained from Institutional Ethics Committee (IEC), Government Theni medical college, Theni. It was ensured that all the ethical principles were followed properly and also the data collected was used only for the intended purpose of the study. As promised by the researchers, strict confidentiality of participants was maintained throughout the process and anonymity was maintained in every possible way. The results obtained from the data collection were handled with confidentiality and the researchers will discard the entire data gathered after the publication of thesis.

## STATISTICAL ANALYSIS

All the data was entered initially into Microsoft Excel 2010 and then these spreadsheets were used for analysis and statistical analysis was done using SPSS version 20.0.

- Descriptive statistics was calculated as frequency, percentage, mean and standard deviation, median and inter-quartile range and depicted using various tables, graphs, diagrams etc.
- Various tests of significance were used according to the type of variable for inferential statistics. Parametric tests like student 't' test was used to compare the means of continuous variables after ensuring that the variable followed normal distribution. Tests for normality such as Kolmogorov Smirnov Test was used to test whether the data followed normal distributions or not. Since the test was statistically not significant (p=0.789), the data was assumed to follow normal distribution. Chi-square test was used to compare the various categorical variables while Yates's correction for continuity was used in Chi-square test to reduce the error in approximation
- Factorial repeated measures ANOVA was employed to test for difference in changes of various (continuous) independent variables such as hemodynamic parameters, coagulation profile variables etc between the hemodilution group and the control group (Between subjects factor)

- The p value of <0.05 was used to reject the null hypothesis in all the statistical tests of significance.

# RESULTS

**Table 1: Age distribution of the study sample (n=60)**

| Age group | Control Group n (%) | Hemodilution Group n (%) | Total n (%) |
|---|---|---|---|
| 31 to 40 years | 6 (20) | 7 (23.3) | 13 (21.7) |
| 41 to 50 years | 16 (53.3) | 20 (66.7) | 36 (60) |
| 51 to 60 years | 6 (20) | 2 (6.7) | 8 (13.3) |
| >60 years | 2 (6.7) | 1 (3.3) | 3 (5) |
| Total | 30 (100) | 30 (100) | 60 (100) |

Chi-square p value: 0.415

Comments: The age distribution of study subjects in both groups can be considered as similar as the minor difference observed was not statistically significant ($p>0.05$). Hence both the groups were comparable.

**Fig 1: Age distribution of the study sample (n=60)**

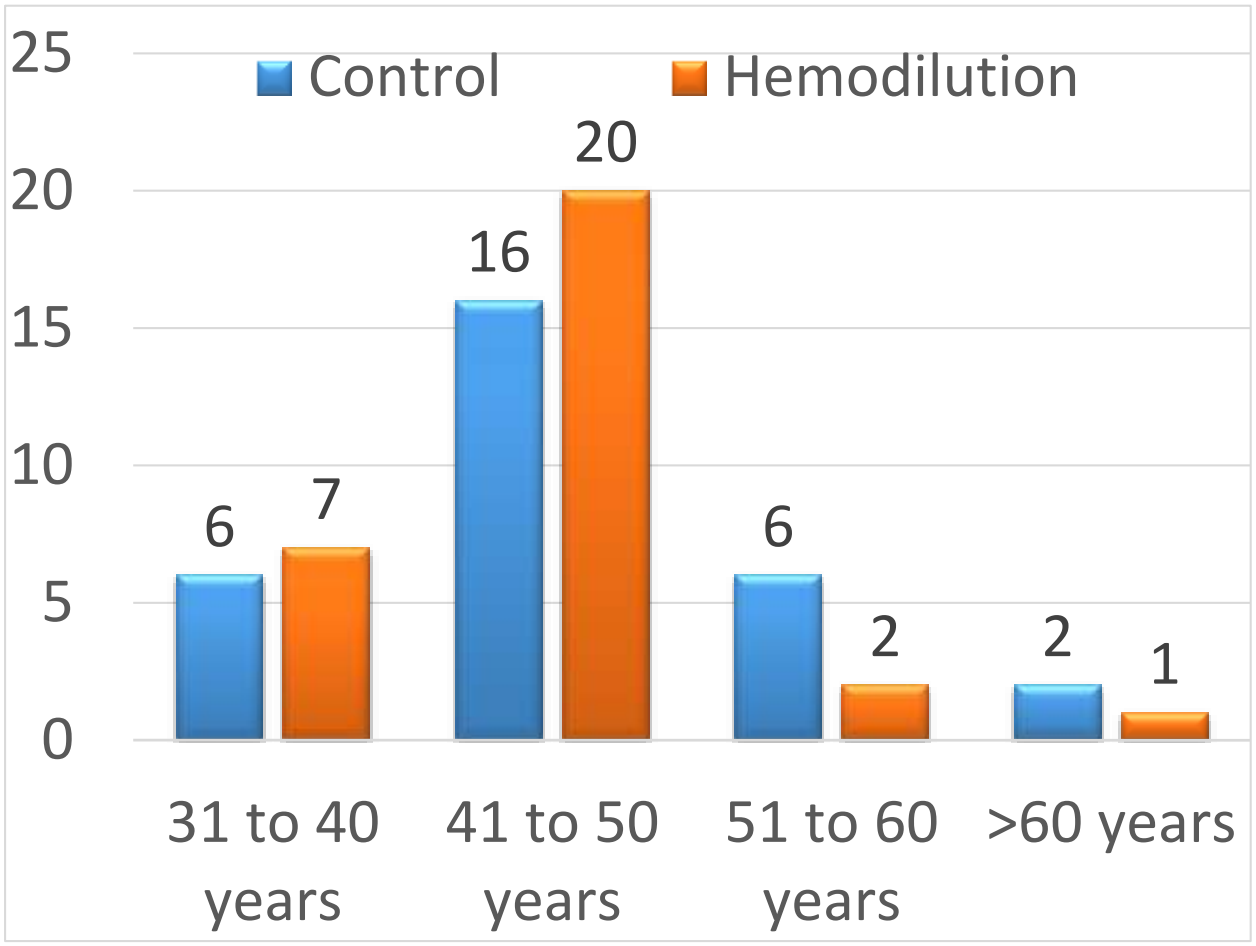


**Table 2: Comparison of mean age of the study sample (n=60)**

| Group | N | Mean Age (years) | Std.Deviation | Mean Difference | Student 't' test p value |
|---|---|---|---|---|---|
| Control | 15 | 48.53 | 8.803 | 3.93 | 0.051 |
| Hemodilution | 17 | 44.60 | 5.230 | | |

Comments: The difference in mean age between the two groups was not statistically significant ($p>0.05$) and hence both the groups were comparable.

**Table 3: Comparison of mean weight of the study sample (n=60)**

| Group | N | Mean Weight (Kgs) | Std.Deviation | Mean Difference | Student 't' test p value |
|---|---|---|---|---|---|
| Control | 15 | 58.60 | 3.440 | 2.567 | 0.063 |
| Hemodilution | 17 | 56.03 | 6.578 | | |

Comments: The difference in mean weight between the two groups was not statistically significant ($p>0.05$) and hence both the groups were comparable with regards to body weight.

**Fig 2: Comparison of mean weight of the study sample (n=60)**

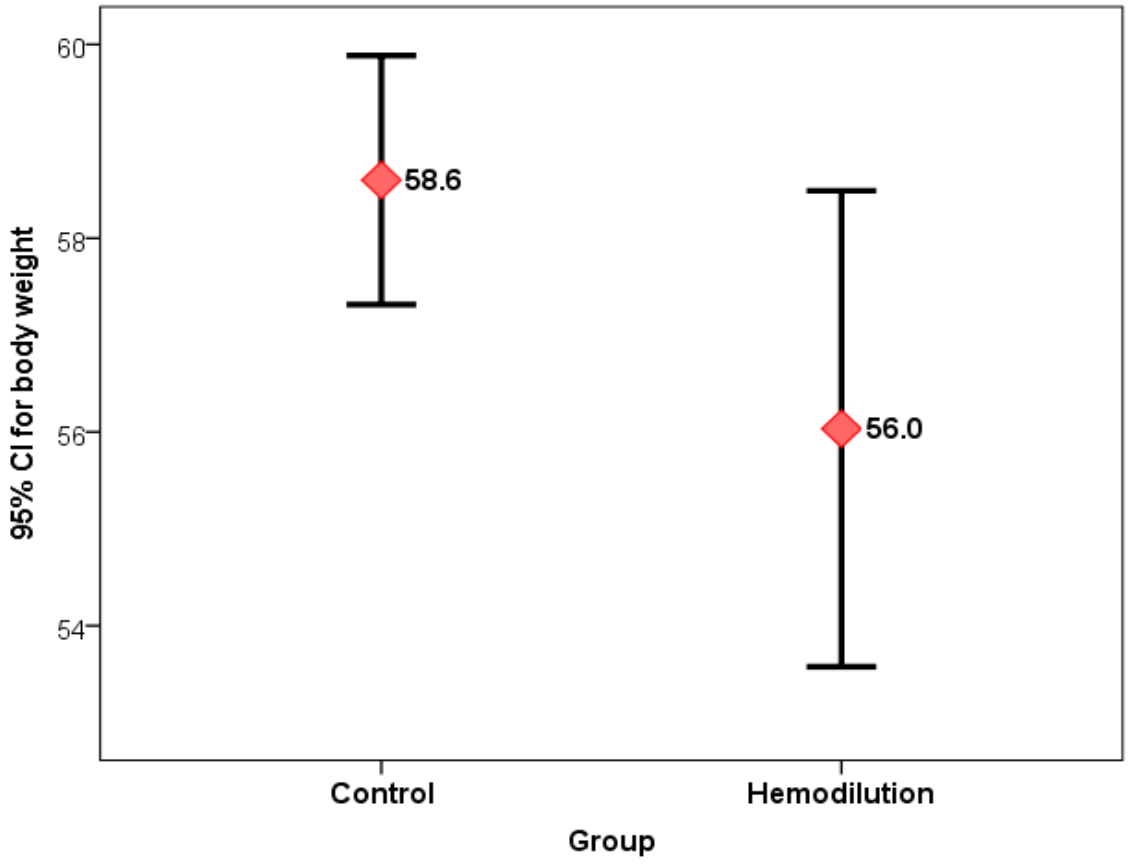



**Table 4: Distribution of the two groups according to ASA Grading (n=60)**

| ASA grade | Control Group n (%) | Hemodilution Group n (%) | Total n (%) |
|---|---|---|---|
| Grade I | 20 (66.7) | 21 (70) | 41 (68.3) |
| Grade II | 10 (33.3) | 9 (30) | 19 (31.7) |
| Total | 30 (100) | 30 (100) | 60 (100) |

Chi-square p value: 0.781

Comments: The difference in distribution of study subjects in both groups according to ASA Grading was not statistically significant (p>0.05). Hence both the groups were comparable.

**Fig 3: Distribution of the two groups according to ASA Grading (n=60)**

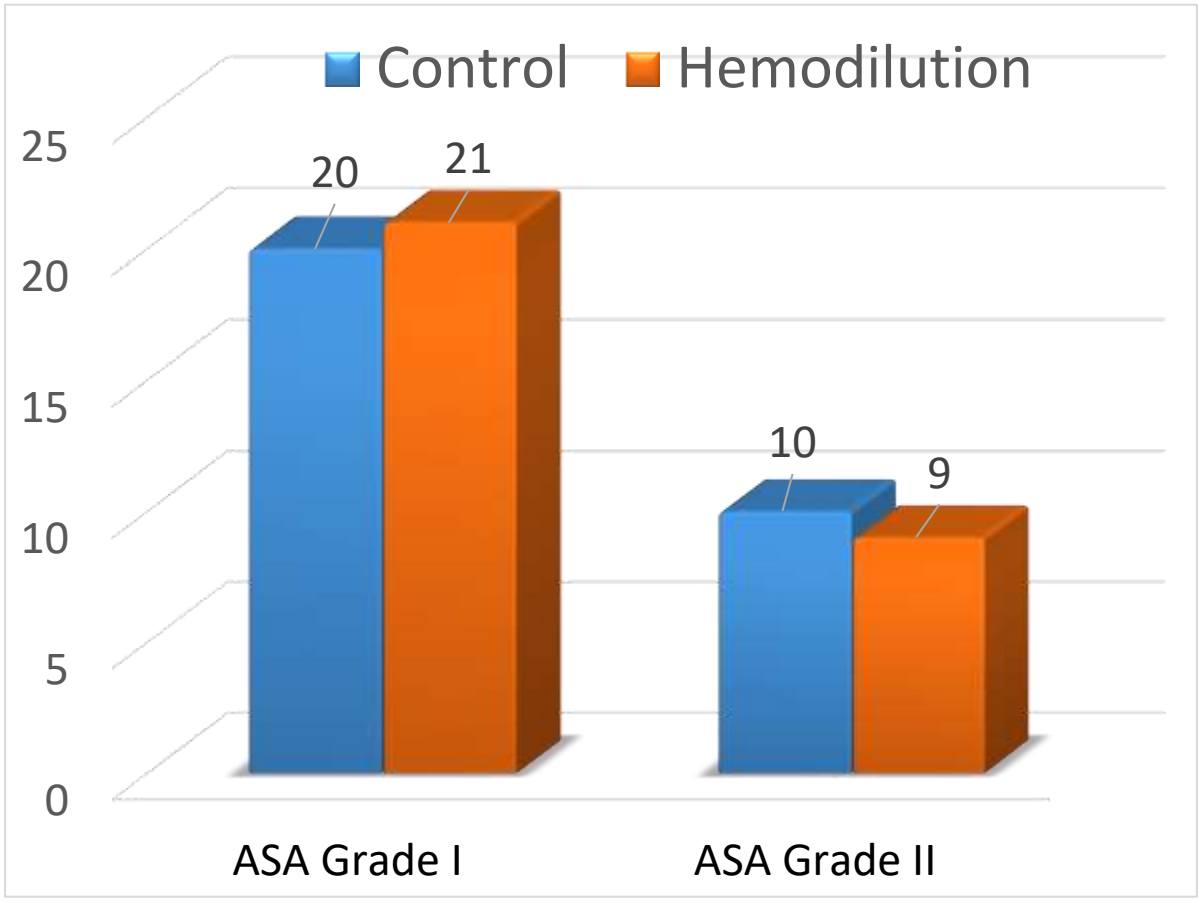


**Table 5: Comparison of mean heart rate of the study groups at various time points (n=60)**

| Mean Heart rate | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean HR | Std. Deviation | Mean HR | Std. Deviation | |
| Pre-op | 83.1 | 3.9 | 84.4 | 11.5 | 0.561 |
| T1 | 85.2 | 4.2 | 90.4 | 15.8 | 0.086 |
| T2 | 90.9 | 4.4 | 90.0 | 12.7 | 0.714 |
| T3 | 88.3 | 4.4 | 90.1 | 15.6 | 0.538 |
| T4 | 89.6 | 5.4 | 89.6 | 10.5 | 1.00 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean heart rate at various time points of the between the control and hemo-dilution groups.

| Model | mean heart rate variation over time | mean heart rate variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 9.069 | 2.143 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | 0.088 |

**Comments:**

1. There was no statistically significant difference between the mean heart rate between the 2 groups throughout the pre-op and post-operative period as suggested by the student't' test.
2. Variation in heart rate: In factorial repeated measures ANOVA, there was a statistically significant variation in mean heart rate over time as $p<0.05$. However there was no statistically significant difference in the changes of heart rate between the 2 groups as $p>0.05$.

**Fig 4: Comparison of mean heart rate of the study groups at various time points (n=60)**

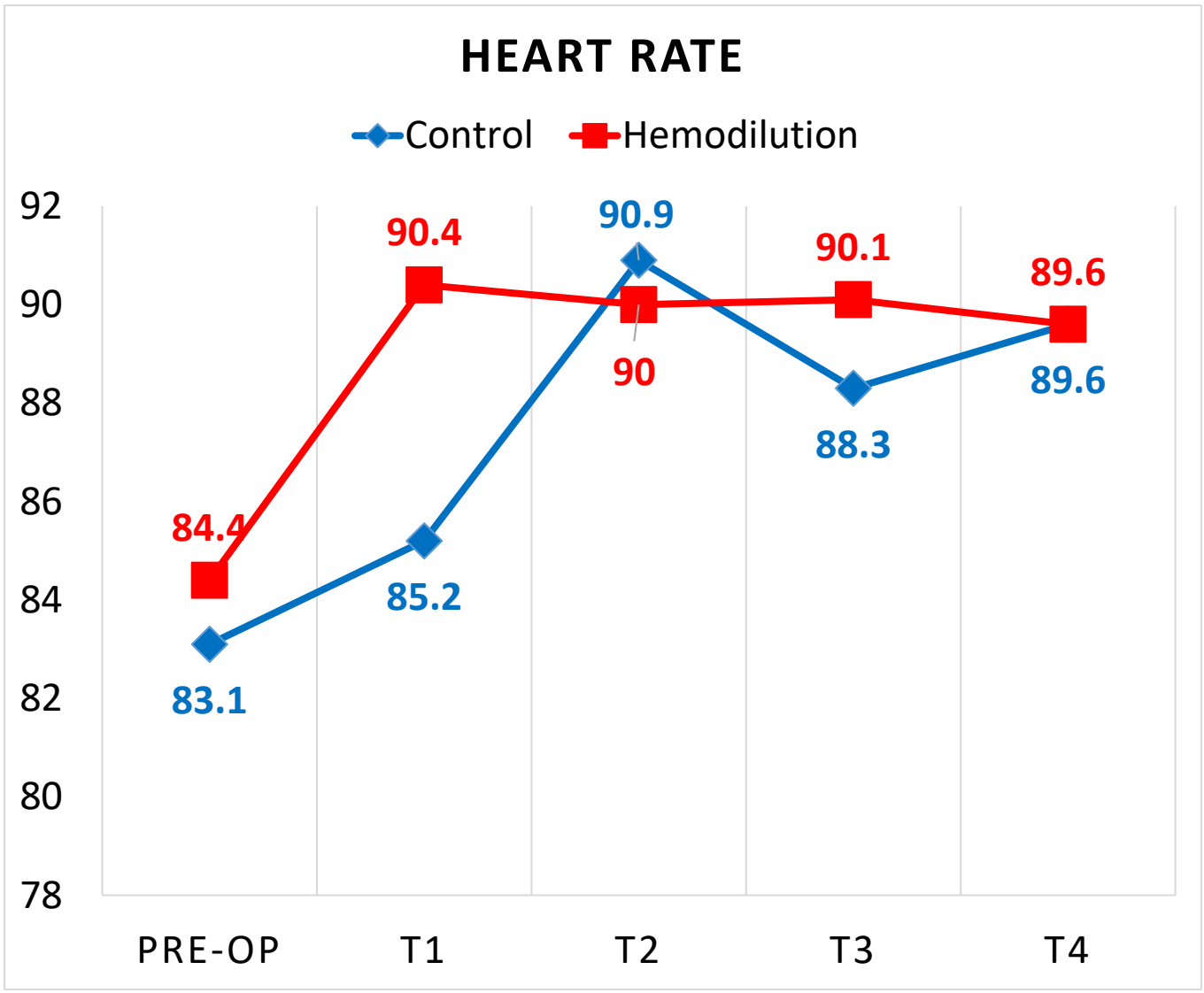


**Table 6: Comparison of mean systolic blood pressure (SBP) of the study groups at various time points (n=60)**

| Mean SBP (mm Hg) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean SBP | Std. Deviation | Mean SBP | Std. Deviation | |
| Pre-op | 123.8 | 12.3 | 128.1 | 6.8 | 0.097 |
| T1 | 125.4 | 18.4 | 124.5 | 8.5 | 0.802 |
| T2 | 118.7 | 16.6 | 112.5 | 11.6 | **0.048** |
| T3 | 119.2 | 14.8 | 119.6 | 11.1 | 0.914 |
| T4 | 122.5 | 10.0 | 124.1 | 5.3 | 0.121 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean systolic blood pressure (SBP) at various time points between the control and hemodilution groups.

| Model | mean SBP variation over time | mean SBP variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 7.721 | 3.663 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | ***0.010*** |

**Comments:**

1. There was no statistically significant difference between the mean systolic blood pressure (SBP) between the 2 groups throughout the pre-operative and post-operative period except at the end of Hemodilution as there was a fall in SBP in hemodilution group but not in control group as suggested by the student 't' test.
2. Variation in systolic blood pressure: In factorial repeated measures ANOVA, there was a statistically significant variation in mean systolic blood pressure (SBP) over time as $p<0.05$. Moreover, subjects in hemodilution group experienced higher variation in systolic blood pressure (decline in T3) than subjects in control group who had less variation in SBP and this difference in the changes of systolic blood pressure over time between the 2 groups was statistically significant.

