"COMPARISON OF CONVENTIONAL CENTRAL VENOUS PRESSURE WITH PERIPHERAL VENOUS PRESSURE AND EXTERNAL JUGULAR VENOUS PRESSURE IN PATIENTS WITH SEPSIS''

By

Dr SREENIDI R

Dissertation submitted to

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In partial fulfillment of the requirements for the degree of

DOCTOR OF MEDICINE

IN

ANAESTHESIOLOGY

Under the guidance of

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LIST OF ABBREVIATIONS USED

bpm	Beats per minute
CVS	Cardio Vascular System
CLABSI	Catheter line associated blood stream infections
CNS	Central Nervous System
CVP	Central venous pressure
CI	Confidence Interval
CBC	Complete blood count
CT	Clotting time
cmH2O	Centimeter of Water
ECG	Electrocardiogram
EJVP	External jugular venous pressure
EJV	External jugular vein
EDV	End diastolic volume
Fr	French
G	Gauge
HR	Heart rate
ICU	Intensive care unit
IJV	Internal jugular vein
IHD	Ischemic heart disease

i.e	that is
LVEDP	Left ventricular end diastolic pressure
LVEDV	Left ventricular end diastolic volume
mmhg	millimeter of mercury
mins	Minutes
OD	Outer diameter
PA	Per abdomen
PEEP	Positive end expiratory pressure
PVP	Peripheral venous pressure
RBS	Random blood sugar
MAP	Mean arterial pressure
HB	Haemoglobin
RS	Respiratory system
RVEDP	Right ventricular end diastolic pressure
RVEDV	Right ventricular end diastolic volume
RR	Respiratory rate
SD	Standard deviation
SPSS	Statistical package for the social sciences
SVC	Superior venacava
SEC	Seconds
SV	Stroke volume

SPO2	Peripheral capillary oxygen saturation
USG	Ultrasonography
WBC	White blood count

ABSTRACT

"COMPARISON OF CONVENTIONAL CENTRAL VENOUS PRESSURE WITH PERIPHERAL VENOUS PRESSURE AND EXTERNAL JUGULAR VENOUS PRESSURE IN PATIENTS WITH SEPSIS "

BACKGROUND

Central venous pressure along with other dynamic and static variables are used to guide fluid therapy in patients with sepsis admitted to critical care unit. However, insertion of central venous catheter is associated with serious complications. Unlike central venous cannulation, patients with vasofix inserted into external jugular vein and peripheral vein are less likely to encounter any serious complications

OBJECTIVES

1. To measure CVP, EJVP and PVP in patients with sepsis during first 24 hour of admission to ICU.
2. To correlate CVP with EJVP and PVP following fluid challenge in above mention patient.
3. To compare the incidence of complications like pnemothorax , arrhythmias and catheter related blood stream infections(CLABSI) in above mention patient

MATERIALS AND METHODS:

A prospective observational study, after obtaining ethical committee approval in R.L. Jalappa Hospital and Research centre was done on 54 adult patients of either sex of above 18 years of age with sepsis admitted in ICU requiring fluid resuscitation after obtaining written informed consent. . Under strict aseptic precautions, each of the patient Peripheral venous pressure,

external jugular venous pressure and central venous pressure is measured simultaneously using water column manometer. Peripheral venous pressure is measured from 16G or 18G vasofix sited in right/left cubital fossa, External jugular venous pressure measured from 16 or 18G vasofix sited in right/left external jugular vein and central venous pressure measured from16 G distal port of 7 French triple lumen central venous catheter of 15cm length sited in right/left internal jugular vein / subclavian vein. Water column manometers are connected to all the three catheters and zeroed at mid –axillary line corresponding to sternal angle .Before fluid challenge peripheral venous pressure, external jugular venous pressure and central venous pressure are measured in all patients admitted with sepsis. All the three venous pressures are repeated 3 times following every fluid challenge of 200ml.The data collected were statistically analyzed using SPSS 22 version software with Chi square test and Independent t test as tests of significance

RESULTS

The observations were analyzed by dividing the patients into 2 groups on the basis of CVP measurements

Group A- patients with **CVP≤10**

Group B- patients with **CVP>10**.

Out of 648 observations, 396 observations belonged to Group A and 252 observations under Group B.

In GROUP A

Total mean CVP was 7.38cmH20, mean EJVP was 10.83cmH20 and mean PVP was 11.17cmH20.

CVP and EJVP -mean difference was 3.9, r=0.386, p=0.192

CVP and PVP -mean difference was 4.3, r=0.137, p= 0.174

In Group A (CVP ≤ 10) mean difference between CVP with PVP and EJVP is >2cmH20 and p value is insignificant.

In GROUP B

Overall mean CVP was 11.90 cmH20, mean EJVP was 12.58 cmH20, and mean PVP was 13.52 cmH20.

CVP and EJVP-mean difference was 1.3, r=0.685, p<0.001

CVP and PVP –mean difference is 1.8, r=0.785, p<0.001

In Group B (CVP >10) mean difference between CVP with PVP and EJVP is <2cmH2O and p value(p<0.001) is strongly significant and comparable.

To evaluate the degree of agreement, Bland and Altman plots were done between CVP - EJVP and CVP –PVP with 95% limits of agreement as the mean difference (1.96SD).

CONCLUSION:

The present study conclude that, there is definite correlation between CVP, EJVP and PVP in a given patient. Further concludes the difference between CVP and EJVP/PVP was minimum (<2cmH2O) when the CVP was>10cmH2O

KEY WORDS:

Central venous pressure, External jugular venous pressure, Peripheral venous pressure, Sepsis

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INTRODUCTION

According to SURVIVING SEPSIS CAMPAIGN 2016[1] guidelines central venous pressure along with other dynamic and static variables are used to guide fluid therapy in patients with sepsis admitted to critical care unit. However, insertion of central venous catheter is associated with serious complications such as venous air embolism, pneumothorax, carotid artery puncture, arrhythmias, perforation of right atrium, cardiac tamponade and catheter related blood stream infections[2]. Unlike central venous cannulation, patients with vasofix inserted into external jugular vein and peripheral vein are less likely to encounter any serious complications.

Till date, only few studies are done to show the association between central venous pressure and peripheral venous pressure[3,4,5,6]. Peripheral venous pressure monitoring is an easy procedure and also can be used as reserve to central venous pressure in governing fluid volume status among critically ill patients[4].

At present, in most of resource limited ICU's still rely on conventional central venous pressure monitoring using water column manometer for managing fluid resuscitation in septic patients[7]. In our study, we measured external jugular venous pressure (EJVP), peripheral venous pressure (PVP) and correlated pressures with central venous pressure (CVP) measured by conventional technique.

OBJECTIVES OF THE STUDY

1. To measure CVP, EJVP and PVP in patients with sepsis during first 24 hour of admission to ICU.
2. To correlate CVP with EJVP and PVP following fluid challenge in above mention patient.
3. To compare the incidence of complications like pnemothorax, arrhythmias and catheter related blood stream infections (CLABSI) in above mention patient.

APPLIED ANATOMY

Cubital fossa is an important area of transition at the arm and the forearm. It is a hollow triangle formed between two forearm muscles by brachioradialis and pronotor teres and is situated in front of elbow with roof formed by skin and superficial fascia containing medial cubital vein.

Medial cubital vein passes obliquely across the roof and connects the **cephalic vein** on the lateral side of the upper limb and on the medial side the **basilic vein**[8] .The lateral cutaneous nerve of forearm lies along with cephalic vein and medial cutaneous nerve of the forearm along the basilic vein.

The continuation of the basilic vein is the axillary vein .At outer border of first rib, it becomes subclavian vein[8]. It receives 5out of 6 tributaries corresponding to branches of axillary artery and cephalic vein.

Veins accompying branches of thoracoacrominal artery drain directly into the cephalic vein.

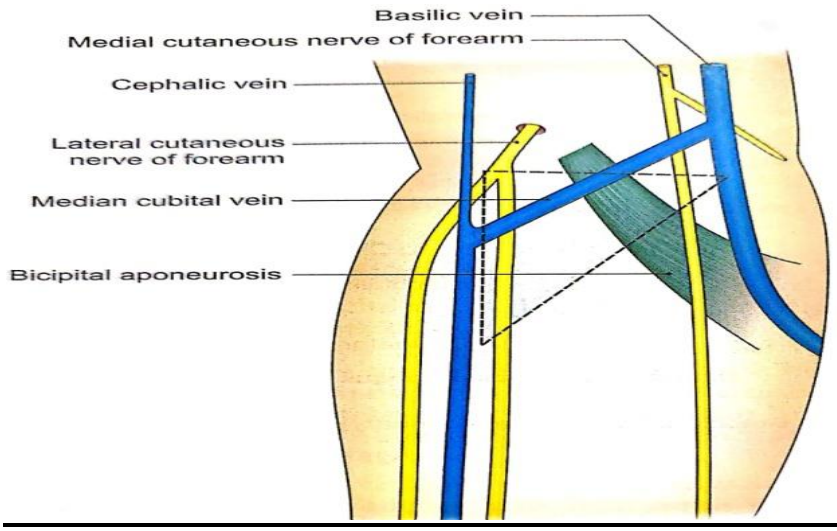


FIG 1-STRUCTURES IN THE ROOF OF CUBITAL FOSSA

SUBCLAVIAN VEIN

Axillary vein continuous as subclavian vein and begins at outer border of the 1st rib[8], as it crosses the base of the posterior triangle, the external jugular vein, and possibly the suprascapular and transverse cervical veins enter it and ends at the medial border of the scalenus anterior by joining the internal jugular vein to form brachiocephalic vein.

Subclavian artery, the scalene anterior and the right phrenic nerve lies in front of it, behind the clavicle and above the first rib and pleura the subclavius.

Its tributaries are

1. The external jugular vein
2. The dorsal scapular vein

Internal jugular vein (IJV)

Sigmoid sinus directly continuous as IJV. It begins at the jugular foramen, and ends behind the sternal end of the clavicle joining the subclavain vein to form the brachiocephalic vein.

It is situated under the sternocleidomastoid muscle on either side of neck, and runs obliquely down the neck.

The internal jugular vein may communicate with external jugular vein through the oblique jugular vein which runs across the anterior border of the sternocleidomastoid in middle of the neck and in lower neck region, vein is located anterior and lateral to carotid artery At the base of neck,IJV joins subclavian to form innominate vein, and the convergence of the right and left innominate veins forms the superior venacava[9].

For cannulation, right sided internal jugular vein is preferred because vessels run a straight course to the right atrium.

Relations

Anterior

1. Sternoceidomastoid

2. Posterior belly of digastrics

3.Superficial belly of omohyoid

4. Parotid gland

5. Styloid process

6. The internal carotid artery, and the glossopharngeal, vagus, accessory and hypoglossal cranial nerves

Posterior

1. Transverse process of atlas

2. Cervical plexus

3. Scalenus anterior

4. First part of subclavian artery

Medial

1. Internal carotid artery

2. Common carotid artery

3. Vagus nerve

Tributaries

1. Inferior petrosal sinus
2. Common facial vein
3. Lingual vein
4. Superior thyroid vein
5. Middle thyroid vein

External jugular vein

The EJV is formed posterior to the angle of mandible as the **posterior auricular vein** and the **retromandibular vein**[9]**.**

The external jugular vein passes straight down the neck in the superficial fascia and it is superficial to the sternocleidomastoid muscle throughout its course, crossing it diagonally as it descends. After reaching the lower part of neck, just above the clavicle and immediately posterior to the sternocleidomastoid muscle, external jugular vein pierces the investing layer of cervical fascia, passes deep to the clavicle and enters **subclavian vein**.

Tributaries received

1. Posterior external jugular vein
2. Transverse cervical and suprascapular vein
3. Anterior jugular vein

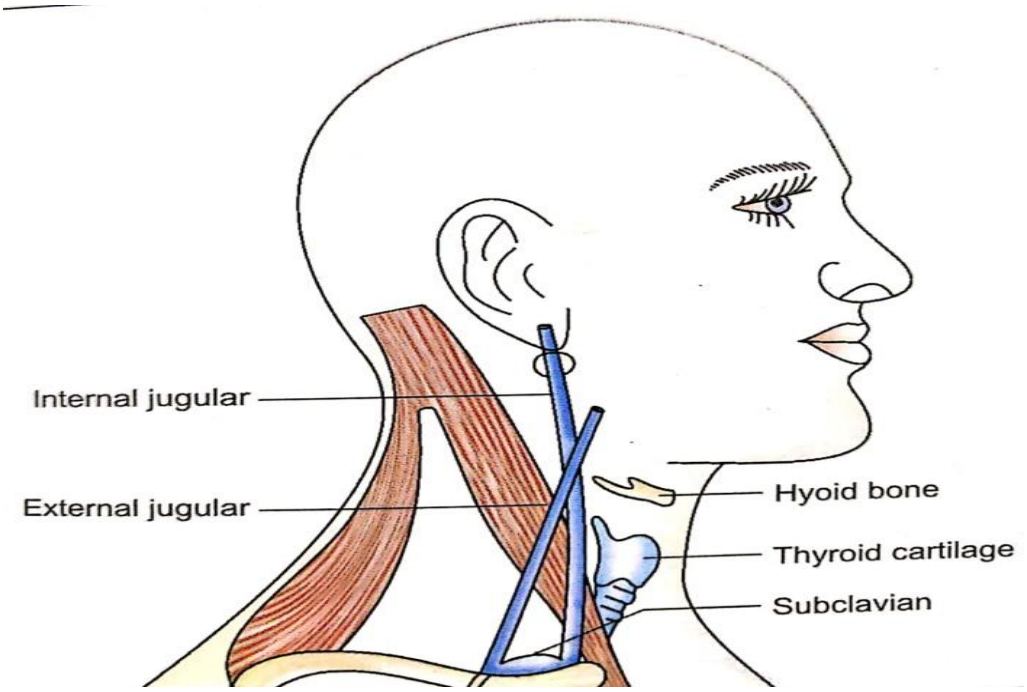


FIG 2-COURSE OF EXTERNAL JUGULAR VEIN

Brachiocephalic vein

Each vein is formed behind the sternoclavicular joint, by the union of the internal jugular vein and the subclavian vein and right sided vein runs vertically downwards but left vein runs obliquely downwards and to the right behind the upper half of the manubrium sterni. The right brachiocephalic vein (2.5cm long) is shorter than the left (6 cm long).

The two brachiocephalic veins join at the lower border of the right first costal cartilage to bring together the superior vena cava.

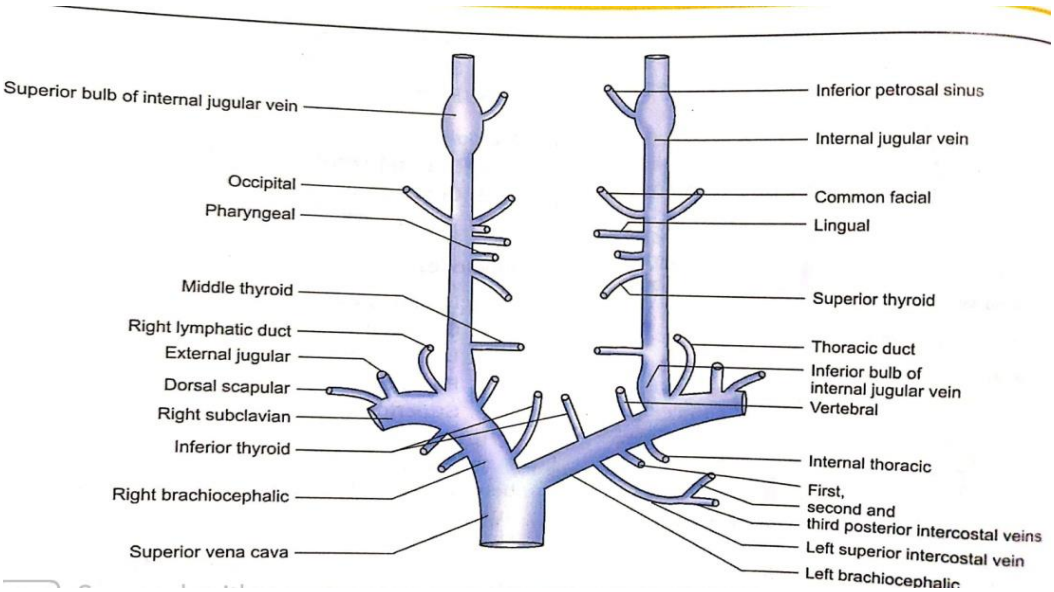


FIG 3-FORMATION OF VEINS OF THE NECK

CENTRAL VENOUS CATHETERIZATION

Indications[10]

1. Rapid resuscitation via infusion of fluids or blood
2. Hemodynamic monitoring for measuring central venous pressures
3. Transvenous cardiac pacing
4. Temporary hemodialysis
5. Drug administration
    - Concentrated vasoactive drugs
    - Hyperalimentation
    - Chemotherapy
    - Agents irritating to peripheral veins
    - Prolonged antibiotic therapy
6. Inability to access peripheral vein
7. Aspiration of air emboli
8. Sampling site for repeated blood testing

Contraindications[10]

1. Infection at the site of insertion
2. Trauma
3. Venous thrombosis at the selected site

SELDINGER TECHNIQUE

It is a method introduced in the early 1950s and called the seldinger technique after its founder[11]. Central venous catheters are placed by threading the catheter over a guide wire .In this technique needle is inserted slowly at the appropriate landmark for the selected access with gentle and constant suction is applied to the connected syringe to the needle.