**Fig 5: Comparison of mean systolic blood pressure (SBP)**

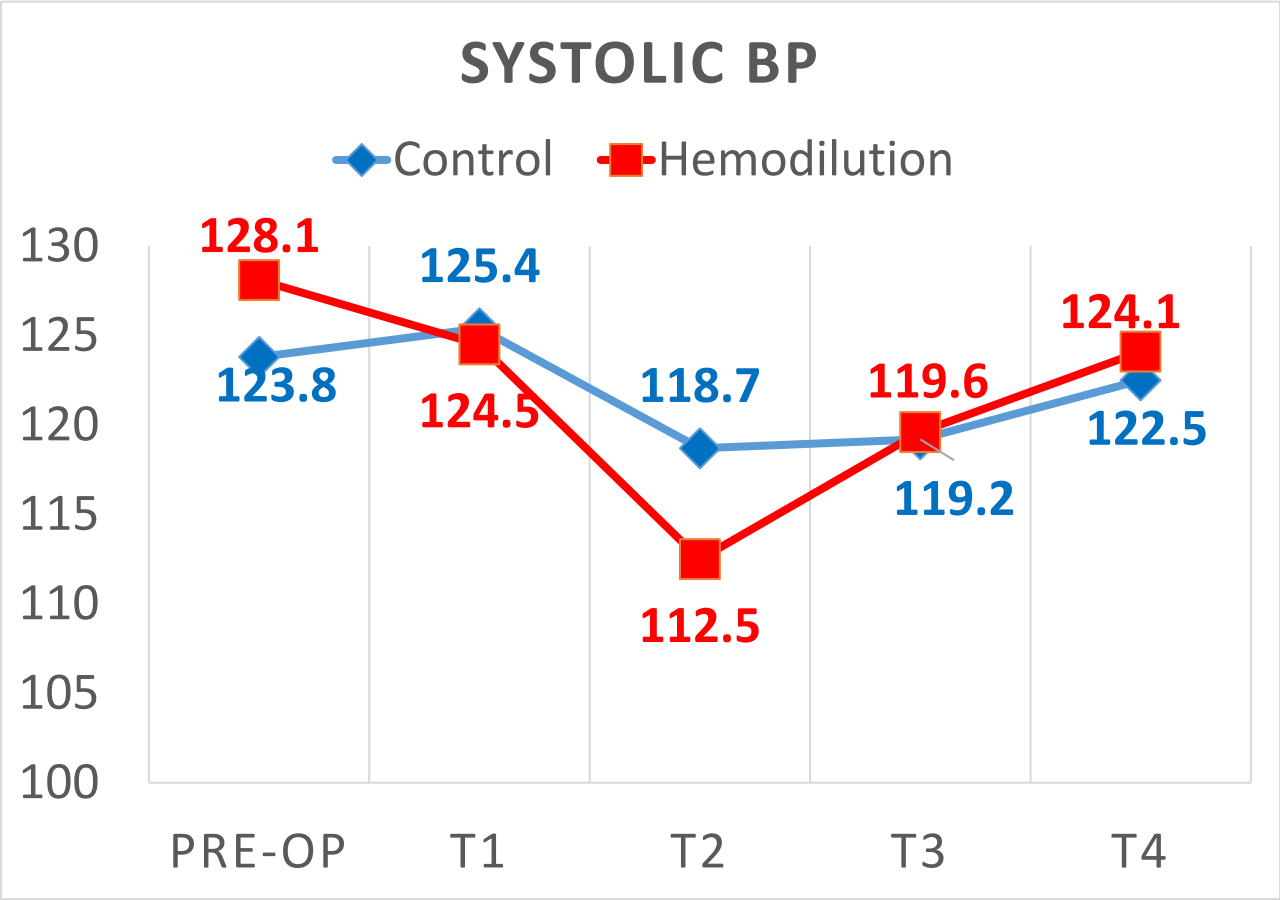


**Table 7: Comparison of diastolic blood pressure (DBP) of study groups at various time points (n=60)**

| Mean DBP (mm Hg) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean DBP | Std. Deviation | Mean DBP | Std. Deviation | |
| Pre-op | 77.9 | 9.2 | 81.7 | 6.8 | 0.070 |
| T1 | 81.6 | 14.1 | 78.7 | 7.8 | 0.334 |
| T2 | 77.3 | 13.0 | 70.6 | 8.2 | ***0.020*** |
| T3 | 79.5 | 10.1 | 78.0 | 6.0 | 0.489 |
| T4 | 82.4 | 8.1 | 82.2 | 4.9 | 0.909 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean diastolic blood pressure (DBP) at various time points between the control and hemodilution groups.

| Model | mean DBP variation over time | mean DBP variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 11.244 | 2.634 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | ***0.044*** |

**Comments:**

1. There was no statistically significant difference between the mean diastolic blood pressure (DBP) between the 2 groups throughout the pre-operative and post-operative period except at the end of Hemodilution there was a fall in SBP in hemodilution group but not in control group as suggested by the student't' test.
2. Variation in diastolic blood pressure: In factorial repeated measures ANOVA, there was a statistically significant variation in mean diastolic blood pressure (DBP) over time as $p<0.05$. Moreover, subjects in hemodilution group experienced higher variation in diastolic blood pressure (decline in T3) than subjects in control group who had less variation in DBP and this difference in the changes of diastolic blood pressure over time between the 2 groups was statistically significant.

**Fig 6: Comparison of mean diastolic blood pressure (DBP)**

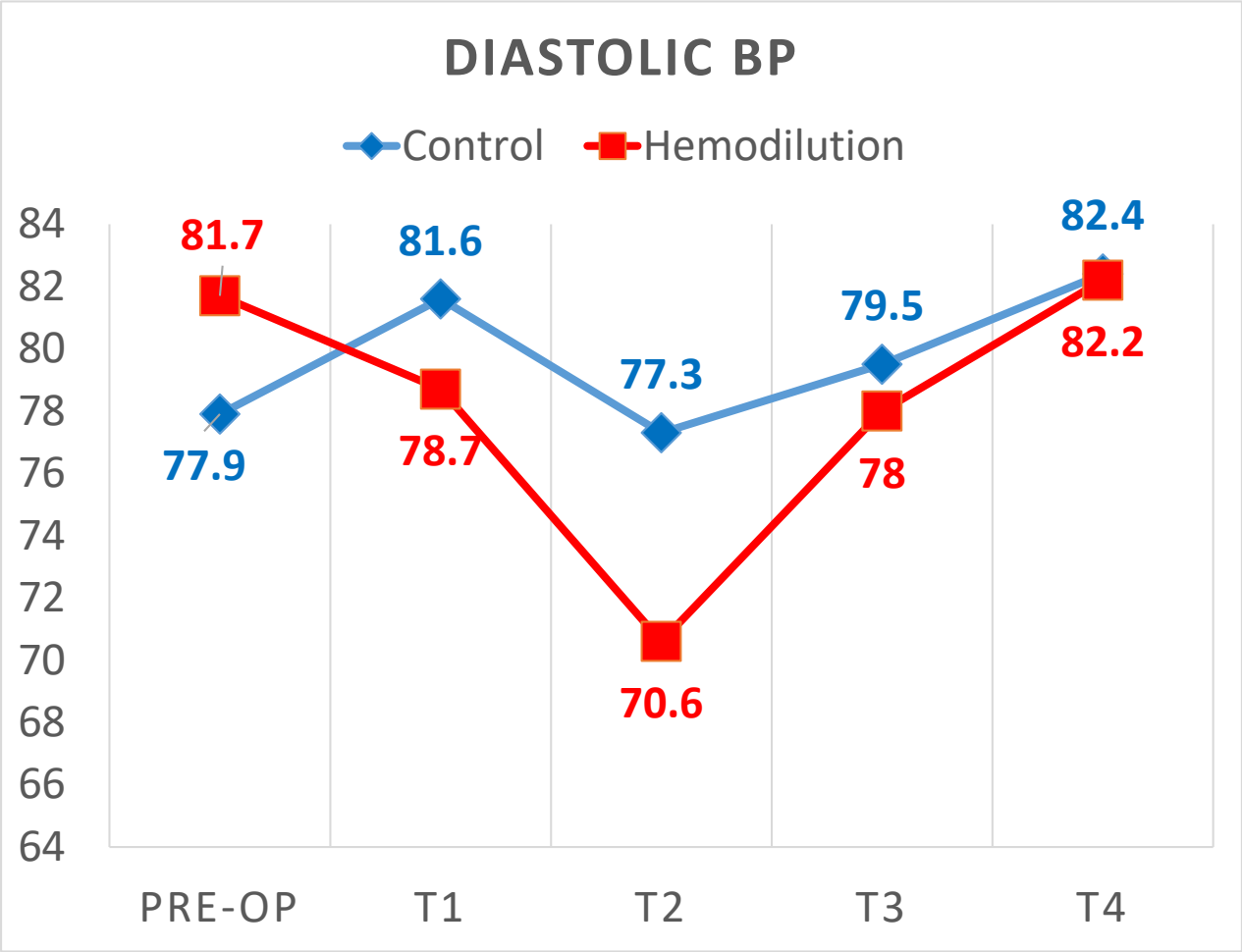


**Table 8: Comparison of mean arterial pressure (MAP) of study groups at various time points (n=60)**

| Mean MAP (mm Hg) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean MAP | Std. Deviation | Mean MAP | Std. Deviation | |
| Pre-op | 92.8 | 9.2 | 96.2 | 5.3 | 0.085 |
| T1 | 96.0 | 15.1 | 94.2 | 8.2 | 0.575 |
| T2 | 90.9 | 13.8 | 84.8 | 9.0 | ***0.048*** |
| T3 | 93.4 | 11.3 | 92.2 | 7.2 | 0.616 |
| T4 | 95.7 | 7.9 | 97.1 | 5.0 | 0.415 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean arterial pressure (MAP) at various time points between the control and hemodilution groups.

| Model | mean MAP variation over time | mean MAP variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 11.260 | 2.240 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | 0.076 |

**Comments:**

1. There was no statistically significant difference between the mean arterial pressure (MAP) between the 2 groups throughout the pre-operative and post-operative period except at the end of Hemodilution /40mins after Induction in Control Group (T2) as there was a fall in MAP in hemodilution group more than the fall in control group as suggested by the student 't' test.
2. Variation in mean arterial pressure: In factorial repeated measures ANOVA, there was a statistically significant variation in mean arterial pressure (MAP) over time as $p<0.05$. However, this variation in MAP happened in same direction in both the groups as there was no statistically significant difference in the changes of mean arterial pressure between the 2 groups.

**Fig 7: Comparison of mean arterial pressure (MAP)**

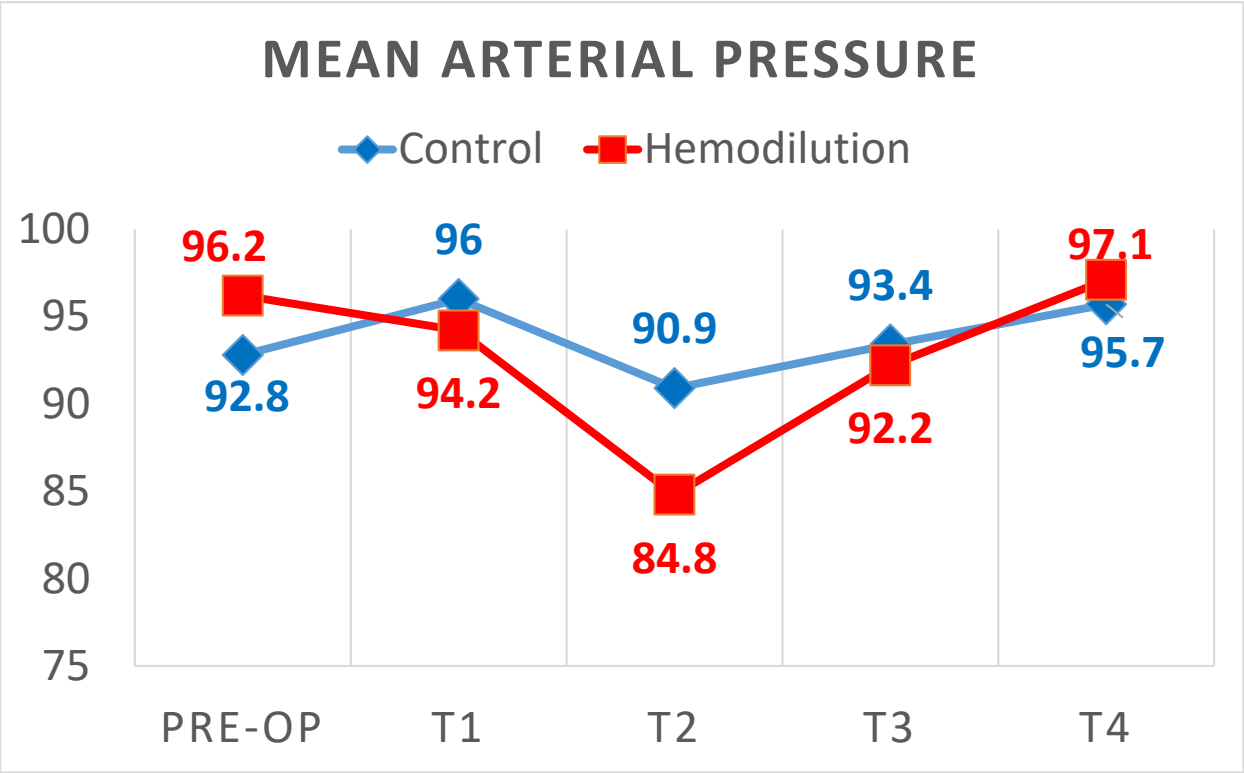


**Table 9: Comparison of mean hemoglobin levels (Hb) of study groups at various time points (n=60)**

| Mean Hb (gms%) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean Hb | Std. Deviation | Mean Hb | Std. Deviation | |
| Pre-op | 10.3 | 0.4 | 11.2 | 0.5 | ***<0.001*** |
| T1 | 10.1 | 0.3 | 10.7 | 0.8 | ***<0.001*** |
| T2 | 9.3 | 0.6 | 9.6 | 0.8 | 0.152 |
| T3 | 9.6 | 0.4 | 10.4 | 1.3 | ***0.001*** |
| T4 | 10.2 | 0.4 | 10.8 | 1.0 | ***0.003*** |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean hemoglobin levels (Hb) at various time points between the control and hemodilution groups.

| Model | mean Hb variation over time | mean Hb variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 52.62 | 2.69 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | ***0.040*** |

**Comments:**

1. There was a statistically significant difference in mean hemoglobin levels (Hb) between the 2 groups throughout the pre-operative and post-operative period except at the end of Hemodilution /40mins after Induction in Control Group (T2) as suggested by the student't' test.
2. Variation in mean hemoglobin levels (Hb): In factorial repeated measures ANOVA, there was a statistically significant variation in mean hemoglobin levels (Hb) over time as $p<0.05$. Moreover, subjects in hemodilution group experienced higher variation in hemoglobin levels than subjects in control group who had less variation in hemoglobin levels and this difference in the changes of hemoglobin levels over time between the 2 groups was statistically significant.