Guide wire is threaded through the needle and then needle is removed and guide wire is left in place. Skin insertion site is incised to create a skin opening of about 0.5 to 1 cm around the guide wire A dilator is introduced over the guide wire into the vein. Skin and vessel are dilated. Catheter is put over the guide wire and guide wire is removed. Blood is aspirated from all ports, which are flushed with saline or heparin solution, and all the port sites that are not intended for immediate use are sealed. Catheter is secured in place with sutures and the entire area is covered to keep it sterile.

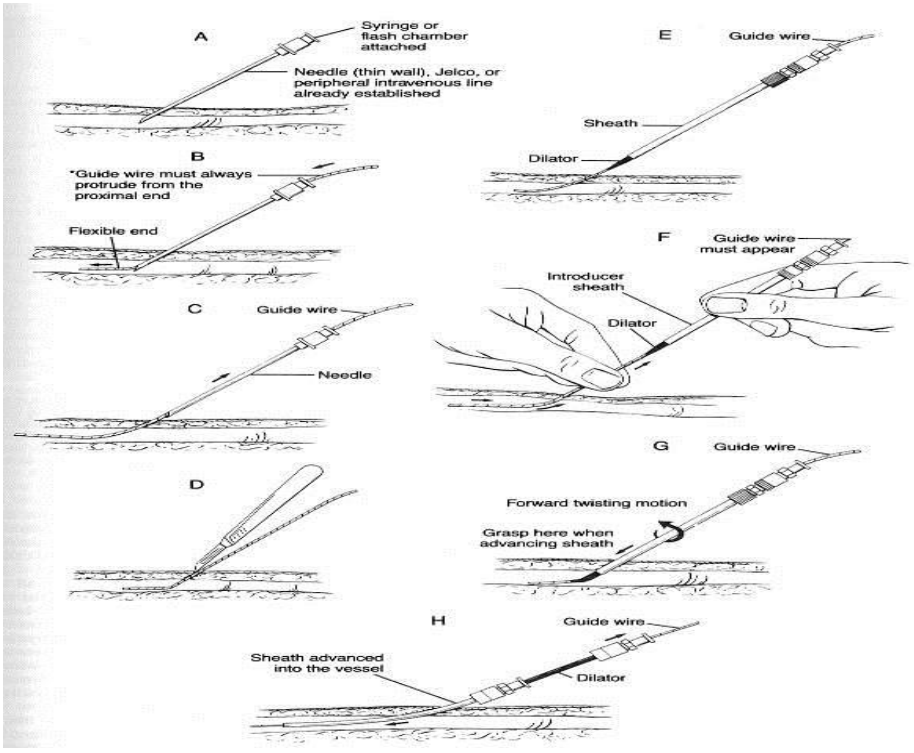


FIG 4 -SELDINGER TECHNIQUE

APPROACHES FOR CENTRAL VENOUS CANNULATION

The subclavian vein

Positioning

- Supine position, head neutral, arm adducted
- Trendelenburg position(10 to 15 degree)
- Shoulders neutral with mild retraction

INFRACLAVICULAR APPROACH

- Junction of middle and medial thirds of clavicle
- Needle should be parallel to skin ,pointing upwards
- Aim towards the supraclavicular notch and just under the clavicle
- Bevel of needle rotated to 3'0 clock position

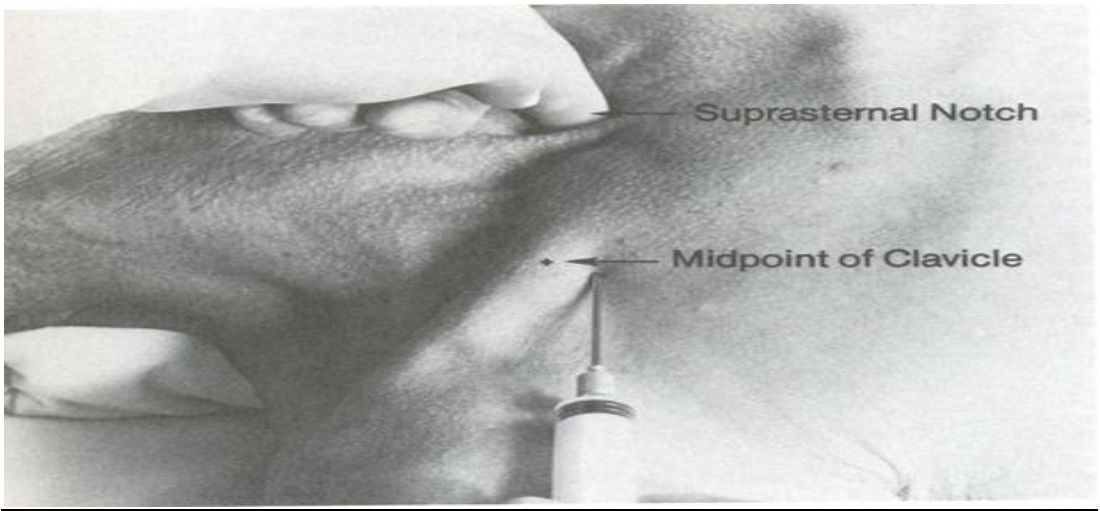


FIG 5- INFRACLAVICULAR APPROACH FOR SUBCLAVIAN VEIN CANNULATION

SUPRACLAVICULAR APPROACH

- Needle inserted to bisect the angle made by lateral margin of sternocleidomastoid and clavicle.
- Direct needle under clavicle, in direction of opposite nipple.
- Turn bevel of needle to 9'0 clock position so the guide wire threads in direction of SVC

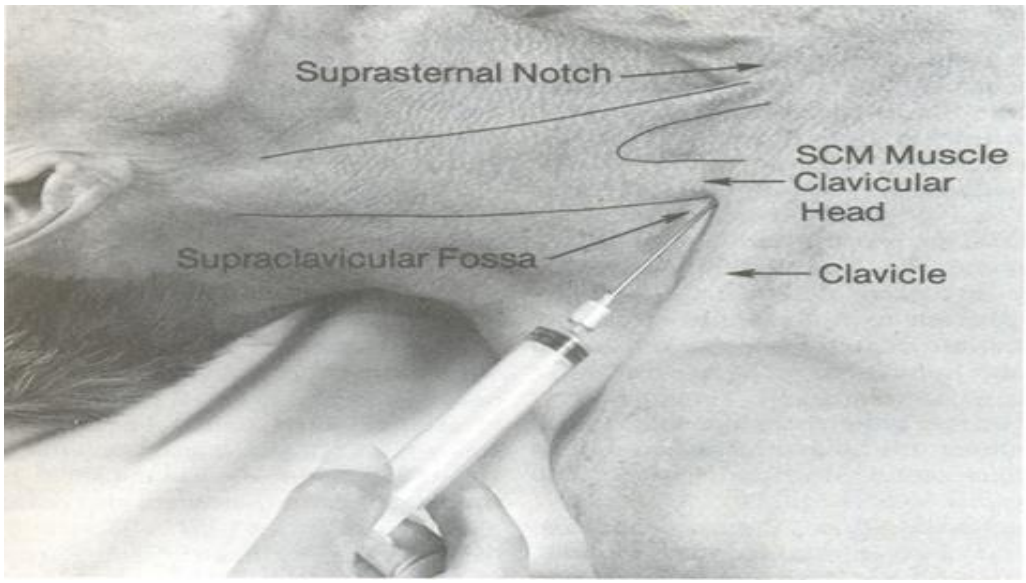


FIG 6 -SUPRACLAVICULAR APPROACH FOR SUBCLAVIAN VEIN CANNULATION

The average distance for cannulations from the subclavian vein to the right atrium is 14.5cm and 18.5cm for right side and left side respectively[10].

INTERNAL JUGULAR VEIN

Positioning

- Right side preferred
- Trendelenburg position(10 to 15 degree)
- Head turned slightly away from side of venipuncture

Approaches

1. Anterior approach
2. Cental approach
3. Posterior approach

ANTERIOR APPROACH

- Locate the area ,which is a triangle made by the clavicle and the sternal and clavicular heads of the SCM muscle
- Gently place three fingers of left hand on carotid artery and artery is retracted towards midline
- Place needle at 45 degrees to the skin, lateral to the carotid artery
- Probe needle aim toward the ipsilateral nipple

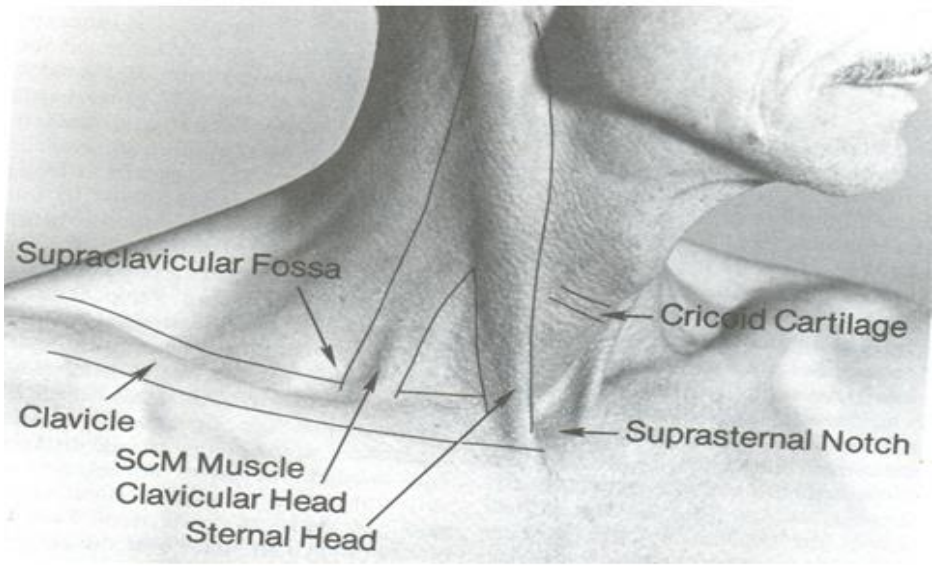


FIG 7-ANTERIOR APPROACH FOR INTERNAL JUGULAR VEIN CANNULATION

POSTERIOR APPROACH

- 1cm superior to point where EJV crosses over lateral edge of sternocleidomastoid
- Probe inserted with bevel positioned at 3'0 clock
- Pointing to suprasternal notch , encountered 5 to 6 cm from skin

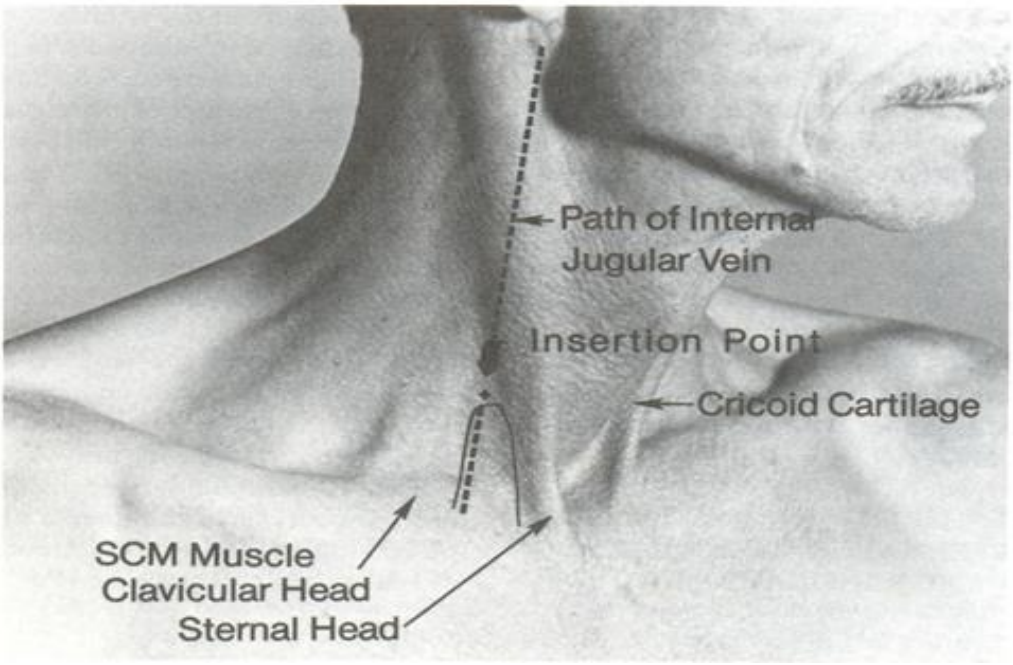


FIG 8-POSTERIOR APPROACH FOR INTERNAL JUGULAR VEIN CANNULATION

CENTRAL APPROACH

- In the central approach, needle is inserted at the joining of the sternal and the clavicular heads of the sternocleidomastoid muscle
- Needle is headed at a 30-45 degree angle to skin medially to the ipsilateral nipple.

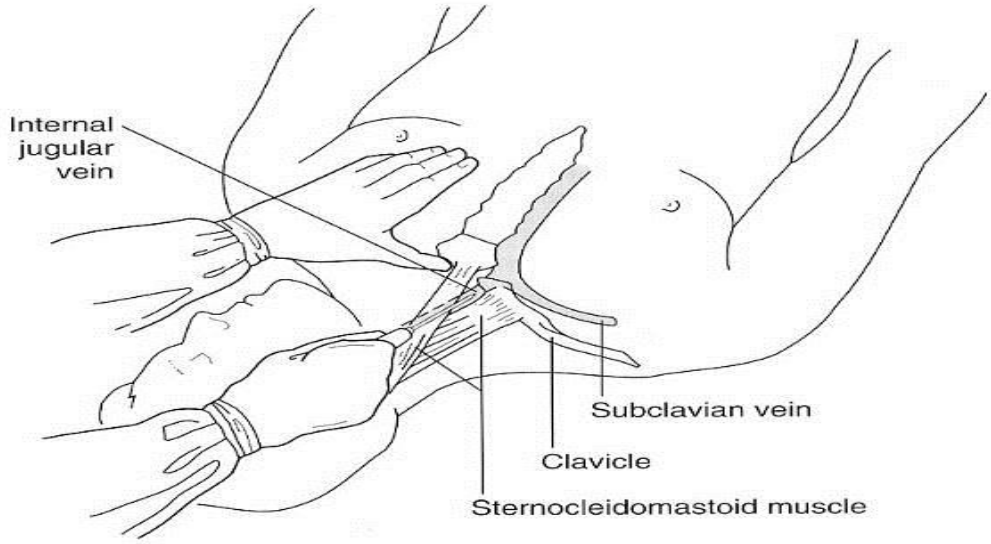


FIG 8-CENTRAL APPROACH FOR INTERNAL JUGULAR VEIN CANNULATION

The average distance for cannulations from internal jugular vein to the right atrium is 12.5 and 13.5cm for right and left side respectively[10].

VASCULAR CATHETERS

Vascular catheters are made of synthetic polymers that are chemically inert, biocompatible and resistant to chemical and thermal degradation.

Most used polymers are made up of polyurethane and silicone.

CATHETER SIZE

The size of vascular catheters is determined by the outside diameter of the catheter which is measured in gauge and French size.

Gauge sizes varies inversely with outside diameter, whereas each increment of one French unit represents an increase of 1/3 millimetre in outer diameter[10].

French size×0.33=outer diameter (mm).

Catheter flow

Hagen –poiseuille equation applies flow through rigid tubes, that can be used to explained flow through the catheter[2,10]. Equation states that steady flow rate(Q) in a rigid tube is directly related to the fourth power of inner radius (r^4)of the tube and is inversely related to the length of the tube(L) and the viscosity of the fluid .

$Q= \Pi r 4(P1 – P2) /8\eta L$

Where Q= flow of liquid

r= radius of the tubing

P1 – P2 = pressure gradient across the tubing

Ƞ (eta) = viscosity

L= length of the tubing

When rapid volume infusion is necessary, shortest available large-bore catheter is the optimal choice.