**Fig 8: Comparison of mean hemoglobin levels (Hb)**

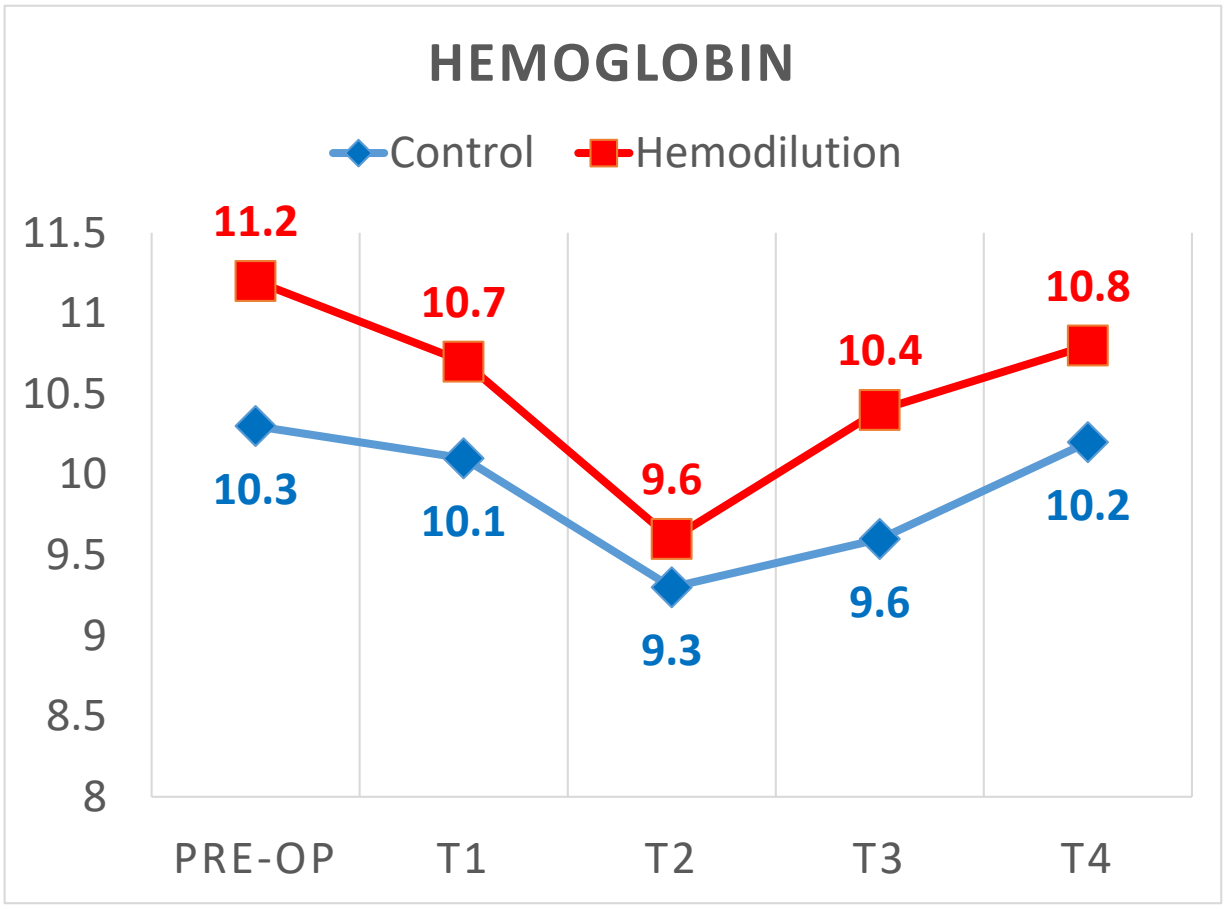


**Table 10: Comparison of mean hematocrit values (HCT) of study groups at various time points (n=60)**

| Mean Hct (%) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean Hct | Std. Deviation | Mean Hct | Std. Deviation | |
| Pre-op | 31.3 | 1.0 | 35.7 | 5.1 | ***<0.001*** |
| T1 | 30.7 | 1.1 | 34.2 | 4.4 | ***<0.001*** |
| T2 | 28.8 | 1.3 | 31.3 | 4.5 | ***0.004*** |
| T3 | 29.3 | 1.2 | 31.8 | 3.8 | ***0.001*** |
| T4 | 30.6 | 1.0 | 33.2 | 3.7 | ***0.001*** |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean hematocrit values (HCT) at various time points between the control and hemodilution groups.

| Model | mean HCT variation over time | mean HCT variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 41.546 | 2.948 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | ***0.028*** |

**Comments:**

1. There was a statistically significant difference between the mean hematocrit values (HCT) between the 2 groups was maintained from baseline and throughout the pre-operative and post-operative period as there was a fall in HCT in both the hemodilution and control group as suggested by the student't' test.
2. Variation in mean hematocrit values (HCT): In factorial repeated measures ANOVA, there was a statistically significant variation in mean hematocrit values (HCT) over time as $p<0.05$. Moreover, subjects in hemodilution group experienced higher variation in hematocrit values (HCT) than subjects in control group and this difference in the changes of hematocrit values (HCT) over time between the 2 groups was statistically significant.

**Fig 9: Comparison of mean hematocrit values (HCT) of study groups at various time points (n=60)**

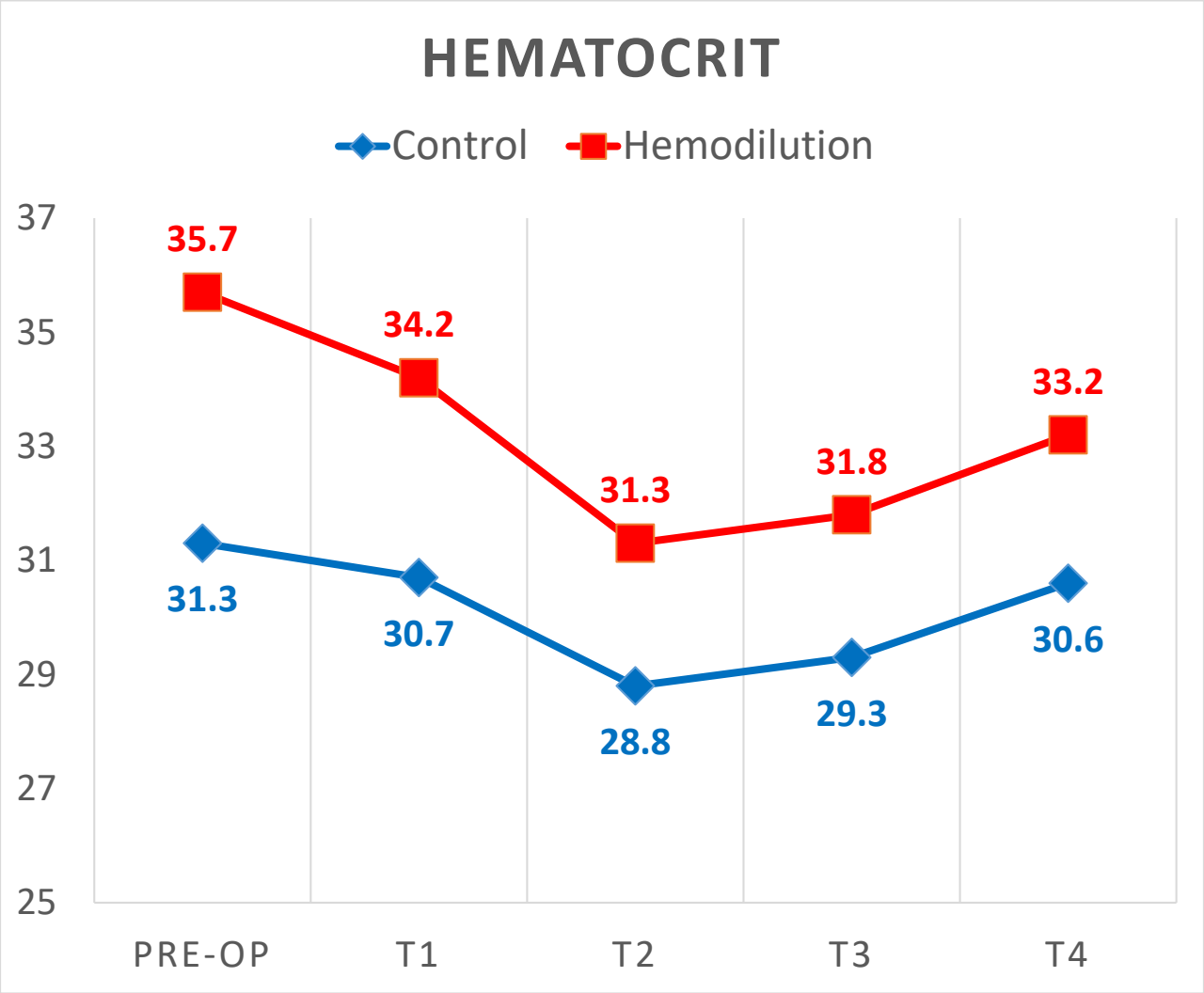


**Table 11: Comparison of mean Platelet count (Plt) of study groups at various time points (n=60)**

| Mean Plt (%) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean Plt | Std. Deviation | Mean Plt | Std. Deviation | |
| Pre-op | 2.85 | 0.29 | 2.92 | 1.01 | 0.686 |
| T1 | 2.66 | 0.35 | 2.73 | 0.68 | 0.592 |
| T2 | 2.48 | 0.41 | 2.51 | 0.62 | 0.865 |
| T3 | 2.46 | 0.39 | 2.33 | 0.50 | 0.243 |
| T4 | 2.58 | 0.29 | 2.31 | 0.49 | 0.053 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean Platelet count (Plt) at various time points between the control and hemodilution groups.

| Model | mean Plt.count variation over time | mean Plt.count variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 12.554 | 2.243 |
| df | 4,55 | 4,55 |
| p value | ***0.002*** | 0.061 |

**Comments:**

1. There was no statistically significant difference between the mean Platelet count (Plt) between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean Platelet count (Plt): In factorial repeated measures ANOVA, there was a statistically significant variation in mean Platelet count (Plt) over time as $p<0.05$. However, this variation in Platelet count (Plt) happened in same direction in both the groups and the minimal difference observed in the changes of mean Platelet count (Plt) between the 2 groups was not statistically significant ($p>0.05$).

**Fig 10: Comparison of mean Platelet count (Plt)**

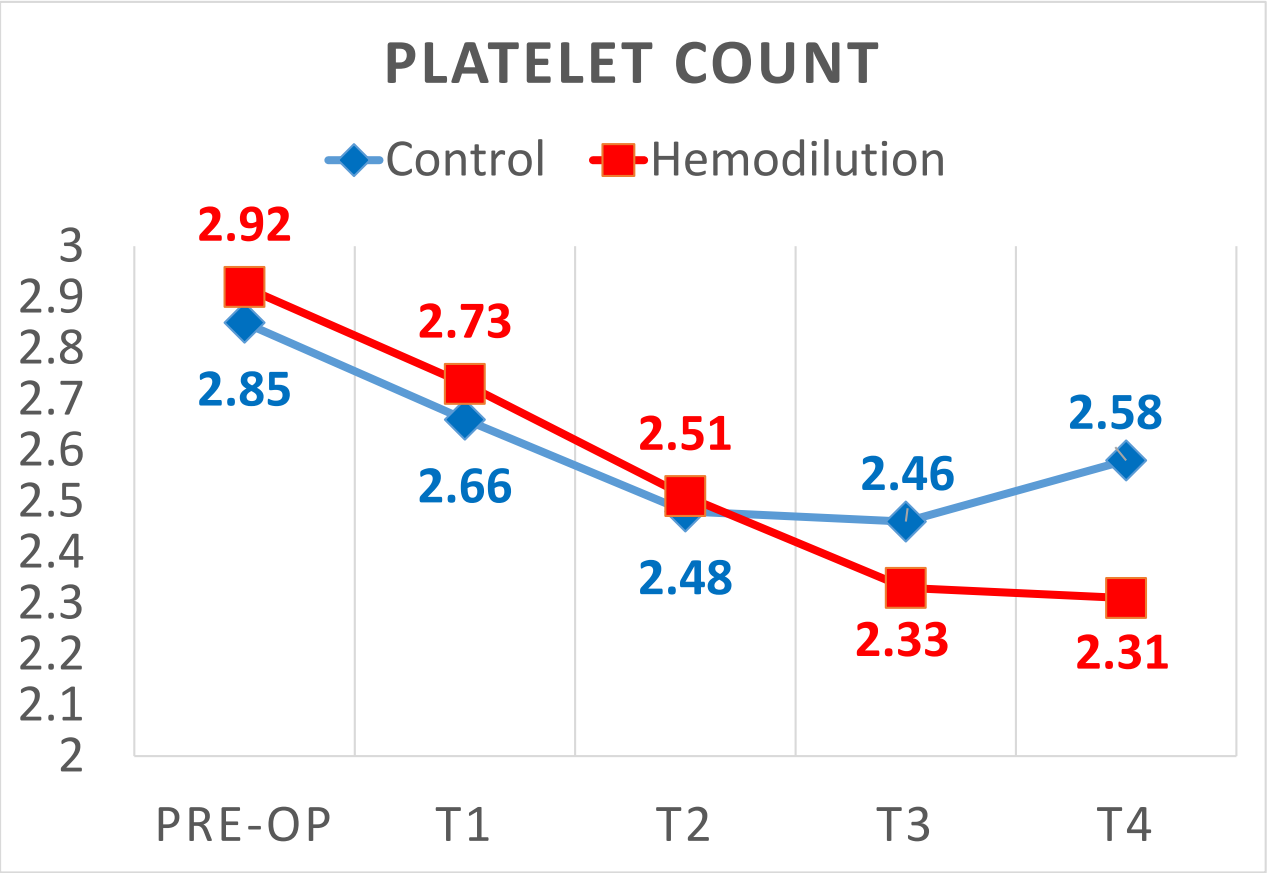


**Table 12: Comparison of mean bleeding time (BT) in seconds of study groups at various time points (n=60)**

| Mean BT (seconds) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean BT | Std. Deviation | Mean BT | Std. Deviation | |
| Pre-op | 136 | 18 | 127 | 28 | 0.127 |
| T1 | 132 | 13 | 126 | 16 | 0.112 |
| T2 | 118 | 15 | 117 | 14 | 0.667 |
| T3 | 121 | 19 | 121 | 19 | 0.937 |
| T4 | 120 | 21 | 114 | 30 | 0.401 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean bleeding time (BT) at various time points between the control and hemodilution groups.

| Model | mean BT variation over time | mean BT variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 5.966 | 0.742 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | 0.568 |

**Comments:**

1. There was no statistically significant difference between the mean bleeding time (BT) between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean bleeding time (BT): In factorial repeated measures ANOVA, there was a statistically significant variation in mean bleeding time (BT) over time as $p<0.05$. However, this variation in bleeding time (BT) happened in same direction in both the groups and the minimal difference observed in the changes of mean bleeding time (BT) between the 2 groups was not statistically significant ($p>0.05$).

**Fig 11: Comparison of mean bleeding time (BT)**

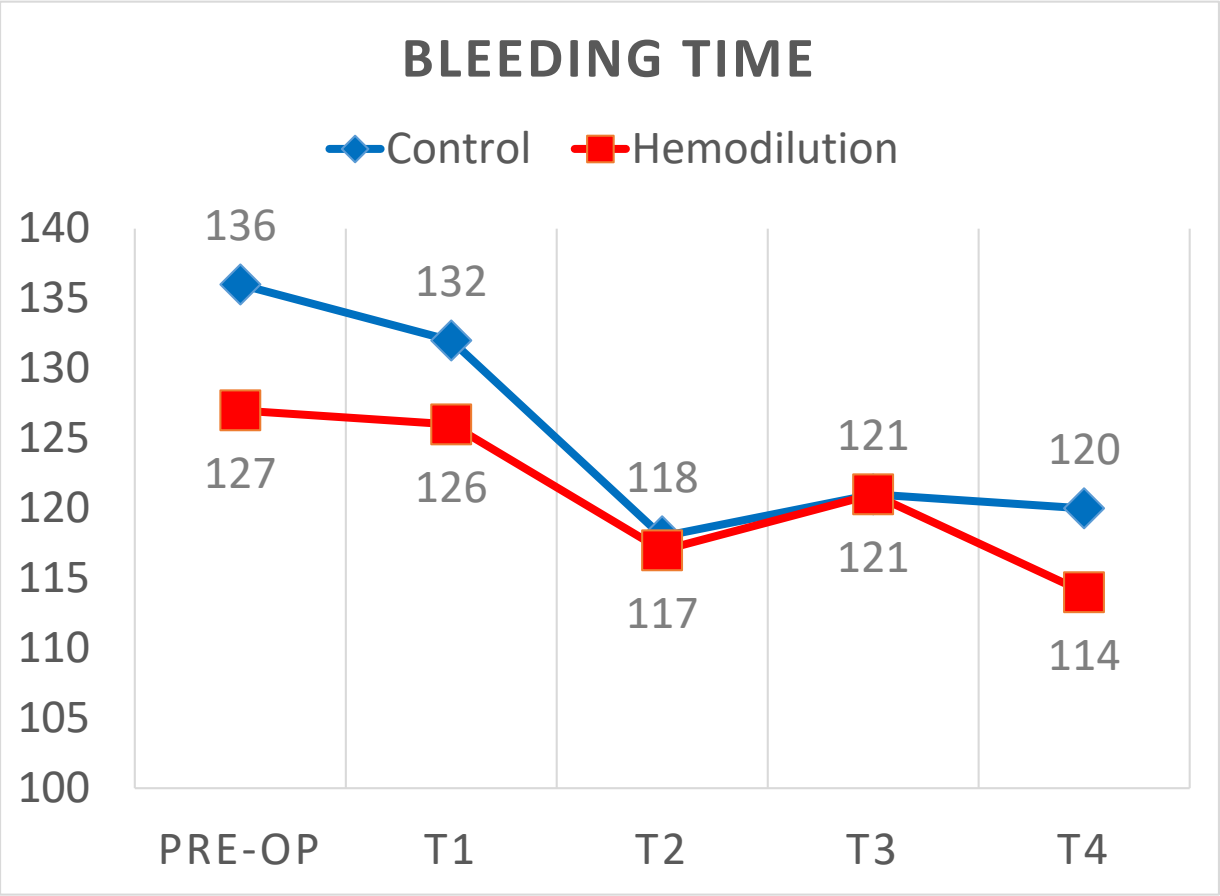


**Table 13: Comparison of mean clotting time (CT) in seconds of study groups at various time points (n=60)**

| Mean CT (mins) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean CT | Std. Deviation | Mean CT | Std. Deviation | |
| Pre-op | 7.2 | 1.1 | 7.5 | 1.1 | 0.230 |
| T1 | 7.2 | 1.1 | 7.9 | 0.8 | 0.058 |
| T2 | 7.8 | 1.0 | 7.7 | 1.0 | 0.684 |
| T3 | 7.7 | 1.1 | 7.9 | 1.1 | 0.483 |
| T4 | 8.1 | 1.0 | 8.0 | 0.9 | 0.729 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean clotting time (CT) at various time points between the control and hemodilution groups.

| Model | mean CT variation over time | mean CT variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 7.492 | 2.315 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | 0.052 |

**Comments:**

1. There was no statistically significant difference between the mean clotting time (CT) between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean clotting time (CT): In factorial repeated measures ANOVA, there was a statistically significant variation in mean clotting time (CT) over time as $p<0.05$. However, this variation in clotting time (CT) happened in same direction in both the groups and the minimal difference observed in the changes of mean clotting time (CT) between the 2 groups was not statistically significant ($p>0.05$).