Common catheter designs

Peripheral vascular catheters are used to cannulate peripheral blood vessels are

typically 16-20gauge catheters that are 1-2 inches in length. The catheter fits snugly over the needle and has tapered end to prevent fraying of the catheter tip. The needle has a clear hub to visualize the flashback of blood that occurs when tip of the needle enters lumen of blood vessel. Once flashback is evident, catheter is advanced over the needle and inside into the lumen of the blood vessel.

Central venous catheters are available in 4 to 9 French sizes, length of 15 to 30cm and have single or multiple infusion channels.7 French size triple lumen is a popular choice in adults typically have one 16G channel and two smaller 18G channels. Shortest 16 cm catheters are intended for right sided and 20cm is long enough for left sided cannulations. In multiple lumen catheters, each lumen must be treated as a separate catheter. Catheters are available with antimicrobial coatings and are radio opaque to confirm tip placement.

ACUTE COMPLICATIONS

1. Due to cardiac irritation by the guide wire or catheter tip.

   - Withdraw the wire passing into the superior vena cava.
   - Always use a cardiac monitor.

2. Haematoma formation – Arterial/Venous puncture

3. Mechanical injury to nearby structures

4.Pneumothorax/Haemothoarx

5.Atrial wall puncture - pericardial tamponade.

6 Air embolus

7.Malposition

8.Lost Guide-wire

CHRONIC COMPLICATIONS

1. Infections(Catheter related blood stream infections)
2. Catheter fragmentation
3. Non function/blockage-fibrin builds on and around the catheter and vessel ,drug precipitates ,lipid deposits.

4.Thrombosis/Thromboembolism

CAROTID ARTERY PUNCTURE

Occurs when carotid artery punctured with a probing needle ,the needle should be removed and pressure to be applied .In the event of catheter has been mistakenly placed in the carotid artery ,not to the remove catheter but to call for vascular surgeon help.

AIR EMBOLISM

Air entry into the venous circulation is an uncommon but potentially lethal complication caused by the movement of air into venous circulation created by pressure gradients by the negative intrathoracic pressure generated during spontaneous breathing and gravitational gradients between site entry and right atrium[12].

Presents with sudden onset of dyspnoea , distressing cough, hypotension and cardiac arrest.

Management

- Provide 100% O2
- Left lateral decubitus with head low Position (Durant maneuver and Trendelenburg position)
- Brace the Central Venous Catheter
- Direct removal of air from the venous circulation by aspiration from a central venous catheter in the right atrium may be attempted

PNEUMOTHORAX

Injury to parietal pleura during central line placement results in pneumothorax and pneumomediastinum most often related to subclavian catheter position[12]. It can be detected using auscultation, ultrasound at the insertion time and also detected on post insertion chest x-ray .Hemodynamic instability and hypoxia obviate the need for emergent chest tube placement.

CARDIAC TAMPONADE

Cardiac perforation is one of the serious complications of central venous catheterization from cardiac aperture of the right atrium. Presents with abrupt onset of dyspnoea can progress to collapse which needs immediate pericardiocentesis to relieve tamponade[2,12].

CLABSI (catheter related bloodstream infections)

- Patient has indwelling vascular catheter for more than 48 hours, developing

  Fever (>100.4 °F) or Hypothermia (< 97.70F) with one of the following:
- Positive blood culture, both peripheral venous blood sample and sample drawn through the vascular catheter growing the same organism or

- Both peripheral venous blood sample and the catheter tip growing the same organism, or
- Common skin contaminant (e.g., diphtherias, Bacillus sp., coagulase-negative staphylococci, or micrococci) is cultured from two or more blood cultures drawn on separate occasions .

PERIPHERAL VEIN INSERTION COMPLICATION

PHLEBITIS SCORE

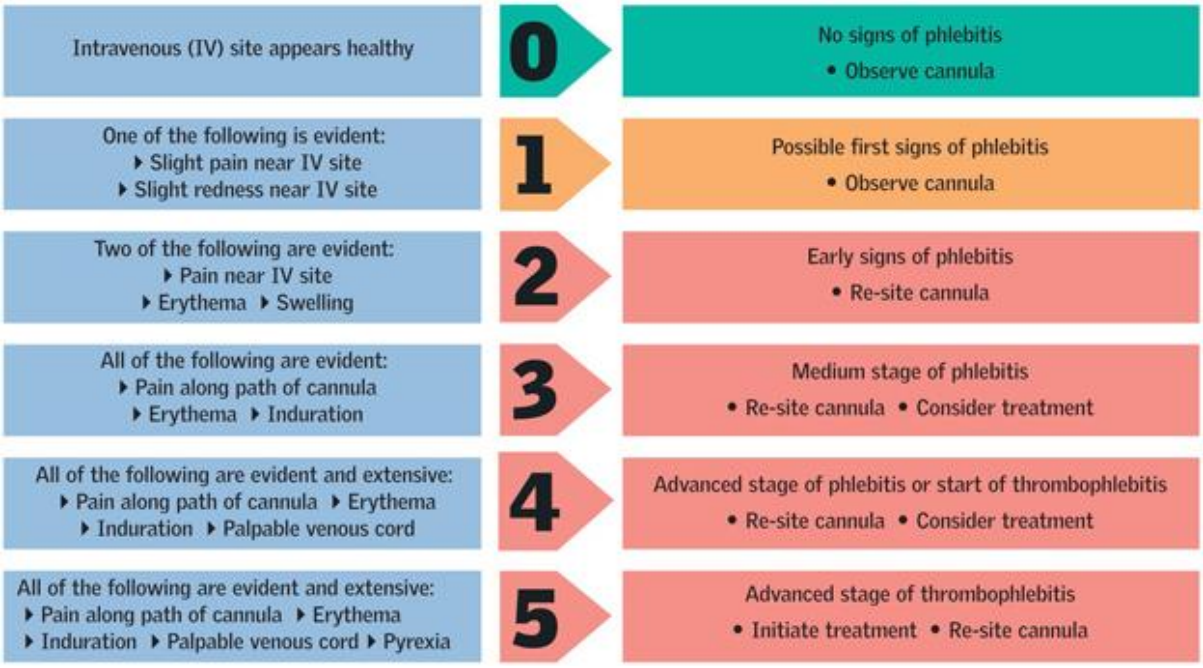


FIG 10- PHLEIBITIS SCORE

PHYSIOLOGICAL PRINCIPLE

- A clinical measure of right ventricular filling pressure is the central venous pressure which has been popularized as hemodynamic measure because of Frank-starling determinant of cardiac stroke output.
- The **Frank–Starling law** of the heart represents the relationship between stroke volume and volume. The law states that the stroke volume of the heart increases in response to an increase in the volume of blood in the ventricles, before contraction when all other factors remain constant.
- The main value of observing central venous pressures lies in their ability to approximate or trend in conjugation with LVEDV because LVEDP predicts LVEDV through Frank –starling Law[10].
- CVP is essentially equivalent to right atrial pressure and serve as reflection of right ventricular preload[13]. The output of right ventricle and output of left ventricle must be approximately same in structurally normal cardiopulmonary system[14]. So RVEDP and LVEDP correlate quiet well and can be alternated as a guideline for monitoring LV preload during fluid therapy[15,10].