**Fig 12: Comparison of mean clotting time (CT) in seconds**

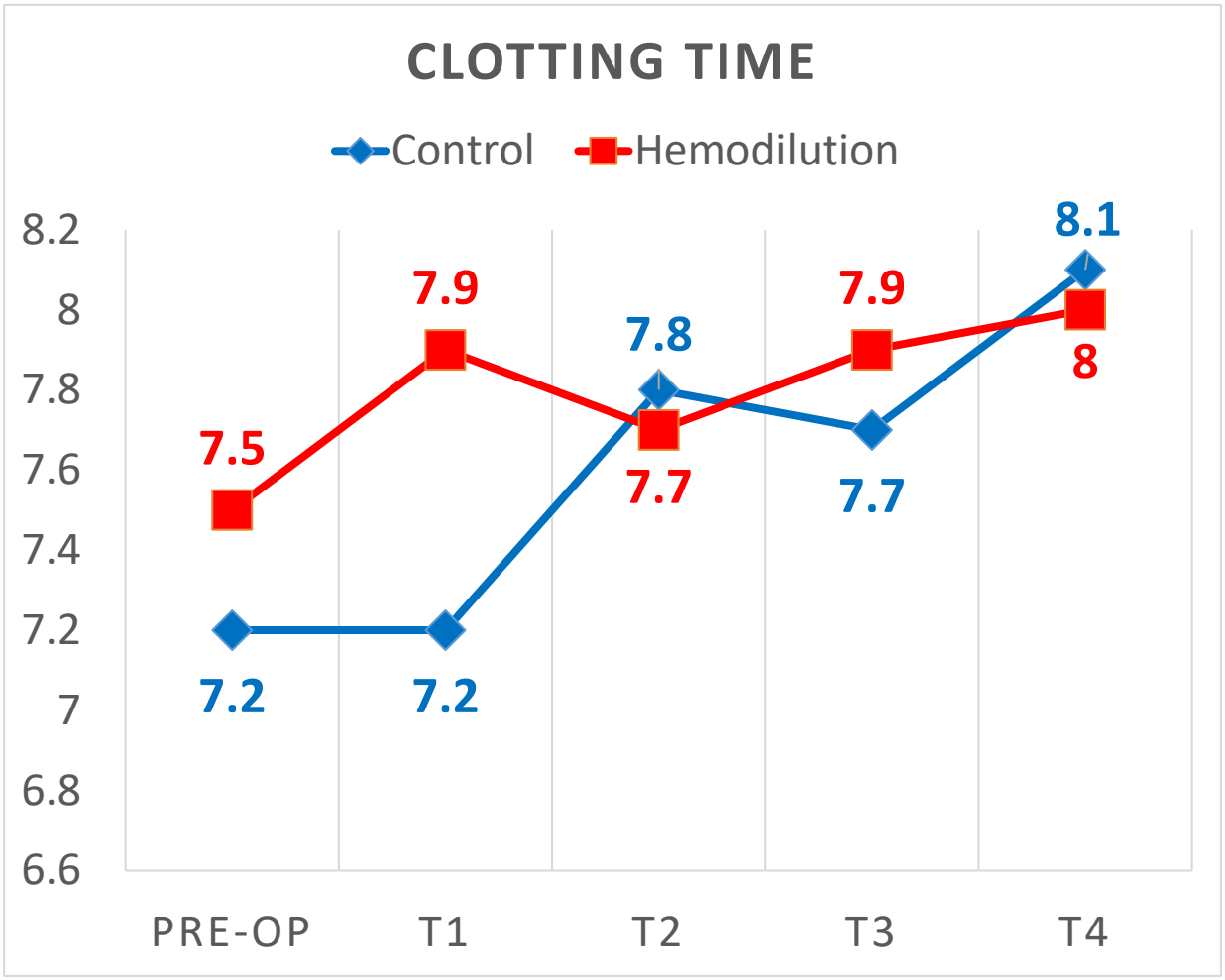


**Table 14: Comparison of activated partial thromboplastin time (aPTT) in seconds of study groups at various time points (n=60)**

| Mean aPTT (seconds) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean aPTT | Std. Deviation | Mean aPTT | Std. Deviation | |
| Pre-op | 34.4 | 2.8 | 35.9 | 2.8 | 0.057 |
| T1 | 35.8 | 2.7 | 36.4 | 2.6 | 0.142 |
| T2 | 37.5 | 2.9 | 37.1 | 2.7 | 0.592 |
| T3 | 36.9 | 2.8 | 37.1 | 2.5 | 0.757 |
| T4 | 37.7 | 2.7 | 37.9 | 2.6 | 0.754 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean aPTT at various time points between the control and hemodilution groups.

| Model | mean aPTT variation over time | mean aPTT variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 7.621 | 1.238 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | 0.306 |

**Comments:**

1. There was no statistically significant difference between the mean aPTT values between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean aPTT: In factorial repeated measures ANOVA, there was a statistically significant variation in mean aPTT over time as $p<0.05$. However, this variation in aPTT happened in same direction in both the groups and the minimal difference observed in the changes of mean aPTT between the 2 groups was not statistically significant ($p>0.05$).

**Fig 13: Comparison of activated partial thromboplastin time (aPTT) in seconds**

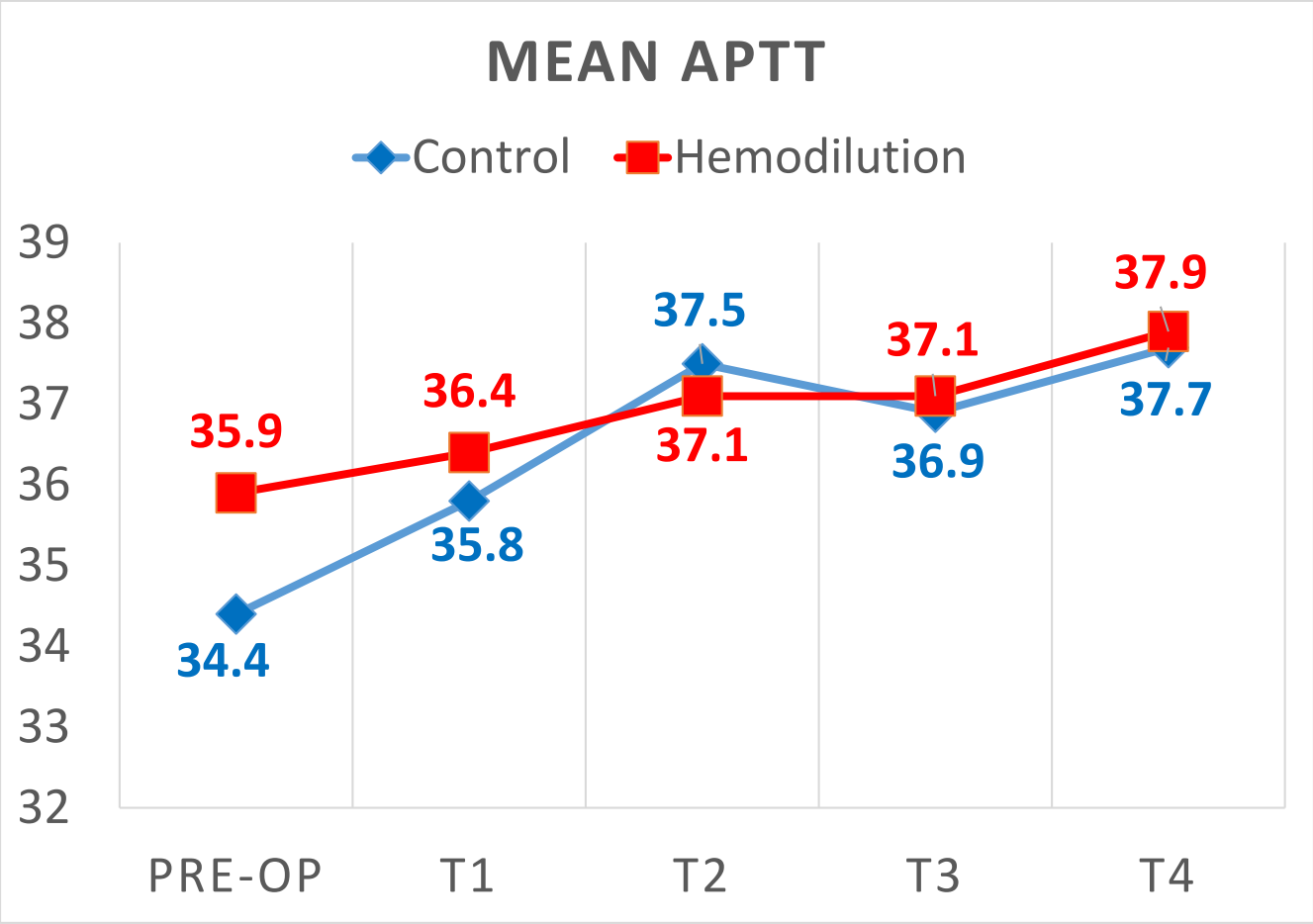


**Table 15: Comparison of international normalized ratio (INR) of study groups at various time points (n=60)**

| Mean INR | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean INR | Std. Deviation | Mean INR | Std. Deviation | |
| Pre-op | 1.105 | 0.059 | 1.130 | 0.048 | 0.079 |
| T1 | 1.194 | 0.040 | 1.206 | 0.039 | 0.236 |
| T2 | 1.251 | 0.056 | 1.261 | 0.070 | 0.513 |
| T3 | 1.274 | 0.034 | 1.293 | 0.040 | 0.060 |
| T4 | 1.246 | 0.048 | 1.242 | 0.047 | 0.735 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean INR at various time points between the control and hemodilution groups.

| Model | mean INR variation over time | mean INR variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 100.19 | 0.653 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | 0.627 |

**Comments:**

1. There was no statistically significant difference between the mean INR values between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean INR: In factorial repeated measures ANOVA, there was a statistically significant variation in mean INR over time as $p<0.05$. However, this variation in INR happened in same direction in both the groups and the minimal difference observed in the changes of mean INR between the 2 groups was not statistically significant ($p>0.05$).

**Table 16: Comparison of mean sodium levels ($Na^+$) meq/l of study groups at various time points (n=60)**

| Mean $NA^+$ (mEq/L) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean $Na^+$ | Std. Deviation | Mean $Na^+$ | Std. Deviation | |
| Pre-op | 141.5 | 1.4 | 140.8 | 1.2 | 0.059 |
| T1 | 141.0 | 1.2 | 140.2 | 1.8 | 0.078 |
| T2 | 139.7 | 1.6 | 140.4 | 2.0 | 0.164 |
| T3 | 139.9 | 2.2 | 140.3 | 1.5 | 0.419 |
| T4 | 141.5 | 1.5 | 141.1 | 1.0 | 0.232 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean sodium levels ($Na^+$) at various time points between the control and hemodilution groups.

| Model | mean sodium ($Na^+$) variation over time | mean sodium ($Na^+$) variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 15.243 | 2.115 |
| df | 4,55 | 4,55 |
| p value | ***0.001*** | 0.189 |

**Comments:**

1. There was no statistically significant difference between the mean sodium levels ($Na^+$) between the 2 groups in the pre-operative and the post-operative period as suggested by the student't' test.
2. Variation in mean sodium levels ($Na^+$): In factorial repeated measures ANOVA, the variation observed in mean sodium levels ($Na^+$) over time was statistically significant as $p<0.05$.
3. However, this variation in sodium levels happened in same direction in both the groups with a fall in sodium levels ($Na^+$) in control group and hemodilution group happening in T1 and T2 respectively and then rising back to pre-operative levels and this difference observed in the changes of mean sodium levels ($Na^+$) between the 2 groups was not statistically significant ($p>0.05$).

**Table 17: Comparison of mean potassium levels ($K^+$) meq/l of study groups at various time points (n=60)**

| Mean $K^+$ (mEq/L) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean $K^+$ | Std. Deviation | Mean $K^+$ | Std. Deviation | |
| Pre-op | 4.1 | 0.1 | 4.2 | 0.2 | 0.084 |
| T1 | 4.0 | 0.1 | 4.1 | 0.2 | 0.067 |
| T2 | 4.0 | 0.3 | 4.1 | 0.3 | 0.300 |
| T3 | 4.0 | 0.2 | 4.1 | 0.2 | 0.063 |
| T4 | 4.2 | 0.2 | 4.1 | 0.2 | 0.100 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean potassium levels ($K^+$) at various time points between the control and hemodilution groups.

| Model | mean $K^+$ level variation over time | mean $K^+$ level variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 2.279 | 2.150 |
| df | 4,55 | 4,55 |
| p value | 0.087 | 0.102 |

**Comments:**

1. There was no statistically significant difference between the mean potassium levels ($K^+$) between the 2 groups in the pre-operative and the post-operative period as suggested by the student't' test.
2. Variation in mean potassium levels ($K^+$): In factorial repeated measures ANOVA, the minor variation observed in mean potassium levels ($K^+$) over time was not statistically significant as $p>0.05$. Also this variation in mean potassium levels ($K^+$) happened in same direction in both the groups and the minimal difference observed in the changes of mean mean potassium levels ($K^+$) between the 2 groups was not statistically significant ($p>0.05$).

**Table 18: Comparison of mean blood sugar (BS) meq/l of study groups at various time points (n=60)**

| Mean RBS (gms%) | Control group | | Hemodilution Group | | Student 't' test p value |
|---|---|---|---|---|---|
| | Mean RBS | Std. Deviation | Mean RBS | Std. Deviation | |
| Pre-op | 94.8 | 9.2 | 97.8 | 26.5 | 0.560 |
| T1 | 104.3 | 8.8 | 102.3 | 26.4 | 0.705 |
| T2 | 116.3 | 7.9 | 114.7 | 21.3 | 0.701 |
| T3 | 128.4 | 4.0 | 125.3 | 18.0 | 0.366 |
| T4 | 136.8 | 6.4 | 129.1 | 17.3 | 0.560 |

T1- Before Hemodilution/ Time after Induction in Control Group

T2- At the End of Hemodilution /40mins after Induction in Control Group

T3- Start of Surgical Closure

T4- 3hr Postoperatively

Factorial- Repeated measures ANOVA test was used to test the difference in mean blood sugar (RBS) at various time points between the control and hemodilution groups.

| Model | mean RBS variation over time | mean RBS variation between 2 groups |
|---|---|---|
| Wilks's Lambda F | 108.21 | 1.657 |
| df | 4,55 | 4,55 |
| p value | ***<0.001*** | 0.198 |

**Comments:**

1. There was no statistically significant difference between the mean blood sugar (RBS) between the 2 groups throughout the pre-operative and post-operative period as suggested by the student't' test.
2. Variation in mean blood sugar (RBS): In factorial repeated measures ANOVA, there was a statistically significant variation in mean blood sugar (RBS) over time as $p<0.05$. However, this variation in blood sugar (RBS) happened in same direction in both the groups and the minimal difference observed in the changes of mean blood sugar (RBS) between the 2 groups was not statistically significant ($p>0.05$).