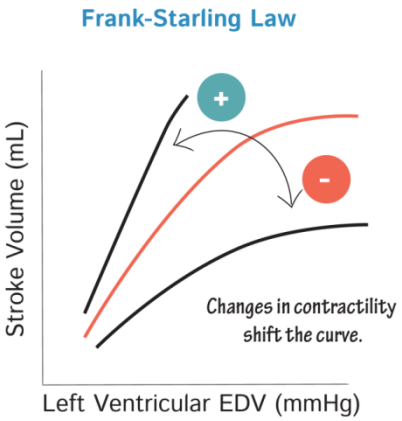


FIG 11- FRANK -STARLING LAW

CENTRAL VENOUS PRESSURE MEASUREMENT USING A WATER MANOMETER

To measure CVP using a water manometer, the following materials are recommended

- Central venous catheter
- Water manometer
- 30-inch IV extension set
- Three-way stopcock
- Measurement scale
- Sterile bag of fluids

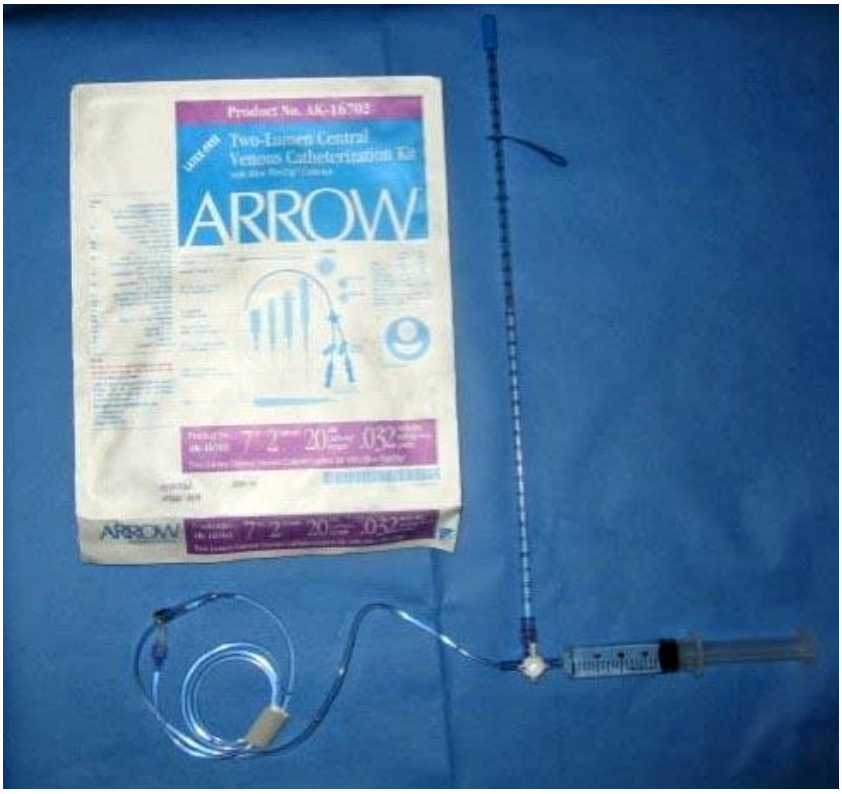


FIG 12-SUPPLIES NEEDED FOR WATER MANOMETER

- Once the patient is placed in the desired position and the catheter is appropriately positioned, connect the water manometer in series with the fluid bag and central venous catheter. With the stopcock turned "off" towards the manometer, the fluid line has to be primed and the extension set with fluid to remove any air bubbles. The patency of the catheter is assessed by allowing fluid from saline bag to flow freely into the catheter. If a multilumen central catheter is used, infusions of fluids through other lumens should be discontinued before obtaining a CVP reading, as they may artificially increase the measurement.

- Before CVP can be measured with a water manometer, identify the zero point on the manometer that corresponds to the patient's right atrium.
- The **zero reference point** for venous pressures in the thorax in a point on the external thorax where the fourth intercostal space intersects the mid -axillary line (the line midway between the anterior and posterior axillary folds)[2,10].
- This **point(phlebostatic axis)** corresponds to the site of the right and left atrium when the patient is in supine position
- To obtain a measurement, fill the manometer with saline significantly till 25. Turn the three-way stopcock so that the column of saline in the manometer is continuous with the central catheter and the stopcock is "off" to the saline bag . The saline in the manometer will decrease till the water pressure in the column equilibrates with the hydrostatic pressure of the blood at the point of the central catheter. Once the saline in the manometer stops falling, it has reached the equilibrium point, which reflects the blood pressure inside the vessel at the head of the catheter tip. The measurement is expressed in cmH2O[16].

- The pressure recorded within the cannula is the intravascular pressure whereas the difference between intravascular and extra vascular pressure is transmural pressure.
- The intravascular pressure is an accurate reflection of the transmural pressure only when the extra vascular pressure is Zero. At the end of expiration when intrathoracic pressure (extra vascular pressure) returns to atmospheric or zero pressure[17]. Therefore intravascular pressure should be measured at the end of expiration.
- In patient on mechanical ventilation ,when external PEEP is applied ,intravascular pressure should be measured at end-expiration when the patient is briefly disconnected from the ventilator.

FACTORS INFLUENCING CENTRAL VENOUS PRESSURE MEASUREMENT

Technical factors

- Patient positioning
- Leveling to phlebostatic axis
- Inconsistent measurement technique with water manometer
- Improper central venous catheter placement
  - Against vessel wall
  - In heart

Physiologic factors

(Applied when pressure transducers are used to measured CVP)

- Changes in intrathoracic pressure
  - Respiration
  - PEEP during mechanical ventilation
- Changes in central venous blood volume
  - Total blood volume
  - Venous return/cardiac output
- Cardiac rhythm disturbances
  - Junctional rhythm
  - Atrial fibrillation
  - Atrioventricular dissociation
- Changes in right ventricular compliance
  - Myocardial stiffness
  - Pericardial disease
  - Cardiac tamponade
- Tricuspid valve disease
  - Tricuspid regurgitation
  - Tricuspid stenosis

Units of measurement

Water filled manometers that record pressure in cmH2O is used to measure CVP. Mercury is 13.6 times more dense than water, pressure measure in cmH20 can be divided by 1.36 is equal to pressure in mmhg[2,10].

REVIEW OF LITERATURE

Kumar D, Ahmed SM, Ali S, Ray U, Varshney A, Doley K in 2015 conducted a studied on 50 critically ill patients on mechanical ventilation.CVP and PVP measurements were taken using a water column manometer. The measurements were taken in the supine position and subsequently after a passive leg raise test of 45 degree. It was showed a fair agreement between CVP and PVP after a PLR of 45 degree when the CVP was>10cmH20.However the correlation was good when the CVP>10cmH20[3].

Arpitha D, Elizabeth, Varghese M studied on 60 critically ill patients in 2013 .CVP and PVP of patients were measured by simultaneously connecting CVP manometer in ICU to the central venous catheter and peripheral venous catheter 3 times a day at interval of 4hours. Their study revealed the association between CVP and PVP with r=0.84,p<0.0001 and has a clinically acceptable agreement. Peripheral system venous pressure monitoring is an easy practice and can be substituted to central venous pressure in establishing fluid volume status among critically ill patients[4].

Ajeet GV, Joseph L, Brian G, Anne SP, Jesse BH, John PK in 2006 studied among 35 patients in medical and surgical ICUs and included patients receiving mechanical ventilator assistance and spontaneously breathing patients, all of whom had pre-existing central venous catheter. To establish the usefulness of the EJV examination in detecting abnormal CVP values, they performed blinded evaluation comparing with CVP measured using an indwelling catheter in critically ill patients with central venous catheters .118 observations was noted down. The reliability for determining low and high CVP was excellent with area under curve of 0.95 and

0.97and conclude the EJV examination correlates well with catheter –measured CVP and is reliable means of identifying low and high CVP values[18].

Sunil R, Vishnu N, Lakshmi K in 2011 studied on 40 adult patients enduring surgical procedures lasting for more than 5 hour. The CVP and PVP were recorded simultaneously at a15 min interval until 4 hour intraoperatively ,followed by hourly during the postoperative period for 4 hour. They concluded that measurement of PVP can be regarded as a replacement to CVP monitoring when conditions are unfeasible for central venous catheterization[5].

Choi SJ, Gwak MS, Ko JS, Kim GS, Kim TH, Ahn H et al studied on 50 adult living donors' .General anesthesia was administered. A 2-lumen central venous catheter was placed in right internal jugular vein and an 18 G peripheral venous catheter was placed at the forearm or antecubital fossa in right arm. The pressure transducers were calibrated and zeroed separately at a level corresponding to the horizontal line extending from mid axillary line and the fourth intercostals space. Real time waveforms and numerical pressures were displayed on a monitor.CVP and PVP were determined. They concluded measurement of PVP in the arm can be a possible to estimate CVP and further obviate catheter related complications in living liver donors[19].

In study done by **Leonard AD, Allsager CM, Parker JL, Swami A, Thompson JP** in 2006 on 40 ASA grade 2 and 3 patients with proximal femoral neck fracture .Anaesthesia was induced with protocol and maintained with mixture of 66% nitrous oxide in oxygen and isoflurane 1-2%.LMA was placed after induction of anaesthesia

and spontaneous respiration maintained using a circle system. After induction of anaesthesia ,18G 150mm single lumen CVP catheter was sited via right IJV and a 20 G 51 mm cannula kept in the ipsilateral external jugular vein .Both catheters were transduced via a three way tap and a single transducer. In conclusion they suggested that EJVP is an acceptable estimate of CVP in the supine position[20].

In another study by **Munis JR, Bhatia S, Lozada LJ** in 2000 on 15 patients posted for neurosurgical procedures. General anesthesia was administered .Central venous catheters were placed through either left or right internal jugular vein approach. Peripheral IV catheters were placed from dorsal hand or distal forearm veins. After flushing and room air zero calibration ,the transducer sets were mechanically flushed with saline and also maintained at midthorax level throughout surgery. Real time waveforms were displayed throughout the case for both CVP and PVP and numerical pressure values were retained. Along with the observation of a strong interdependence between PVP trends and CVP trends in both craniotomy and complex spine surgery, PVP appears to warrant further their analysis as a clinical volume monitor[6].

Rajeev DS, Sheela V studied on 25 cases posted for neurosurgical patients during 2013.18 G IV cannula in right upper limb and 18 G central venous catheter was cannulated to right subclavian vein. The three way with venous extension in line with the central venous catheter , and thereby connected to the pressure transducer which was zeroed at the level of right atrium. Zeroing of the catheters was done.CVP and PVP were recorded immediately after their placement and recorded as at zero minute.CVP and PVP were simultaneously measured at 15 minutes interval. Concluded that there was an association between CVP and PVP and PVP can be used

to anticipate CVP as an easier surrogate measurement for the assessment of right heart filling pressure and also for guidance of fluid therapy in neurosurgical patients[21].

Desjardins R, Denault AY, Bélisle S, Carrier M, Babin D, Lévesque S et al in 2000 has done study on 20 patients undergoing an elective cardiac surgical procedure under cardiopulmonary bypass. Patients were premeditated and sedated with midazolam at1-2 mg IV during insertion of 15cm triple lumen catheter .PVP was monitored through 32 mm 16G catheter inserted in a vein of the antecubital fossa and catheter was attached to a Y-connector . One arm was connected to low compliance tubing to a pressure transducer. Display monitor measures PVP using built in algorithm which calculates mean pressure[22].

Study done in 2005 by **Hadimioglu N, Ertug Z, Yegin A, Sanli S, Gurkan A, Demirbas A** on 30 consecutive kidney recipients ,peripheral IV catheters were placed in dorsal hand. Central venous catheters 7F, 3 lumen were placed through a right internal jugular approach.The pressure tubing of the transducer system were connected to the distal lumen of the central venous catheter or to a peripheral catheter.CVP and PVP were measured simultaneously before and after the induction of positive pressure ventilation, immediately following induction of anaesthesia,1 hour after induction, at reperfusion of the kidney, at the end of operation.HR,MAP,mean CVP, and mean PVP determined at end-expiration. They concluded in a population of 30 patients undergoing kidney transplantation PVP values manifested a high magnitude of agreement with CVP and hence PVP monitoring may be a rapid,non invasive tool for physicians to use to assess volume status in patients without significant cardiac dysfunction[23].

Bombardieri AM, Beckman J, Shaw P, Girardi FP, Ma Y, Memtsoudis SG did a prospective observational study during 2010 on 35 patients undergoing spine surgery. 18G peripheral catheter in the forearm or hand and a central catheter into the internal jugular vein were placed. Both continuous flush transducers were zeroed in the prone position at the level of the phlebostatic axis .Real time transducer data were displayed on a monitor .CVP and PVP values were collected simultaneously and recorded at 5 min intervals throughout surgery and in the recovery room. Concluded with there was limited correlation between PVP and post and CVP in the prone position during surgery and postoperatively in the recovery room[24].

Radhakrishna N, Singh S, Sharma S, Bajaj V, Taank P did a study during Jan 2015 to Feb 2016 on 60 patients between 20 to 80 years of age during surgery .After anesthetic induction followed by tracheal intubation, central venous access was obtained by using 7F or 7.5 F double or triple lumen catheter with placement through internal jugular or subclavian vein.Peipheral venous access was obtained by placing standard intravenous catheter (16 or 18G) in the ante -cubital vein in cubital fossa. The pressure transducers were all calibrated at the mid thoracic level at the point of intersection between mid axillary line and the fourth intercostals space and connected to penlon anaesthesia work station. Both transducers were brought to this same line and zeroed separately[25] .

Tugrul M, Camci E, Pembeci K, Al-Darsani A, Telci in 2004 did a prospective study on 500 patients on ASA 1-4 patients undergoing surgical procedures under surgical procedures were included.16 G or 18 G peripheral over the needle intravenous catheters were used placed on dorsal veins or forearm veins. Central venous catheters

were introduced after induction of anaesthesia via internal jugular or subclavian vein. Pressure tubing of the introducer system was attached to the distal lumen of the central venous catheter or to the peripheral catheter. Transducers were zeroed at midchest level before each measurement. Measurements were performed at end expiration, mean pressure values of peripheral and central veins were recorded. They conclude that the relationships between 2 methods of venous pressure measurement cannot be denied and is manifested by slightly higher peripheral pressures independent of size, insertion site and patient position[26].

Charalambous C, Barker TA, Zipitis CS, Siddique I, Swindell R, Jackson R, Benson J conducted a prospective study in 2003 to determine the relationship between central (CVP) and peripheral (PVP) venous pressures 20 critically ill patients in the intensive care unit. CVP and PVP were measured on five different occasions. They conclude that PVP measurement does not give an accurate estimate of the absolute value of CVP in individual patients. However, as changes in PVP parallel, in direction, changes in CVP, serial measurements of PVP may have a value in determining volume status and guiding fluid therapy in critically ill patients[27].

Kim SH, Park SY, Cui J did a investigation from 2009-2010 on 46 patients undertaking elective laparoscopic colorectal surgery .A 7 Fr triple lumen central venous catheter was inserted via the right internal jugular vein and a 22G cannula inserted in either vein of dorsum of hand or forearm. All catheters were connected to a continuous pressure monitoring kit. The transducer was zero at the level of right atrium ,4cm below the fourth intercostal space.

The CVP and PVP measurements were recorded simultaneously during end-

expiratory phase .The venous pressure measurements pairs were analyzed for correlation, and the bland Altman plots of repeated measures were used to evaluate. Concluded that PVP exhibit a strong correlation and agreement with CVP under increased intrathoracic pressure of pneumoperitoneum in trendelenburg position and can be used as an alternative to CVP. All patients were given 500 ml of crystalloid at the start of the surgery as preload .Measurements of the venous pressure from the central and peripheral catheters were performed before and after 5 minutes of completion of preload and every 15 min thereafter during entire surgical procedure .All recordings were noted at end expiration. They observed that, if that CVP-PVP difference is known,PVP monitoring can be used to compute hemodynamic changes caused by changes in intravascular volume .

Measurements were taken several periods following induction of anaesthesia, fluid challenge, application of PEEP, administration of NTG.They concluded that PVP can accurately estimate CVP in cardiac surgical patients under awake or Positive pressure ventilation, under general anaesthesia, PEEP and the administration of vasodialating drugs[28].

In Study done by **Abdullah MH,Soliman Hel D,Morad WS** in 2011 on 40 living liver donors during 2000,central venous catheter was placed along right internal jugular vein via ultrasound guidance and 16G i.v venous catheter was inserted at the external jugular vein and attached to the same type of tubing and the pressure transducer as central venous pressure. Real time waveforms and numeric pressure values were displayed on a monitor via 2 separate channels and measurements were of venous pressure were taken after induction and 15 minutes thereafter. They concluded that CVP catheter placement can be avoided and replaced by a less invasive method

such as EJVP in living donor liver transplant and allowed equivalent monitor even during fluid restriction phases[29].

A study done by **Sperry BW, Campbell J, Yanavitski M, Kapadia S, Tang WHW, Hanna M** conducted study between 2014 and 2015 who were admitted with an acute heart failure syndrome .Peripheral venous access was obtained using 18 G in upper extremity and internal jugular central venous access was obtained.CVP and PCWP were measured at end expiration using standard pressure transducers after being zeroed at phlebostatic axis.PVP then measured immediately by the connecting the pressure line of transducer to the peripheral iv line and transducer remained zero at phleboststic axis. They concluded in patients with acute heart failure syndromes, assessment of PVP demonstrates high correlation with CVP.So PVP may be helpful in the standard bedside clinical assessment of volume status in these patients to help guide decongestive therapy[30].