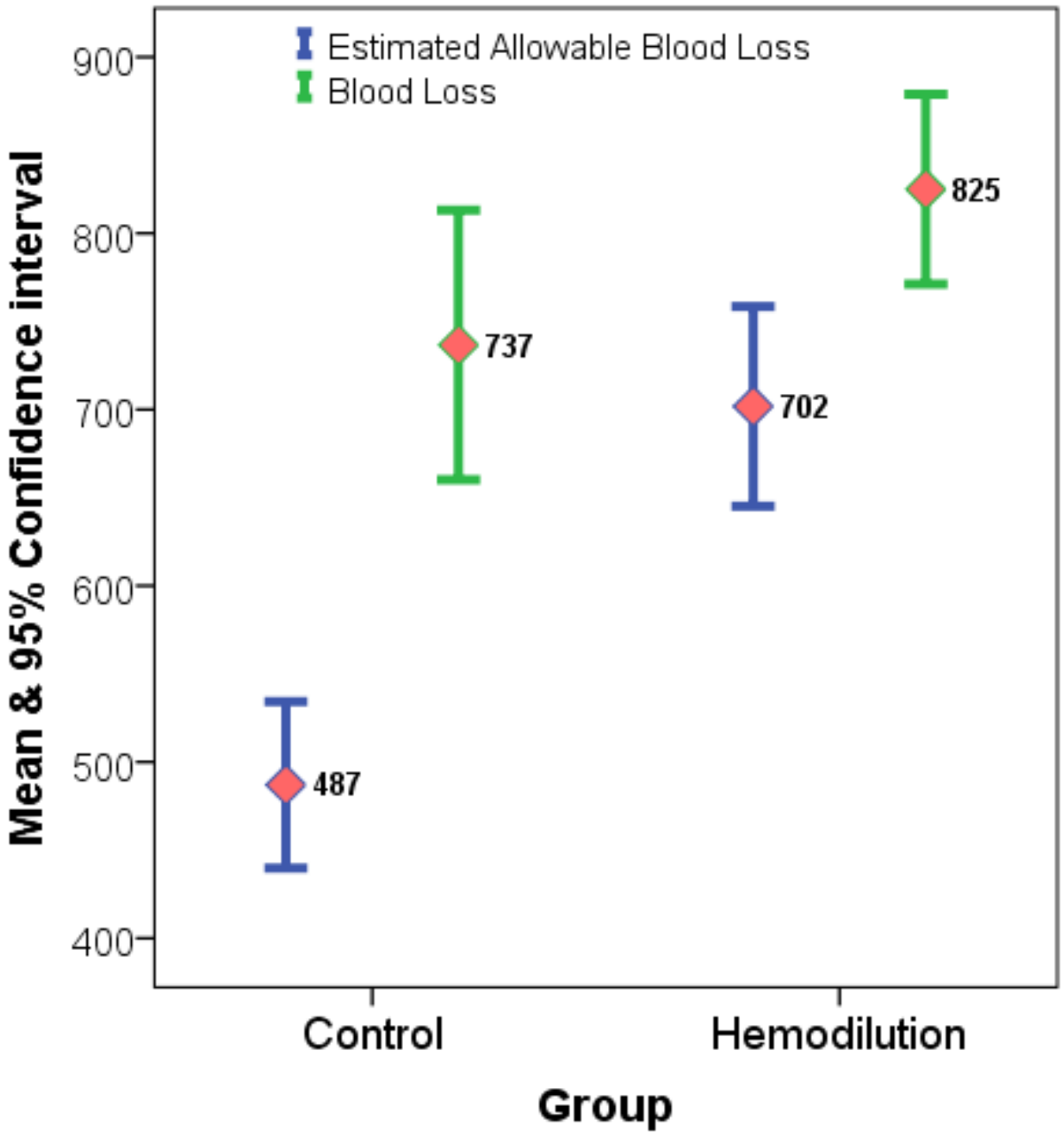
**Table 19: Comparison of blood loss in ml between the two groups of the study sample (n=60)**

| Parameter | Group | N | Mean | S.D | Mean Difference | p value |
|---|---|---|---|---|---|---|
| Estimated Blood volume (EBV) | Control | 30 | 3809.0 | 223.6 | 166.83 | 0.063 |
| | Hemodilution | 30 | 3642.2 | 427.6 | | |
| Estimated allowable blood loss (EABL) | Control | 30 | 487.1 | 126.5 | 241.74 | ***<0.001*** |
| | Hemodilution | 30 | 701.8 | 151.7 | | |
| Blood loss (BL) | Control | 30 | 736.7 | 204.7 | 88.33 | 0.058 |
| | Hemodilution | 30 | 825.0 | 144.3 | | |

Comments:

1. The minor difference in mean Estimated Blood volume (EBV) between the two groups was not statistically significant ($p>0.05$).
2. The mean Estimated allowable blood loss (EABL) was higher in hemodilution group than the control group and this difference was statistically significant ($p<0.05$).
3. The difference observed in mean blood loss (BL) between the two groups was not statistically significant ($p>0.05$) though blood loss was higher in the hemodilution group.

**Fig 14: Comparison of blood loss in ml between the two groups**



# DISCUSSION

This hospital based, randomised control study was done to determine the safety of acute normovolemic hemodilution (ANH) and to compare the hemodynamic alterations between patients receiving acute normovolemic hemodilution (ANH) and patients receiving conventional homologous blood transfusion among patients who were posted for elective total abdominal hysterectomy in Government Theni medical college Hospital, Theni. A total of 60 adult patients admitted to the Gynaecology department were randomised into 2 groups such as 30 patients in Group I/Control group to receive homologous blood transfusion and 30 patients in Group II/Hemodilution group to receive normovolemic hemodilution under standard protocol.

**Demographic parameters:** The mean age ± S.D of the patients in Control group was 48.53 ± 8.8 and in Hemodilution group it was 44.6 ± 5.23 years but this minor difference in mean age between the two groups was not statistically significant ($p>0.05$). Majority were in the age group of 41 to 50 years. These findings are similar to Gokhale et al (41) who compared ANH with PABD in gynaecological surgeries as 46% were in 41 to 50 years age group.

The mean weight ± S.D of the patients in Control group was 58.6 ± 3.4 and in Hemodilution group it was 56.03 ± 6.57 Kg but this minor difference in mean weight between the two groups was not statistically significant ($p>0.05$). This finding can

compared to Mirhasemi et al (42) who reported a mean weight of patients posted for gynaecological surgeries as 56 ± 6.57 Kg.

**ASA grade:** Majority were in ASA grade 1 followed by grade 2. Patients in control group and hemodilution group were almost equally distributed according to ASA grading.

**Changes in Hemodynamic parameters:**

- **Heart rate:** No statistically significant difference between the mean heart rate between the 2 groups throughout the pre-op and post-operative period. There was a statistically significant variation in mean heart rate in both the groups over time. However there was no statistically significant difference in the changes of heart rate between the 2 groups. These findings are similar to that of Goodnough LT et al (10) in which there was no significant variations in HR between the 2 groups.
- **Systolic BP (SBP):** There was a statistically significant difference in the mean systolic blood pressure (SBP) between the 2 groups only at the end of Hemodilution as there was a fall in SBP in hemodilution group but not in control group. There was a statistically significant variation over time in mean systolic blood pressure (SBP) in both the groups and subjects in hemodilution group experienced greater fall in systolic blood pressure (decline in T3) than subjects in control group and this difference was statistically significant

- **Diastolic BP (DBP):** There was a statistically significant difference in the mean diastolic blood pressure (DBP) between the 2 groups only at the end of Hemodilution as there was a fall in DBP in hemodilution group. There was a statistically significant variation over time in mean diastolic blood pressure (DBP) in both the groups and subjects in hemodilution group experienced greater fall in diastolic blood pressure than subjects in control group and this difference was statistically significant
- **Mean arterial pressure (MAP):** There was a statistically significant difference in the mean arterial pressure between the 2 groups only at the end of Hemodilution as there was a fall in MAP in hemodilution group. There was a statistically significant variation over time in mean arterial pressure (MAP) in both the groups. However there was no statistically significant difference in the changes of MAP between the 2 groups.

These findings can be corroborated with that of Santoso et al (39) in which except arterial pH and oxygen consumption, there was a fall in perfusion indices including blood pressure and there was tachycardia reported. In contrast, Naqash IA et al (38) reported that there was no statistically significant changes in heart rate and mean blood pressure between the controls an ANH group. Also Firodiya et al (43) reported a statistically significant fall in blood pressure but however it can be considered that it was clinically insignificant as the fall in BP was only 3 mmHg.

- **Hemoglobin levels (Hb):** The statistically significant difference in mean hemoglobin levels (Hb) between the 2 groups present at the baseline was maintained throughout the pre-operative and post-operative period except at the end of Hemodilution were this difference diminished because of the greater fall in hemoglobin levels in the hemodilution group than the control group. There was a statistically significant variation over time in mean hemoglobin levels (Hb) and subjects in hemodilution group experienced greater fall in hemoglobin levels (Hb) (decline in T2: 1.1 gms% in Hemodilution Vs 0.8gms% in control) than subjects in control group and this difference was statistically significant. This is in contrats to the findings of Naqash IA et al (38) as they observed no statistically significant variation in mean hemoglobin levels between the two groups
- **Hematocrit values (HCT):** The statistically significant difference in mean hematocrit levels (HCT) between the 2 groups present at the baseline was maintained throughout the pre-operative and post-operative period. There was a statistically significant variation in HCT over time in both the groups and subjects in hemodilution group experienced greater fall in HCT than subjects in control group (2.9% Vs 1.9%) at the end of hemodilution and this difference was statistically significant. According to Rehm et al (40), the intra-operative Hct was 30.5% in controls and 21.9% in ANH group while the post-operative Hct was 25.7% Vs 27.2% in control and ANH groups, respectively.

- **Platelet Count, Bleeding time, Clotting time, activated partial thromboplastin time (aPTT), INR:** There was no statistically significant difference between the mean levels of these parameters between the 2 groups from the baseline, throughout the pre-operative and post-operative period. Though there was a significant variation in these variables over time, these changes happened similarly in both the groups. These findings can be compared to that of Jones et al (44) as they reported that there was a significant changes in platelet count, bleeding time, and clotting time in patients who had ANH undergoing radical prostatectomy though they did not include the control group. Also Messmer K et al (3) reported that there is no change in coagulation profile associated with ANH.
- **Mean sodium and potassium levels:** There was no statistically significant difference between the mean levels of these parameters between the 2 groups from the baseline, throughout the pre-operative and post-operative period except that there was a fall in sodium levels in T1 and T2 in both groups before rising back to pre-operative levels.
- **Estimated allowable Blood loss (EABL):** The mean EABL ± S.D of the patients in control group was 487.1 ± 126 ml and in Hemodilution group it was 701.8 ± 151 ml and this difference in mean EABL between the two groups was statistically significant ($p<0.001$).

- **Blood loss (BL):** The difference observed in mean blood loss (BL) between the two groups was not statistically significant ($p>0.05$) though blood loss was higher in the hemodilution group.

| Study | Control Group | Hemodilution Group |
|---|---|---|
| Current | 736 ± 204 ml | 825 ± 144 ml |
| Naqash IA et al (38) | 835.29 ± 684 ml | 865 ± 409.7 ml |
| Rehm et al (40) | - | 1.256 ± 892 ml |

Hence from the above findings, it can be observed that acute normovolemic hemodilution is a safe and effective alternative to homologous blood transfusion and can limit the need for blood transfusion especially in resource limited settings.

# SUMMARY

This hospital based experimental study was done to determine the safety and hemodynamic alterations associated with acute normovolemic hemodilution (ANH) by comparing with conventional homologous blood transfusion among patients posted for elective hysterectomy in Government Theni medical college Hospital, Theni. The study population included 60 patients divided equally and randomly into either Group I called control group to receive homologous blood transfusion or Group II called Hemodilution group to receive acute normovolemic hemodilution as per standard protocol. All patients were subjected to routine pre-operative screening tests and hemodynamic responses were monitored throughout the peri-operative period along with coagulation profile, electrolytes and blood loss.

The important study findings are summarised below:

- Both the control group and hemodilution group were comparable in terms of age and ASA grading
- Heart rate (HR): No statistically significant difference in the changes of heart rate was observed between the 2 groups
- Blood pressure: There was a statistically significant variation over time in mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) in both the groups and subjects in hemodilution group experienced greater fall in systolic blood pressure (decline at the start of surgical closure) and this fall was statistically significant

- Mean arterial pressure (MAP): There was no statistically significant difference in the changes of MAP between the 2 groups
- Hemoglobin levels (Hb): subjects in hemodilution group experienced greater fall in hemoglobin (1.1 gms% 0.8gms%) than subjects in control group at the end of hemodilution and this difference was statistically significant.
- Hematocrit values (HCT): subjects in hemodilution group experienced greater fall in HCT than subjects in control group (2.9% Vs 1.9%) at the end of hemodilution and this difference was statistically significant
- Platelet Count, Bleeding time, Clotting time, activated partial thromboplastin time (aPTT), INR: Though all these parameters changed during the peri-operative period, the changes were similar in both the groups
- Sodium and potassium levels: There was no statistically significant difference in the changes of sodium and potassium levels between the 2 groups
- Blood loss: The difference in mean blood loss (BL) between the two groups was not statistically significant ($p>0.05$) though blood loss was higher in the hemodilution group

# CONCLUSION

Based on the findings of this experimental study we can conclude the following:

- Acute normovolemic dilution is a safe alternative to homologous blood transfusion as there was no significant change in hemodynamic parameters and coagulation profile
- There was a fall in hemoglobin level and hematocrit values at the end of hemodilution but it reverted to normal levels after re-infusion.
- Hematocrit cut-off of 30% can be safely used as a limit for normovolemic hemodilution.
- Acute normovolemic dilution is a safe and effective alternative to homologous blood transfusion especially in resource-limited settings and can reduce or limit the use of homologous blood transfusions and consequently the risks associated with it.

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**PROFORMA**

# ACUTE NORMOVOLEMIC HEMODILUTION

DATE:

VENUE:

NAME: IP NO:

AGE/SEX: ASA RISK:

DIAGNOSIS:
WEIGHT:

PROCEDURE:

TIME OF INDUCTION:

DURATION OF SURGERY:

INTUBATION TIME:

GROUP : C (CONTROL)
H(HEMODILUTION)

| **HEMODYNAMIC CHANGES** | **PREOP** | **T1** | **T2** | **T3** | **T4** |
|---|---|---|---|---|---|
| HEART RATE | | | | | |
| SBP | | | | | |
| DBP | | | | | |
| MAP | | | | | |
| RR | | | | | |
| ETCO2 | | | | | |

| OBSERVED PARAMETERS | | | | | |
|---|---|---|---|---|---|
| Hb | | | | | |
| HCT | | | | | |
| PLT | | | | | |
| BT/CT | | | | | |
| Na | | | | | |
| k | | | | | |
| RBS | | | | | |
| PT/aptt | | | | | |
| INR | | | | | |

## T1- TIME AFTER INDUCTION/BEFORE HEMODILUTION

## T2- AT THE END OF HEMODILUTION /40mins AFTER INDUCTION IN CONTROL GROUP

## T3- START OF SURGICAL CLOSURE

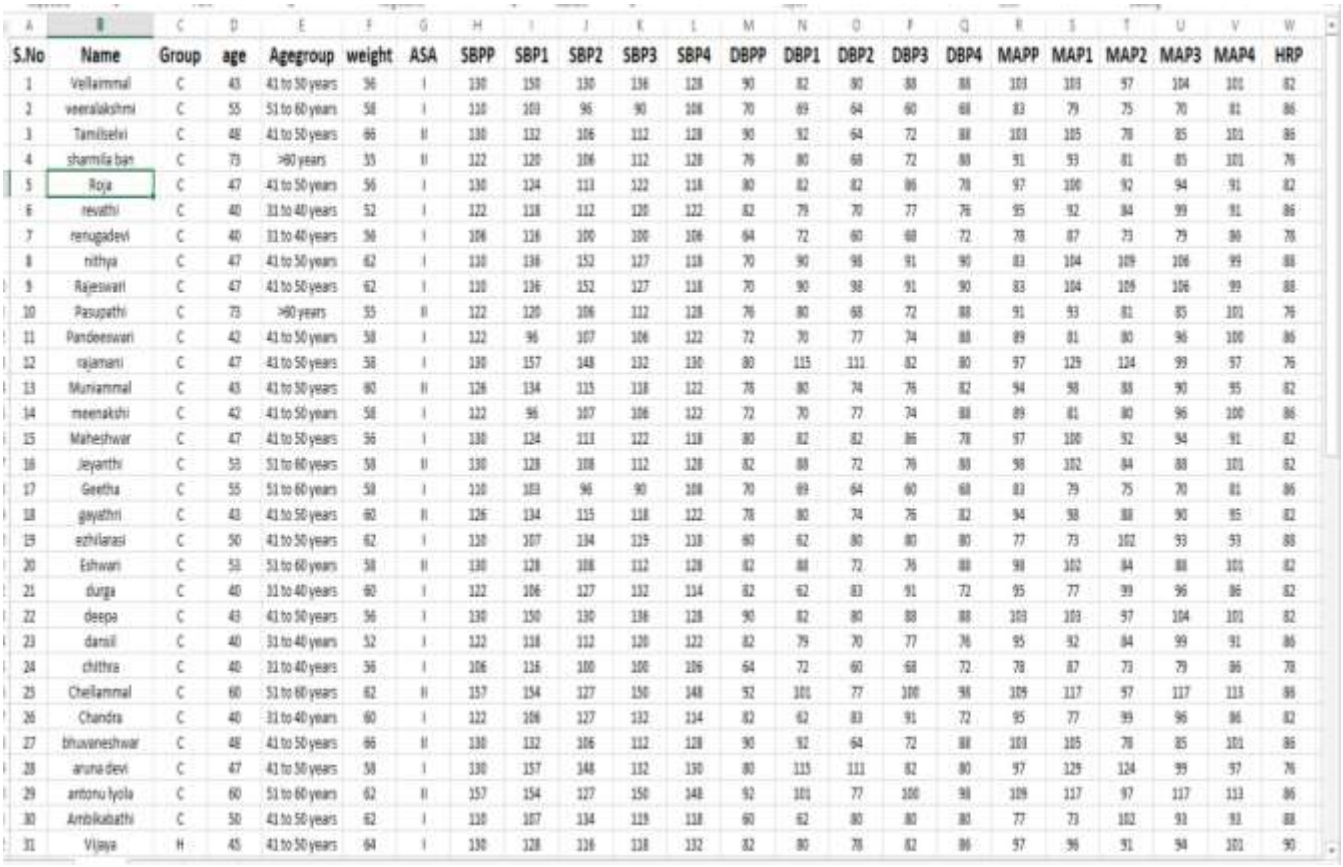
## T4- 3Hr POSTOPERATIVELY

COMPLICATIONS:

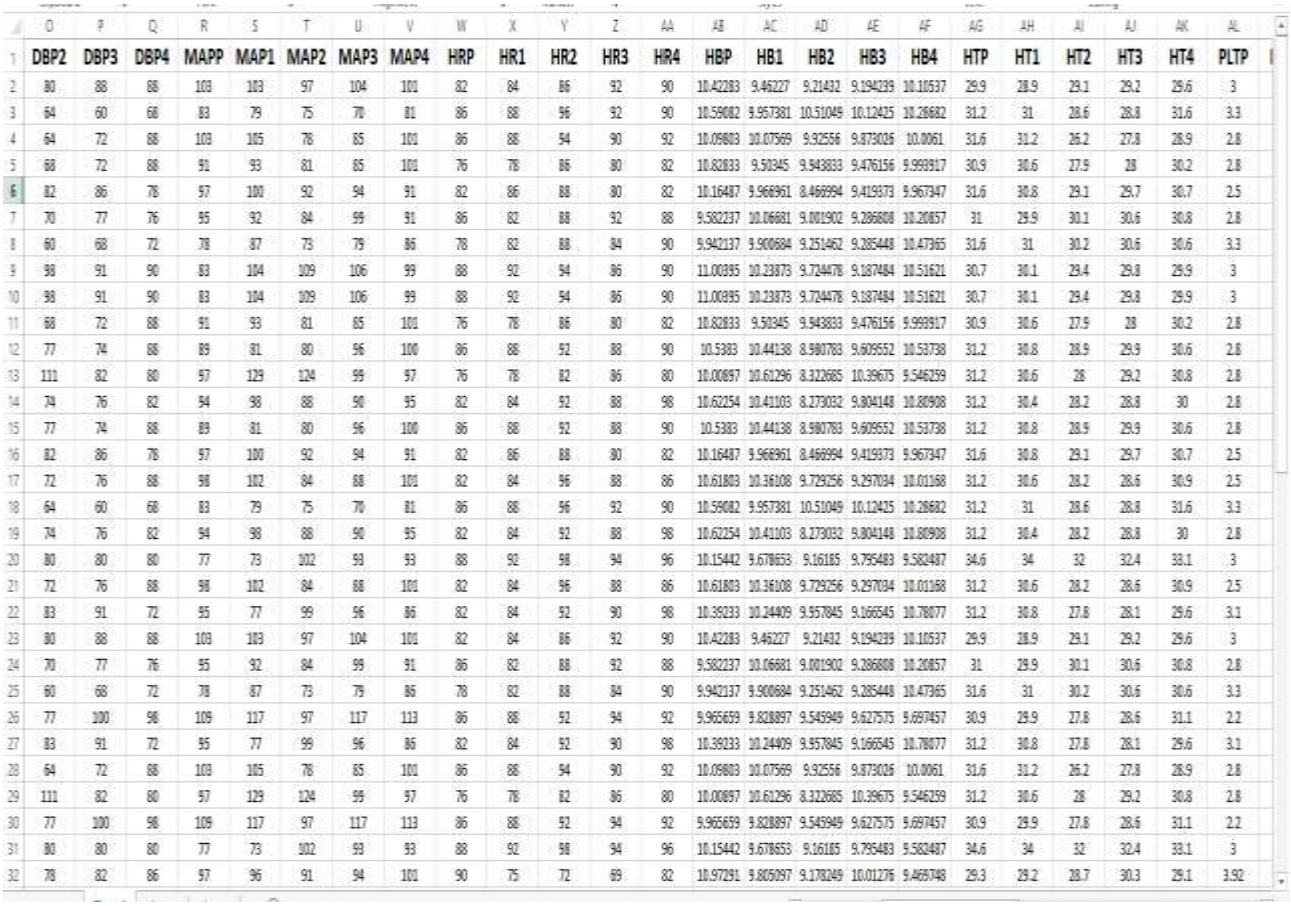
TIME OF REVERSAL:

EXTUBATION:

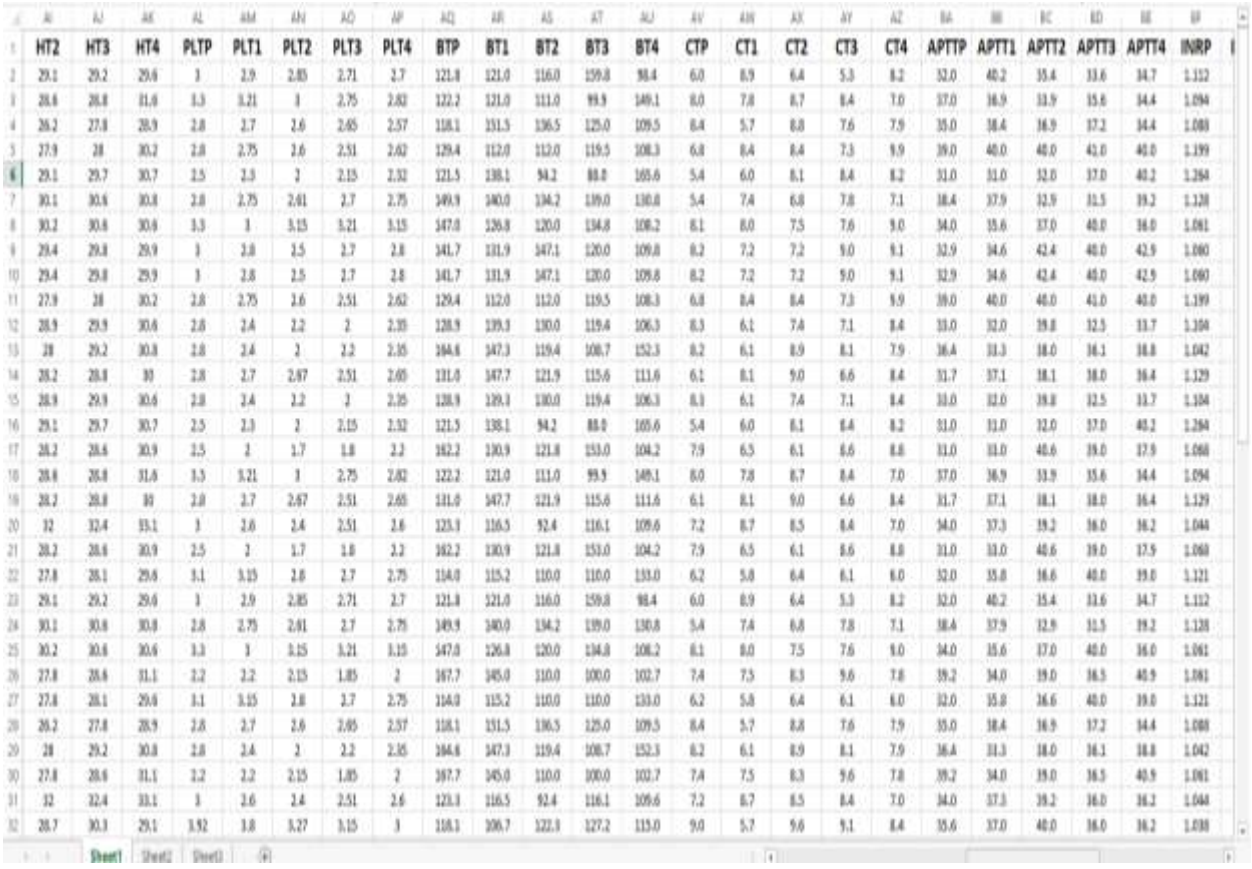
EBV/EABL OF THE PATIENT:



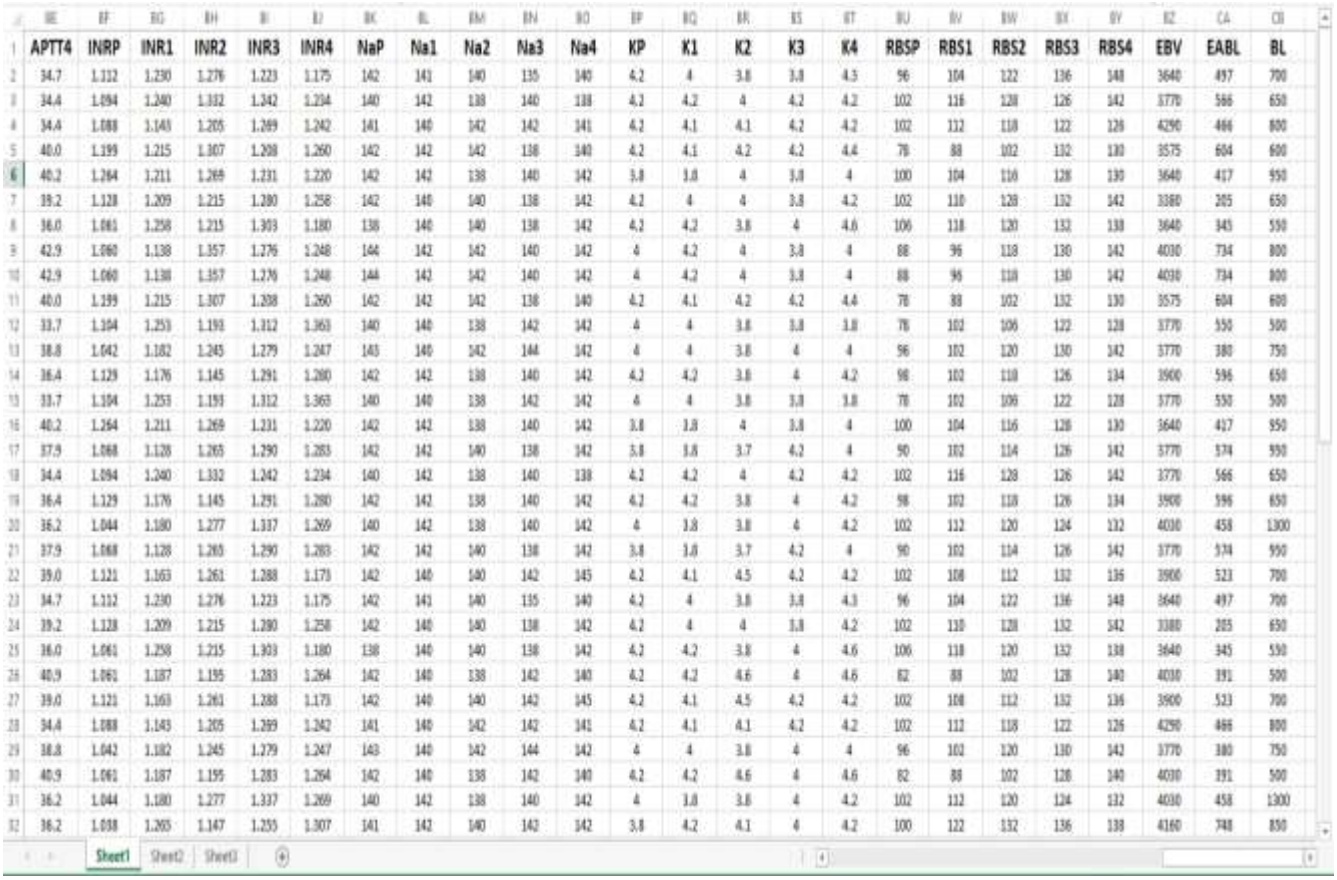
| S.No | Name | Group | age | Agegroup | weight | ASA | SBPP | SBP1 | SBP2 | SBP3 | SBP4 | DBPP | DBP1 | DBP2 | DBP3 | DBP4 | MAPP | MAP1 | MAP2 | MAP3 | MAP4 | HRP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Vellammal | C | 43 | 41 to 50 years | 56 | I | 130 | 150 | 130 | 136 | 128 | 90 | 82 | 80 | 88 | 88 | 103 | 103 | 97 | 104 | 101 | 82 |
| 2 | veeralakshmi | C | 55 | 51 to 60 years | 58 | I | 110 | 103 | 96 | 90 | 108 | 70 | 69 | 64 | 60 | 68 | 83 | 79 | 75 | 70 | 81 | 86 |
| 3 | Tamilselvi | C | 48 | 41 to 50 years | 66 | II | 130 | 132 | 106 | 112 | 128 | 90 | 92 | 64 | 72 | 88 | 103 | 105 | 78 | 85 | 101 | 86 |
| 4 | sharmila ban | C | 73 | >60 years | 55 | II | 122 | 120 | 106 | 112 | 128 | 76 | 80 | 68 | 72 | 80 | 91 | 93 | 81 | 85 | 101 | 76 |
| 5 | Roja | C | 47 | 41 to 50 years | 56 | I | 130 | 124 | 113 | 122 | 118 | 80 | 82 | 82 | 86 | 78 | 97 | 100 | 92 | 94 | 91 | 82 |
| 6 | revathi | C | 40 | 31 to 40 years | 52 | I | 122 | 118 | 112 | 120 | 122 | 82 | 79 | 70 | 77 | 76 | 95 | 92 | 84 | 99 | 91 | 86 |
| 7 | renugadevi | C | 40 | 31 to 40 years | 56 | I | 106 | 116 | 100 | 100 | 106 | 64 | 72 | 60 | 68 | 72 | 78 | 87 | 73 | 79 | 86 | 78 |
| 8 | nithya | C | 47 | 41 to 50 years | 62 | I | 110 | 136 | 152 | 127 | 118 | 70 | 90 | 98 | 91 | 90 | 83 | 104 | 109 | 106 | 99 | 88 |
| 9 | Rajeswari | C | 47 | 41 to 50 years | 62 | I | 110 | 136 | 152 | 127 | 118 | 70 | 90 | 98 | 91 | 90 | 83 | 104 | 109 | 106 | 99 | 88 |
| 10 | Pasupathi | C | 73 | >60 years | 55 | II | 122 | 120 | 106 | 112 | 128 | 76 | 80 | 68 | 72 | 80 | 91 | 93 | 81 | 85 | 101 | 76 |
| 11 | Pandeeswari | C | 42 | 41 to 50 years | 58 | I | 122 | 96 | 107 | 106 | 122 | 72 | 70 | 77 | 74 | 88 | 89 | 81 | 80 | 96 | 100 | 86 |
| 12 | rajamani | C | 47 | 41 to 50 years | 58 | I | 130 | 157 | 148 | 132 | 130 | 80 | 115 | 111 | 82 | 80 | 97 | 129 | 124 | 99 | 97 | 76 |
| 13 | Muniammal | C | 43 | 41 to 50 years | 60 | II | 126 | 134 | 115 | 118 | 122 | 78 | 80 | 74 | 76 | 82 | 94 | 98 | 88 | 90 | 95 | 82 |
| 14 | meenakshi | C | 42 | 41 to 50 years | 58 | I | 122 | 96 | 107 | 106 | 122 | 72 | 70 | 77 | 74 | 88 | 89 | 81 | 80 | 96 | 100 | 86 |
| 15 | Maheshwar | C | 47 | 41 to 50 years | 56 | I | 130 | 124 | 113 | 122 | 118 | 80 | 82 | 82 | 86 | 78 | 97 | 100 | 92 | 94 | 91 | 82 |
| 16 | Jeyanthi | C | 55 | 51 to 60 years | 58 | II | 130 | 128 | 108 | 112 | 128 | 82 | 88 | 72 | 76 | 88 | 98 | 102 | 84 | 88 | 101 | 82 |
| 17 | Geetha | C | 55 | 51 to 60 years | 58 | I | 110 | 103 | 96 | 90 | 108 | 70 | 69 | 64 | 60 | 68 | 83 | 79 | 75 | 70 | 81 | 86 |
| 18 | gayathri | C | 43 | 41 to 50 years | 60 | II | 126 | 134 | 115 | 118 | 122 | 78 | 80 | 74 | 76 | 82 | 94 | 98 | 88 | 90 | 95 | 82 |
| 19 | ezhilarasi | C | 50 | 41 to 50 years | 62 | I | 110 | 107 | 134 | 119 | 118 | 60 | 62 | 80 | 80 | 80 | 77 | 73 | 102 | 93 | 93 | 88 |
| 20 | Eshwari | C | 55 | 51 to 60 years | 58 | II | 130 | 128 | 108 | 112 | 128 | 82 | 88 | 72 | 76 | 88 | 98 | 102 | 84 | 88 | 101 | 82 |
| 21 | durga | C | 40 | 31 to 40 years | 60 | I | 122 | 106 | 127 | 132 | 114 | 82 | 62 | 83 | 91 | 72 | 95 | 77 | 99 | 96 | 86 | 82 |
| 22 | deepa | C | 43 | 41 to 50 years | 56 | I | 130 | 150 | 130 | 136 | 128 | 90 | 82 | 80 | 88 | 88 | 103 | 103 | 97 | 104 | 101 | 82 |
| 23 | dansil | C | 40 | 31 to 40 years | 52 | I | 122 | 118 | 112 | 120 | 122 | 82 | 79 | 70 | 77 | 76 | 95 | 92 | 84 | 99 | 91 | 86 |
| 24 | chithra | C | 40 | 31 to 40 years | 56 | I | 106 | 116 | 100 | 100 | 106 | 64 | 72 | 60 | 68 | 72 | 78 | 87 | 73 | 79 | 86 | 78 |
| 25 | Chellammal | C | 60 | 51 to 60 years | 62 | II | 157 | 154 | 127 | 150 | 148 | 92 | 101 | 77 | 100 | 98 | 109 | 117 | 97 | 117 | 113 | 86 |
| 26 | Chandra | C | 40 | 31 to 40 years | 60 | I | 122 | 106 | 127 | 132 | 114 | 82 | 62 | 83 | 91 | 72 | 95 | 77 | 99 | 96 | 86 | 82 |
| 27 | bhuvaneshwar | C | 48 | 41 to 50 years | 66 | II | 130 | 132 | 106 | 112 | 128 | 90 | 92 | 64 | 72 | 88 | 103 | 105 | 78 | 85 | 101 | 86 |
| 28 | aruna devi | C | 47 | 41 to 50 years | 58 | I | 130 | 157 | 148 | 132 | 130 | 80 | 115 | 111 | 82 | 80 | 97 | 129 | 124 | 99 | 97 | 76 |
| 29 | antonu lyola | C | 60 | 51 to 60 years | 62 | II | 157 | 154 | 127 | 150 | 148 | 92 | 101 | 77 | 100 | 98 | 109 | 117 | 97 | 117 | 113 | 86 |
| 30 | Ambikabathi | C | 50 | 41 to 50 years | 62 | I | 110 | 107 | 134 | 119 | 118 | 60 | 62 | 80 | 80 | 80 | 77 | 73 | 102 | 93 | 93 | 88 |
| 31 | Vijaya | H | 45 | 41 to 50 years | 64 | I | 130 | 128 | 116 | 118 | 132 | 82 | 80 | 78 | 82 | 86 | 97 | 96 | 91 | 94 | 101 | 90 |



| O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DBP2 | DBP3 | DBP4 | MAPP | MAP1 | MAP2 | MAP3 | MAP4 | HRP | HR1 | HR2 | HR3 | HR4 | HBP | HB1 | HB2 | HB3 | HB4 | HTP | HT1 | HT2 | HT3 | HT4 | PLTP |
| 80 | 88 | 88 | 103 | 103 | 97 | 104 | 101 | 82 | 84 | 86 | 92 | 90 | 10.42283 | 9.46227 | 9.21432 | 9.194239 | 10.10537 | 29.9 | 28.9 | 29.1 | 29.2 | 29.6 | 3 |
| 64 | 60 | 68 | 83 | 79 | 75 | 70 | 81 | 86 | 88 | 96 | 92 | 90 | 10.56082 | 9.957381 | 10.51049 | 10.12425 | 10.28682 | 31.2 | 31 | 28.6 | 28.8 | 31.6 | 3.3 |
| 64 | 72 | 88 | 103 | 105 | 78 | 85 | 101 | 86 | 88 | 94 | 90 | 92 | 10.05803 | 10.07569 | 9.92556 | 9.873026 | 10.0061 | 31.6 | 31.2 | 26.2 | 27.8 | 28.9 | 2.8 |
| 68 | 72 | 88 | 91 | 93 | 81 | 85 | 101 | 76 | 78 | 86 | 80 | 82 | 10.82833 | 9.50345 | 9.943833 | 9.476156 | 9.999917 | 30.9 | 30.6 | 27.9 | 28 | 30.2 | 2.8 |
| 82 | 86 | 78 | 97 | 100 | 92 | 94 | 91 | 82 | 86 | 88 | 80 | 82 | 10.16487 | 9.968961 | 8.466994 | 9.419373 | 9.967347 | 31.6 | 30.8 | 29.1 | 29.7 | 30.7 | 2.5 |
| 70 | 77 | 76 | 95 | 92 | 84 | 99 | 91 | 86 | 82 | 88 | 92 | 88 | 9.582237 | 10.06681 | 9.001902 | 9.286808 | 10.20857 | 31 | 29.9 | 30.1 | 30.6 | 30.8 | 2.8 |
| 60 | 68 | 72 | 78 | 87 | 73 | 79 | 86 | 78 | 82 | 88 | 84 | 90 | 9.942137 | 9.900684 | 9.251462 | 9.285448 | 10.47365 | 31.6 | 31 | 30.2 | 30.6 | 30.6 | 3.3 |
| 98 | 91 | 90 | 83 | 104 | 109 | 106 | 99 | 88 | 92 | 94 | 86 | 90 | 11.00395 | 10.23873 | 9.724478 | 9.187484 | 10.51621 | 30.7 | 30.1 | 29.4 | 29.8 | 29.9 | 3 |
| 98 | 91 | 90 | 83 | 104 | 109 | 106 | 99 | 88 | 92 | 94 | 86 | 90 | 11.00395 | 10.23873 | 9.724478 | 9.187484 | 10.51621 | 30.7 | 30.1 | 29.4 | 29.8 | 29.9 | 3 |
| 68 | 72 | 88 | 91 | 93 | 81 | 85 | 101 | 76 | 78 | 86 | 80 | 82 | 10.82833 | 9.50345 | 9.943833 | 9.476156 | 9.999917 | 30.9 | 30.6 | 27.9 | 28 | 30.2 | 2.8 |
| 77 | 74 | 88 | 89 | 81 | 80 | 96 | 100 | 86 | 88 | 92 | 88 | 90 | 10.5383 | 10.44138 | 8.980783 | 9.609552 | 10.53738 | 31.2 | 30.8 | 28.9 | 29.9 | 30.6 | 2.8 |
| 111 | 82 | 80 | 97 | 129 | 124 | 99 | 97 | 76 | 78 | 82 | 86 | 80 | 10.00897 | 10.61296 | 8.322685 | 10.39675 | 9.546259 | 31.2 | 30.6 | 28 | 29.2 | 30.8 | 2.8 |
| 74 | 76 | 82 | 94 | 98 | 88 | 90 | 95 | 82 | 84 | 92 | 88 | 98 | 10.62254 | 10.41103 | 8.273032 | 9.804148 | 10.80908 | 31.2 | 30.4 | 28.2 | 28.8 | 30 | 2.8 |
| 77 | 74 | 88 | 89 | 81 | 80 | 96 | 100 | 86 | 88 | 92 | 88 | 90 | 10.5383 | 10.44138 | 8.980783 | 9.609552 | 10.53738 | 31.2 | 30.8 | 28.9 | 29.9 | 30.6 | 2.8 |
| 82 | 86 | 78 | 97 | 100 | 92 | 94 | 91 | 82 | 86 | 88 | 80 | 82 | 10.16487 | 9.968961 | 8.466994 | 9.419373 | 9.967347 | 31.6 | 30.8 | 29.1 | 29.7 | 30.7 | 2.5 |
| 72 | 76 | 88 | 98 | 102 | 84 | 88 | 101 | 82 | 84 | 96 | 88 | 86 | 10.61803 | 10.36108 | 9.729256 | 9.297034 | 10.01168 | 31.2 | 30.6 | 28.2 | 28.6 | 30.9 | 2.5 |
| 64 | 60 | 68 | 83 | 79 | 75 | 70 | 81 | 86 | 88 | 96 | 92 | 90 | 10.56082 | 9.957381 | 10.51049 | 10.12425 | 10.28682 | 31.2 | 31 | 28.6 | 28.8 | 31.6 | 3.3 |
| 74 | 76 | 82 | 94 | 98 | 88 | 90 | 95 | 82 | 84 | 92 | 88 | 98 | 10.62254 | 10.41103 | 8.273032 | 9.804148 | 10.80908 | 31.2 | 30.4 | 28.2 | 28.8 | 30 | 2.8 |
| 80 | 80 | 80 | 77 | 73 | 102 | 93 | 93 | 88 | 92 | 98 | 94 | 96 | 10.15442 | 9.678653 | 9.16185 | 9.795483 | 9.582487 | 34.6 | 34 | 32 | 32.4 | 33.1 | 3 |
| 72 | 76 | 88 | 98 | 102 | 84 | 88 | 101 | 82 | 84 | 96 | 88 | 86 | 10.61803 | 10.36108 | 9.729256 | 9.297034 | 10.01168 | 31.2 | 30.6 | 28.2 | 28.6 | 30.9 | 2.5 |
| 83 | 91 | 72 | 95 | 77 | 99 | 96 | 86 | 82 | 84 | 92 | 90 | 98 | 10.39233 | 10.24409 | 9.557845 | 9.166545 | 10.78077 | 31.2 | 30.8 | 27.8 | 28.1 | 29.6 | 3.1 |
| 80 | 88 | 88 | 103 | 103 | 97 | 104 | 101 | 82 | 84 | 86 | 92 | 90 | 10.42283 | 9.46227 | 9.21432 | 9.194239 | 10.10537 | 29.9 | 28.9 | 29.1 | 29.2 | 29.6 | 3 |
| 70 | 77 | 76 | 95 | 92 | 84 | 99 | 91 | 86 | 82 | 88 | 92 | 88 | 9.582237 | 10.06681 | 9.001902 | 9.286808 | 10.20857 | 31 | 29.9 | 30.1 | 30.6 | 30.8 | 2.8 |
| 60 | 68 | 72 | 78 | 87 | 73 | 79 | 86 | 78 | 82 | 88 | 84 | 90 | 9.942137 | 9.900684 | 9.251462 | 9.285448 | 10.47365 | 31.6 | 31 | 30.2 | 30.6 | 30.6 | 3.3 |
| 77 | 100 | 98 | 109 | 117 | 97 | 117 | 113 | 86 | 88 | 92 | 94 | 92 | 9.965659 | 9.828897 | 9.545949 | 9.627575 | 9.697457 | 30.9 | 29.9 | 27.8 | 28.6 | 31.1 | 2.2 |
| 83 | 91 | 72 | 95 | 77 | 99 | 96 | 86 | 82 | 84 | 92 | 90 | 98 | 10.39233 | 10.24409 | 9.557845 | 9.166545 | 10.78077 | 31.2 | 30.8 | 27.8 | 28.1 | 29.6 | 3.1 |
| 64 | 72 | 88 | 103 | 105 | 78 | 85 | 101 | 86 | 88 | 94 | 90 | 92 | 10.05803 | 10.07569 | 9.92556 | 9.873026 | 10.0061 | 31.6 | 31.2 | 26.2 | 27.8 | 28.9 | 2.8 |
| 111 | 82 | 80 | 97 | 129 | 124 | 99 | 97 | 76 | 78 | 82 | 86 | 80 | 10.00897 | 10.61296 | 8.322685 | 10.39675 | 9.546259 | 31.2 | 30.6 | 28 | 29.2 | 30.8 | 2.8 |
| 77 | 100 | 98 | 109 | 117 | 97 | 117 | 113 | 86 | 88 | 92 | 94 | 92 | 9.965659 | 9.828897 | 9.545949 | 9.627575 | 9.697457 | 30.9 | 29.9 | 27.8 | 28.6 | 31.1 | 2.2 |
| 80 | 80 | 80 | 77 | 73 | 102 | 93 | 93 | 88 | 92 | 98 | 94 | 96 | 10.15442 | 9.678653 | 9.16185 | 9.795483 | 9.582487 | 34.6 | 34 | 32 | 32.4 | 33.1 | 3 |
| 78 | 82 | 86 | 97 | 96 | 91 | 94 | 101 | 90 | 75 | 72 | 69 | 82 | 10.97291 | 9.805097 | 9.178249 | 10.01276 | 9.468748 | 29.3 | 29.2 | 28.7 | 30.3 | 29.1 | 3.92 |



| HT2 | HT3 | HT4 | PLTP | PLT1 | PLT2 | PLT3 | PLT4 | BTP | BT1 | BT2 | BT3 | BT4 | CTP | CT1 | CT2 | CT3 | CT4 | APTTP | APTT1 | APTT2 | APTT3 | APTT4 | INRP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29.1 | 29.2 | 29.6 | 3 | 2.9 | 2.85 | 2.71 | 2.7 | 121.8 | 121.0 | 116.0 | 159.8 | 98.4 | 6.0 | 8.9 | 6.4 | 5.3 | 8.2 | 32.0 | 40.2 | 35.4 | 33.6 | 34.7 | 1.112 |
| 28.6 | 28.8 | 31.6 | 3.3 | 3.21 | 3 | 2.75 | 2.82 | 122.2 | 121.0 | 111.0 | 99.9 | 149.1 | 8.0 | 7.8 | 8.7 | 8.4 | 7.0 | 37.0 | 36.9 | 33.9 | 35.6 | 34.4 | 1.094 |
| 26.2 | 27.8 | 28.9 | 2.8 | 2.7 | 2.6 | 2.65 | 2.57 | 118.1 | 151.5 | 136.5 | 125.0 | 109.5 | 8.4 | 5.7 | 8.8 | 7.6 | 7.9 | 35.0 | 38.4 | 36.9 | 37.2 | 34.4 | 1.088 |
| 27.9 | 28 | 30.2 | 2.8 | 2.75 | 2.6 | 2.51 | 2.62 | 129.4 | 112.0 | 112.0 | 119.5 | 108.3 | 6.8 | 8.4 | 8.4 | 7.3 | 9.9 | 39.0 | 40.0 | 40.0 | 41.0 | 40.0 | 1.199 |
| 29.1 | 29.7 | 30.7 | 2.5 | 2.3 | 2 | 2.15 | 2.32 | 121.5 | 138.1 | 94.2 | 88.0 | 165.6 | 5.4 | 6.0 | 8.1 | 8.4 | 8.2 | 31.0 | 31.0 | 32.0 | 37.0 | 40.2 | 1.264 |
| 30.1 | 30.6 | 30.8 | 2.8 | 2.75 | 2.61 | 2.7 | 2.75 | 149.9 | 140.0 | 134.2 | 139.0 | 130.8 | 5.4 | 7.4 | 6.8 | 7.8 | 7.1 | 38.4 | 37.9 | 32.9 | 31.5 | 39.2 | 1.128 |
| 30.2 | 30.6 | 30.6 | 3.3 | 3 | 3.15 | 3.21 | 3.15 | 147.0 | 126.8 | 120.0 | 134.8 | 108.2 | 6.1 | 8.0 | 7.5 | 7.6 | 9.0 | 34.0 | 35.6 | 37.0 | 40.0 | 38.0 | 1.081 |
| 29.4 | 29.8 | 29.9 | 3 | 2.8 | 2.5 | 2.7 | 2.8 | 141.7 | 131.9 | 147.1 | 120.0 | 109.8 | 8.2 | 7.2 | 7.2 | 9.0 | 9.1 | 32.9 | 34.6 | 42.4 | 40.0 | 42.5 | 1.080 |
| 29.4 | 29.8 | 29.9 | 3 | 2.8 | 2.5 | 2.7 | 2.8 | 141.7 | 131.9 | 147.1 | 120.0 | 109.8 | 8.2 | 7.2 | 7.2 | 9.0 | 9.1 | 32.9 | 34.6 | 42.4 | 40.0 | 42.5 | 1.080 |
| 27.9 | 28 | 30.2 | 2.8 | 2.75 | 2.6 | 2.51 | 2.62 | 129.4 | 112.0 | 112.0 | 119.5 | 108.3 | 6.8 | 8.4 | 8.4 | 7.3 | 9.9 | 39.0 | 40.0 | 40.0 | 41.0 | 40.0 | 1.199 |
| 28.9 | 29.9 | 30.6 | 2.8 | 2.4 | 2.2 | 2 | 2.35 | 128.9 | 139.3 | 130.0 | 119.4 | 106.3 | 8.3 | 6.1 | 7.4 | 7.1 | 8.4 | 33.0 | 32.0 | 39.8 | 32.5 | 33.7 | 1.104 |
| 28 | 29.2 | 30.8 | 2.8 | 2.4 | 2 | 2.2 | 2.35 | 164.8 | 147.3 | 119.4 | 108.7 | 152.3 | 8.2 | 6.1 | 8.9 | 8.1 | 7.9 | 36.4 | 33.3 | 38.0 | 36.1 | 38.8 | 1.042 |
| 28.2 | 28.8 | 30 | 2.8 | 2.7 | 2.67 | 2.51 | 2.65 | 131.0 | 147.7 | 121.9 | 115.6 | 111.6 | 6.1 | 8.1 | 9.0 | 6.6 | 8.4 | 31.7 | 37.1 | 38.1 | 38.0 | 36.4 | 1.129 |
| 28.9 | 29.9 | 30.6 | 2.8 | 2.4 | 2.2 | 2 | 2.35 | 128.9 | 139.3 | 130.0 | 119.4 | 106.3 | 8.3 | 6.1 | 7.4 | 7.1 | 8.4 | 33.0 | 32.0 | 39.8 | 32.5 | 33.7 | 1.104 |
| 29.1 | 29.7 | 30.7 | 2.5 | 2.3 | 2 | 2.15 | 2.32 | 121.5 | 138.1 | 94.2 | 88.0 | 165.6 | 5.4 | 6.0 | 8.1 | 8.4 | 8.2 | 31.0 | 31.0 | 32.0 | 37.0 | 40.2 | 1.264 |
| 28.2 | 28.6 | 30.9 | 2.5 | 2 | 1.7 | 1.8 | 2.2 | 162.2 | 130.9 | 121.8 | 153.0 | 104.2 | 7.9 | 6.5 | 6.1 | 8.6 | 8.8 | 33.0 | 33.0 | 40.6 | 39.0 | 37.9 | 1.068 |
| 28.6 | 28.8 | 31.6 | 3.3 | 3.21 | 3 | 2.75 | 2.82 | 122.2 | 121.0 | 111.0 | 99.9 | 149.1 | 8.0 | 7.8 | 8.7 | 8.4 | 7.0 | 37.0 | 36.9 | 33.9 | 35.6 | 34.4 | 1.094 |
| 28.2 | 28.8 | 30 | 2.8 | 2.7 | 2.67 | 2.51 | 2.65 | 131.0 | 147.7 | 121.9 | 115.6 | 111.6 | 6.1 | 8.1 | 9.0 | 6.6 | 8.4 | 31.7 | 37.1 | 38.1 | 38.0 | 36.4 | 1.129 |
| 32 | 32.4 | 33.1 | 3 | 2.6 | 2.4 | 2.51 | 2.6 | 123.3 | 116.5 | 92.4 | 116.1 | 109.6 | 7.2 | 8.7 | 8.5 | 8.4 | 7.0 | 34.0 | 37.3 | 39.2 | 36.0 | 36.2 | 1.044 |
| 28.2 | 28.6 | 30.9 | 2.5 | 2 | 1.7 | 1.8 | 2.2 | 162.2 | 130.9 | 121.8 | 153.0 | 104.2 | 7.9 | 6.5 | 6.1 | 8.6 | 8.8 | 33.0 | 33.0 | 40.6 | 39.0 | 37.9 | 1.068 |
| 27.8 | 28.1 | 29.6 | 3.1 | 3.15 | 2.8 | 2.7 | 2.75 | 114.0 | 115.2 | 110.0 | 110.0 | 133.0 | 6.2 | 5.8 | 6.4 | 6.1 | 8.0 | 32.0 | 35.8 | 36.6 | 40.0 | 39.0 | 1.121 |
| 29.1 | 29.2 | 29.6 | 3 | 2.9 | 2.85 | 2.71 | 2.7 | 121.8 | 121.0 | 116.0 | 159.8 | 98.4 | 6.0 | 8.9 | 6.4 | 5.3 | 8.2 | 32.0 | 40.2 | 35.4 | 33.6 | 34.7 | 1.112 |
| 30.1 | 30.6 | 30.8 | 2.8 | 2.75 | 2.61 | 2.7 | 2.75 | 149.9 | 140.0 | 134.2 | 139.0 | 130.8 | 5.4 | 7.4 | 6.8 | 7.8 | 7.1 | 38.4 | 37.9 | 32.9 | 31.5 | 39.2 | 1.128 |
| 30.2 | 30.6 | 30.6 | 3.3 | 3 | 3.15 | 3.21 | 3.15 | 147.0 | 126.8 | 120.0 | 134.8 | 108.2 | 6.1 | 8.0 | 7.5 | 7.6 | 9.0 | 34.0 | 35.6 | 37.0 | 40.0 | 38.0 | 1.081 |
| 27.8 | 28.6 | 31.1 | 2.2 | 2.2 | 2.15 | 1.85 | 2 | 167.7 | 145.0 | 110.0 | 100.0 | 102.7 | 7.4 | 7.5 | 8.3 | 9.6 | 7.8 | 39.2 | 34.0 | 39.0 | 36.5 | 40.9 | 1.081 |
| 27.8 | 28.1 | 29.6 | 3.1 | 3.15 | 2.8 | 2.7 | 2.75 | 114.0 | 115.2 | 110.0 | 110.0 | 133.0 | 6.2 | 5.8 | 6.4 | 6.1 | 8.0 | 32.0 | 35.8 | 36.6 | 40.0 | 39.0 | 1.121 |
| 26.2 | 27.8 | 28.9 | 2.8 | 2.7 | 2.6 | 2.65 | 2.57 | 118.1 | 151.5 | 136.5 | 125.0 | 109.5 | 8.4 | 5.7 | 8.8 | 7.6 | 7.9 | 35.0 | 38.4 | 36.9 | 37.2 | 34.4 | 1.088 |
| 28 | 29.2 | 30.8 | 2.8 | 2.4 | 2 | 2.2 | 2.35 | 164.8 | 147.3 | 119.4 | 108.7 | 152.3 | 8.2 | 6.1 | 8.9 | 8.1 | 7.9 | 36.4 | 33.3 | 38.0 | 36.1 | 38.8 | 1.042 |
| 27.8 | 28.6 | 31.1 | 2.2 | 2.2 | 2.15 | 1.85 | 2 | 167.7 | 145.0 | 110.0 | 100.0 | 102.7 | 7.4 | 7.5 | 8.3 | 9.6 | 7.8 | 39.2 | 34.0 | 39.0 | 36.5 | 40.9 | 1.081 |
| 32 | 32.4 | 33.1 | 3 | 2.6 | 2.4 | 2.51 | 2.6 | 123.3 | 116.5 | 92.4 | 116.1 | 109.6 | 7.2 | 8.7 | 8.5 | 8.4 | 7.0 | 34.0 | 37.3 | 39.2 | 36.0 | 36.2 | 1.044 |
| 28.7 | 30.3 | 29.1 | 3.92 | 3.8 | 3.27 | 3.15 | 3 | 118.1 | 106.7 | 122.3 | 127.2 | 115.0 | 9.0 | 5.7 | 9.6 | 9.1 | 8.4 | 35.6 | 37.0 | 40.0 | 36.0 | 36.2 | 1.038 |



| APTT4 | INRP | INR1 | INR2 | INR3 | INR4 | NaP | Na1 | Na2 | Na3 | Na4 | KP | K1 | K2 | K3 | K4 | RBSP | RBS1 | RBS2 | RBS3 | RBS4 | EBV | EABL | BL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.7 | 1.112 | 1.230 | 1.276 | 1.223 | 1.175 | 142 | 141 | 140 | 135 | 140 | 4.2 | 4 | 3.8 | 3.8 | 4.3 | 96 | 104 | 122 | 136 | 148 | 3640 | 497 | 700 |
| 34.4 | 1.094 | 1.240 | 1.332 | 1.242 | 1.234 | 140 | 142 | 138 | 140 | 138 | 4.2 | 4.2 | 4 | 4.2 | 4.2 | 102 | 116 | 128 | 126 | 142 | 3770 | 566 | 650 |
| 34.4 | 1.088 | 1.143 | 1.205 | 1.299 | 1.242 | 141 | 140 | 142 | 142 | 141 | 4.2 | 4.1 | 4.1 | 4.2 | 4.2 | 102 | 112 | 118 | 122 | 128 | 4290 | 486 | 800 |
| 40.0 | 1.199 | 1.215 | 1.307 | 1.208 | 1.260 | 142 | 142 | 142 | 138 | 140 | 4.2 | 4.1 | 4.2 | 4.2 | 4.4 | 78 | 88 | 102 | 132 | 130 | 3575 | 604 | 600 |
| 40.2 | 1.264 | 1.211 | 1.269 | 1.231 | 1.220 | 142 | 142 | 138 | 140 | 142 | 3.8 | 3.8 | 4 | 3.8 | 4 | 100 | 104 | 116 | 128 | 130 | 3640 | 417 | 950 |
| 39.2 | 1.128 | 1.209 | 1.215 | 1.280 | 1.258 | 142 | 140 | 140 | 138 | 142 | 4.2 | 4 | 4 | 3.8 | 4.2 | 102 | 110 | 128 | 132 | 142 | 3380 | 205 | 650 |
| 36.0 | 1.061 | 1.258 | 1.215 | 1.303 | 1.180 | 138 | 140 | 140 | 138 | 142 | 4.2 | 4.2 | 3.8 | 4 | 4.6 | 106 | 118 | 120 | 132 | 138 | 3640 | 345 | 550 |
| 42.9 | 1.060 | 1.138 | 1.357 | 1.276 | 1.248 | 144 | 142 | 142 | 140 | 142 | 4 | 4.2 | 4 | 3.8 | 4 | 88 | 96 | 118 | 130 | 142 | 4030 | 734 | 800 |
| 42.9 | 1.060 | 1.138 | 1.357 | 1.276 | 1.248 | 144 | 142 | 142 | 140 | 142 | 4 | 4.2 | 4 | 3.8 | 4 | 88 | 96 | 118 | 130 | 142 | 4030 | 734 | 800 |
| 40.0 | 1.199 | 1.215 | 1.307 | 1.208 | 1.260 | 142 | 142 | 142 | 138 | 140 | 4.2 | 4.1 | 4.2 | 4.2 | 4.4 | 78 | 88 | 102 | 132 | 130 | 3575 | 604 | 600 |
| 33.7 | 1.104 | 1.253 | 1.193 | 1.312 | 1.363 | 140 | 140 | 138 | 142 | 142 | 4 | 4 | 3.8 | 3.8 | 3.8 | 78 | 102 | 106 | 122 | 128 | 3770 | 550 | 500 |
| 38.8 | 1.042 | 1.182 | 1.245 | 1.279 | 1.247 | 143 | 140 | 142 | 144 | 142 | 4 | 4 | 3.8 | 4 | 4 | 96 | 102 | 120 | 130 | 142 | 3770 | 380 | 750 |
| 36.4 | 1.129 | 1.176 | 1.145 | 1.291 | 1.280 | 142 | 142 | 138 | 140 | 142 | 4.2 | 4.2 | 3.8 | 4 | 4.2 | 98 | 102 | 118 | 126 | 134 | 3900 | 596 | 650 |
| 33.7 | 1.104 | 1.253 | 1.193 | 1.312 | 1.363 | 140 | 140 | 138 | 142 | 142 | 4 | 4 | 3.8 | 3.8 | 3.8 | 78 | 102 | 106 | 122 | 128 | 3770 | 550 | 500 |
| 40.2 | 1.264 | 1.211 | 1.269 | 1.231 | 1.220 | 142 | 142 | 138 | 140 | 142 | 3.8 | 3.8 | 4 | 3.8 | 4 | 100 | 104 | 116 | 128 | 130 | 3640 | 417 | 950 |
| 37.9 | 1.088 | 1.128 | 1.265 | 1.290 | 1.283 | 142 | 142 | 140 | 138 | 142 | 3.8 | 3.8 | 3.7 | 4.2 | 4 | 90 | 102 | 114 | 126 | 142 | 3770 | 574 | 950 |
| 34.4 | 1.094 | 1.240 | 1.332 | 1.242 | 1.234 | 140 | 142 | 138 | 140 | 138 | 4.2 | 4.2 | 4 | 4.2 | 4.2 | 102 | 116 | 128 | 126 | 142 | 3770 | 566 | 650 |
| 36.4 | 1.129 | 1.176 | 1.145 | 1.291 | 1.280 | 142 | 142 | 138 | 140 | 142 | 4.2 | 4.2 | 3.8 | 4 | 4.2 | 98 | 102 | 118 | 126 | 134 | 3900 | 596 | 650 |
| 36.2 | 1.044 | 1.180 | 1.277 | 1.337 | 1.269 | 140 | 142 | 138 | 140 | 142 | 4 | 3.8 | 3.8 | 4 | 4.2 | 102 | 112 | 120 | 124 | 132 | 4030 | 458 | 1300 |
| 37.9 | 1.088 | 1.128 | 1.265 | 1.290 | 1.283 | 142 | 142 | 140 | 138 | 142 | 3.8 | 3.8 | 3.7 | 4.2 | 4 | 90 | 102 | 114 | 126 | 142 | 3770 | 574 | 950 |
| 39.0 | 1.121 | 1.163 | 1.261 | 1.288 | 1.173 | 142 | 140 | 140 | 142 | 145 | 4.2 | 4.1 | 4.5 | 4.2 | 4.2 | 102 | 108 | 112 | 132 | 136 | 3900 | 523 | 700 |
| 34.7 | 1.112 | 1.230 | 1.276 | 1.223 | 1.175 | 142 | 141 | 140 | 135 | 140 | 4.2 | 4 | 3.8 | 3.8 | 4.3 | 96 | 104 | 122 | 136 | 148 | 3640 | 497 | 700 |
| 39.2 | 1.128 | 1.209 | 1.215 | 1.280 | 1.258 | 142 | 140 | 140 | 138 | 142 | 4.2 | 4 | 4 | 3.8 | 4.2 | 102 | 110 | 128 | 132 | 142 | 3380 | 205 | 650 |
| 36.0 | 1.061 | 1.258 | 1.215 | 1.303 | 1.180 | 138 | 140 | 140 | 138 | 142 | 4.2 | 4.2 | 3.8 | 4 | 4.6 | 106 | 118 | 120 | 132 | 138 | 3640 | 345 | 550 |
| 40.9 | 1.061 | 1.187 | 1.195 | 1.283 | 1.264 | 142 | 140 | 138 | 142 | 140 | 4.2 | 4.2 | 4.6 | 4 | 4.6 | 82 | 88 | 102 | 128 | 140 | 4030 | 391 | 500 |
| 39.0 | 1.121 | 1.163 | 1.261 | 1.288 | 1.173 | 142 | 140 | 140 | 142 | 145 | 4.2 | 4.1 | 4.5 | 4.2 | 4.2 | 102 | 108 | 112 | 132 | 136 | 3900 | 523 | 700 |
| 34.4 | 1.088 | 1.143 | 1.205 | 1.299 | 1.242 | 141 | 140 | 142 | 142 | 141 | 4.2 | 4.1 | 4.1 | 4.2 | 4.2 | 102 | 112 | 118 | 122 | 128 | 4290 | 486 | 800 |
| 38.8 | 1.042 | 1.182 | 1.245 | 1.279 | 1.247 | 143 | 140 | 142 | 144 | 142 | 4 | 4 | 3.8 | 4 | 4 | 96 | 102 | 120 | 130 | 142 | 3770 | 380 | 750 |
| 40.9 | 1.061 | 1.187 | 1.195 | 1.283 | 1.264 | 142 | 140 | 138 | 142 | 140 | 4.2 | 4.2 | 4.6 | 4 | 4.6 | 82 | 88 | 102 | 128 | 140 | 4030 | 391 | 500 |
| 36.2 | 1.044 | 1.180 | 1.277 | 1.337 | 1.269 | 140 | 142 | 138 | 140 | 142 | 4 | 3.8 | 3.8 | 4 | 4.2 | 102 | 112 | 120 | 124 | 132 | 4030 | 458 | 1300 |
| 36.2 | 1.038 | 1.265 | 1.147 | 1.255 | 1.307 | 141 | 142 | 140 | 142 | 142 | 3.8 | 4.2 | 4.1 | 4 | 4.2 | 100 | 122 | 132 | 136 | 138 | 4160 | 748 | 850 |

Sheet1 Sheet2 Sheet3

# Consent Form for Blood Transfusion

**If you agree to have a blood transfusion, please sign below.**

I have received a thorough explanation about blood transfusions and their risks by reading "Information about Blood Transfusions", and I understand the content. I have also confirmed the details described below in the "types and amount of scheduled blood transfusions". As a result, I agree to have a blood transfusion. (Even after you sign, you can withdraw your agreement at any time.) I also agree that my blood transfusion may be cancelled based on my doctor's decision, and that the details of my blood transfusion may be changed from those described below in the "types and amount of scheduled blood transfusion" based on my doctor's decision in case of a life-threatening emergency or if my doctor decides that a blood transfusion is necessary during my treatment.

■**Types and amount of scheduled blood transfusion**

1. Types: ☐My own blood ☐Red cell products ☐Platelet products
   ☐Fresh frozen plasma ☐Other (  )
2. Amount:_____(ml)

**Date of agreement (YYYY/MM/DD):** ____/____/____

**Patient's name :** _____ **(print)**

**Patient's signature :** _____

**Patient's address :** _____

**Representative's name :** _____ **(print)**

**Representative's signature :** _____ **(relationship to patient:** _____**)**

**Representative's address :** _____

**If you refuse to have blood transfusion, please read the following statement. If you understand it, please sign below.**

I have received an explanation of the necessity of a blood transfusion; however, I refuse to have a blood transfusion. I will not hold my doctor or hospital liable regarding the consequences of my decision.

**Date of signature (YYYY/MM/DD):** ____/____/____

**Patient's name :** _____ **(print)**

**Patient's signature :** _____

**Patient's address :** _____

**Representative's name :** _____ **(print)**

**Representative's signature :** _____ **(relationship to patient:** _____**)**

**Representative's address :** _____

---

I provided the explanation about blood transfusion to the person who signed above.

**Date of explanation (YYYY/MM/DD):**____/____/____ **Department:**_____

**Attending doctor:**_____ **Seal**

I confirm that the patient (or his/her representative) above has agreed or refused to have a blood transfusion by signing this document.

**Date of confirmation (YYYY/MM/DD):**____/____/____ **Department:**_____

**Attending doctor:**_____ **Seal**

*If the patient is a minor who does not have the ability to agree, or cannot agree and sign because of a lack of consciousness or other medical condition, the signature in the "Representative" section above must be provided by a parent, guardian, responsible adult, or relative.

Ref. No. 2544/ME1/18

Government Theni Medical College
Theni Dated: 07.06.2018

**Institutional Ethical Committee:**

**Convenor:**

**Dr. T. Thirunavukkarasu, M.D., D.A.,**
Dean
Govt. Theni Medical College
Theni

Sub: Medical Education – Govt. Theni Medical College, Theni – Ethical Committee – Minutes – Communicated – Reg.

The Ethical Committee Meeting of the Govt. Theni Medical College, Theni was held at 10.30 A.M. on 07.06.2018 at 150 Lecture Hall, Government Theni Medical College Hospital, Theni.

The following Members of the Committee have attended the Meeting.

| | | | |
|---|---|---|---|
| 1. | **Convener** | : | **Dr. T. Thirunavukkarasu, M.D., D.A., Dean** |
| 2. | **Member Secretary** | : | **Dr. M. Ilangovan, M.S., Deputy Superintendent** |
| 3 | **Members** | | |
| | Professor of Medicine | : | **Dr. P. K. Ganesh Babu, M.D.,** |
| | Professor of Surgery | : | **Dr. R. Murugesan, M.S.,** |
| | Professor of Obs. & Gynaec. | : | **Dr. Thangamani, M.D., O.G.,** |
| | Professor of Micro Biology | : | **Dr. K.M. Mythreyee, M.D.,** |
| 4. | **Chairman (Private Consultant)** | : | **Dr. Paulraj, M.D.,** Ramya Clinic, Periyakulam Road, Theni. |
| 5. | **Lawyer** | : | **Thiru.K.Murugesan, B.Com., B.L.,** S/o.Kamaraj, Ambedkar Nagar, Varusanadu, Theni District. |
| 6. | **Sociologist** | : | **Sr. Anaestescia** Director, Jeevan Jothi Hospital Community Care Centre, Periyakulam Road, Kailasapatti, Theni Dist. |
| 7. | **Public** | : | **Mr. P. Deenadhayalan, M.A.,** Land Lord, Koduvilarpatti, Theni District. |

The following Project was approved by the Committee:

| Name and Designation | Name of the Project | Remarks |
|---|---|---|
| Dr. N. Santhosh Kumar First Year MD (Anaes.) Post Graduate | Acute Normovolemic Hemodilution in patients undergoing Total Abdominal Hysterectomy – A randomized controlled trial | Approved |

Please note that the investigator should adhere the following: He/she should get a detailed informed consent from the Patients/participants and maintain Confidentially.

1. He/she should carry out the work without detrimental to regular activities as well as without extra expenditure to the institution.
2. He/she should inform the Institution Ethical Committee in case of any change of study procedure site and investigation or guide.
3. He/she should not deviate for the area of the work for which applied for Ethical Clearance. He/She should inform the Institution Ethical Committee immediately, in case of any adverse events or any serious adverse reactions.
4. He/she should abide to the rules and regulations of the institution.
5. He/she should complete the work within the specific period and apply for if any extension of time is required. He/she should apply for permission again and do the work.
6. He/she should submit the summary of the research work to the Ethical Committee on completion of the work.
7. He/she should not claim any funds from the institution while doing the work or on completion.
8. He/she should understand that the members of Institutional Ethical Committee have the right to monitor the work with prior intimation.

Chairman

Convenor
DEAN
GOVT. THENI MEDICAL COLLEGE HOSPITAL
THENI-625 512.

To

Dr.M. PALRAJ,M.D.,
Civil Surgeon Retd.,
SAMYA HOSPITAL
THENI - 625 531.
Regn. No: 28094

The above individual through Head of the Department concerned.

# ***PLAGIARISM CERTIFICATE***

This is to certify that this dissertation work titled "**ACUTE NORMOVOLEMIC HEMODILUTION PATIENTS UNDERGOING TOTAL ABDOMINAL HYSTERECTOMY-A RANDOMISED CONTROLLED TRIAL"** of the candidate **DR. SANTHOSH KUMAR** with registration Number **201720754** for the award of **M.D. DEGREE IN ANAESTHESIOLOGY BRANCH X** was personally verified by me in the urkund.com website for the purpose of plagiarism check. I have found that the uploaded thesis file contains from introduction to conclusion pages and the result shows 11percentage of plagiarism in the dissertation.

***Guide & Supervisor sign with Seal***

**Prof. Dr. M.BALASUBRAMANI, *M.D.,DA.,***

Place: Theni **Professor**

Date : Department of Anaesthesiology

Government Theni Medical College

Theni.

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3592192/
https://www.sciencedirect.com/science/article/pii/S1110184911000614
https://www.researchgate.net/publication/24433431_Perioperative_blood_conservation
https://www.researchgate.net/publication/8509199_Acute_normovolemic_hemodilution
https://www.researchgate.net/publication/12595858_Changes_in_Intravascular_Volume_during_Acute_Normovolemic_Hemodilution_and_Intraoperative_Retransfusion_in_Patients_with_Radical_Hysterectomy

## Instances where selected sources appear:

51