MATERIAL AND METHODS:

STUDY DESIGN

This is a prospective observational study

SOURCE OF DATA:

Fifty four patients received to R L Jalappa Hospital, Intensive care unit with sepsis requiring fluid resuscitation from January 2018 to May 2019

METHOD OF COLLECTION OF DATA:

INCLUSION CRITERIA

Patients of above 18years of age with sepsis admitted in ICU requiring fluid resuscitation.

EXCLUSION CRITERIA

- Patients with h/o cardiovascular disease.
- Coagulopathy.
- Inability to cannulate central/peripheral vein.
- Infection at the site of cannulation

SAMPLING PROCEDURE:

Our study was conducted on 54 patients of either sexes of above 18 years of age ,received to ICU with sepsis requiring fluid resuscitation from January 2018 to May 2019 after obtaining clearance from ethical committee from our institutional ethical committee . Study was started after obtaining written informed consent taken from patient or next of kin. Necessary investigations like complete blood count, bleeding

time and clotting time were done in all patients prior to cannulation to rule out coagulopathy. Under strict aseptic precautions, each of the Peripheral venous pressure, external jugular venous pressure and central venous pressure is measured simultaneously using water column manometer. Initially 10 observations were done under supervision before start of study. Peripheral venous pressure is measured from 16G or 18G vasofix sited in right/left cubital fossa, External jugular venous pressure measured from 16 or 18G vasofix sited in right/left external jugular vein and central venous pressure measured from16 G distal port of 7 French triple lumen central venous catheter of 15cm length sited in right/left internal jugular vein / subclavian vein. Water column manometers are connected to all the three catheters and zeroed at mid –axillary line corresponding to sternal angle. The zero point was identified on the manometer that corresponds to the patient's right atrium[2,10].zero reference point for venous pressures in the thorax in a point on the external thorax where the fourth intercstal space intersects the mid -axillary line(the line midway between the anterior and posterior axillary folds). When the patient is in supine position ,this point(phlebostatic axis) corresponds to the location of the right and left atrium Recordings of the measurements that corresponds with the lower meniscus of the normal saline was taken as reading for CVP ,PVP and EJVP. The measurement is ex-pressed in cmH2O.If the patient is on mechanical ventilation, we subtracted the PEEP value above 5cmH20 from the actual measurement of CVP value. Before fluid challenge peripheral venous pressure, external jugular venous pressure and central venous pressure are measured in all patients admitted with sepsis. All the three venous pressures are repeated 3 times following every fluid challenge of 200ml.

Following insertion of central line, patient was subjected for chest x-ray to rule out pneumothorax . After check x-ray ,we also checked the catheter tip position. Catheter

tip position should ideally above the level of carina. This is the joining of the right and left innominate veins with the superior vena cava(SVC). If the catheter tip is too high in position ,those values are associated with inaccurate values of CVP measured ,hence such values were not considered in our study. If the patient develops any arrhythmias 12 lead ECG would be recorded and arrhythmias will be analyzed .If there is doubtful of catheter related blood stream infection after 48 hours of following central venous cannulation, two blood cultures will be done .One sample taken from central line and another from peripheral site. Peripheral venous catheters were changed every 72 hours or earlier when the signs of phlebitis noticed according to institutional practice.

SAMPLE SIZE

Sample size was estimated based on correlation co –efficient between central venous pressure and peripheral venous pressure from the study by **Kumar et al**[3] at the baseline with 90% power, 99% C.I and Type 1 Error 1%. Calculated sample size of 53 was obtained **.**

SAMPLE SIZE ESTIMATION FORMULA

Calculated using n-Master

$$n=\frac{[Z_{1-\beta}+Z_{1-\alpha/2}]^2}{[r^2/1-r^2]}$$

n=Sample size

$Z_{1-\beta}$ =power=1.28

$Z_{1-\alpha/2}$ = confidence Interval=99%

r = correlation efficient=0.44

STATISTICAL ANALYSIS:

Statistical analysis will be done using SPSS Version 22 software. The representation of the categorical data will be it in the form of frequencies and proportions. Chi-square will be the test of significance [31] . The representation of all the quantitative data will be done by mean, standard deviation and confidence interval. Significance of difference in means between groups will be done by independent student t test[32]. Correlation co-efficient will be applied to study the relation between continuous variables It is said to be statistically significant when p value <0.05[31, 32].

In the present study ,descriptive and inferential statistical analysis has been carried out. Continuous measurements results are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%)Assessment of significance is at 5 % level of significance. The following assumptions on data are made.

Assumptions:

1. Dependent variables are normally distributed
2. Samples taken from the population should be random, Cases of the samples taken should be independent
3. To find the significance Student t test (two tailed, dependent) has been used to study parameters on continuous scale within each group.

To find the significance of study parameters Chi-square/ Fisher Exact test has been used on categorical scale between 2 or more groups, Non-parametric setting for Qualitative data analysis. When cell samples are very small, Fisher Exact test was used.

Pearson correlation between study variables is done to find the degree of relationship[30], Pearson correlation co-efficient ranging between -1 to 1, -1 being the perfect negative correlation, 0 is the no correlation and 1 means perfect Positive correlation.

The Bland–Altman method derives the mean difference between two methods of reading (the 'bias'), and 95% limits of agreement as the mean difference (2 SD) [or more precisely (1.96 SD)]. The better agreement is when there is small range between these two limits[30] .

Significant figures

+ Suggestive significance (P value: $0.05<P<0.10$)

* Moderately significant (P value:$0.01<P \leq 0.05$)

** Strongly significant (P value : $P \leq 0.01$)

Software for the Statistics: The software namely SPSS 22.0, and R environment ver.3.2.2 were used for the statistical analysis of the data and Microsoft word and Excel are used to produce graphs, tables etc[33].

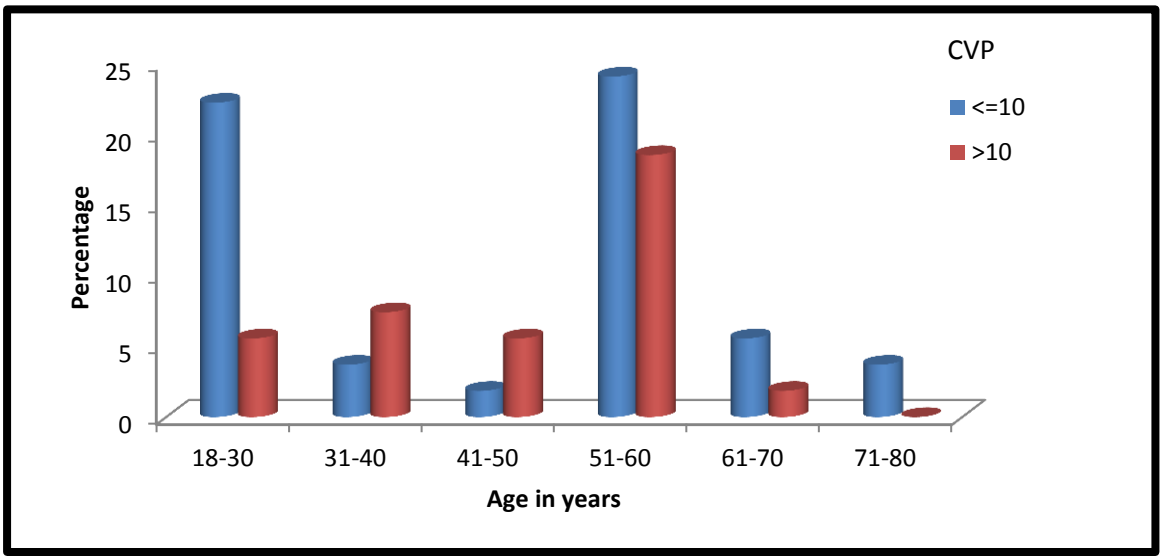
RESULTS

Table 1: **Age distribution of patients studied**

Age in years	Total	CVP	
		<=10	>10
18-30	15(27.78%)	12(22.22%)	3(5.56%)
31-40	6(11.11%)	2(3.7%)	4(7.41%)
41-50	4(7.41%)	1(1.85%)	3(5.56%)
51-60	23(42.59%)	13(24.07%)	10(18.52%)
61-70	4(7.41%)	3(5.56%)	1(1.85%)
71-80	2(3.7%)	2(3.7%)	0(0%)
Total	54(100%)	33(61.11%)	21(38.89%)

P=0.148, Not Significant, Fisher Exact Test

There was no significant association of mean CVP with demographic variable like age.



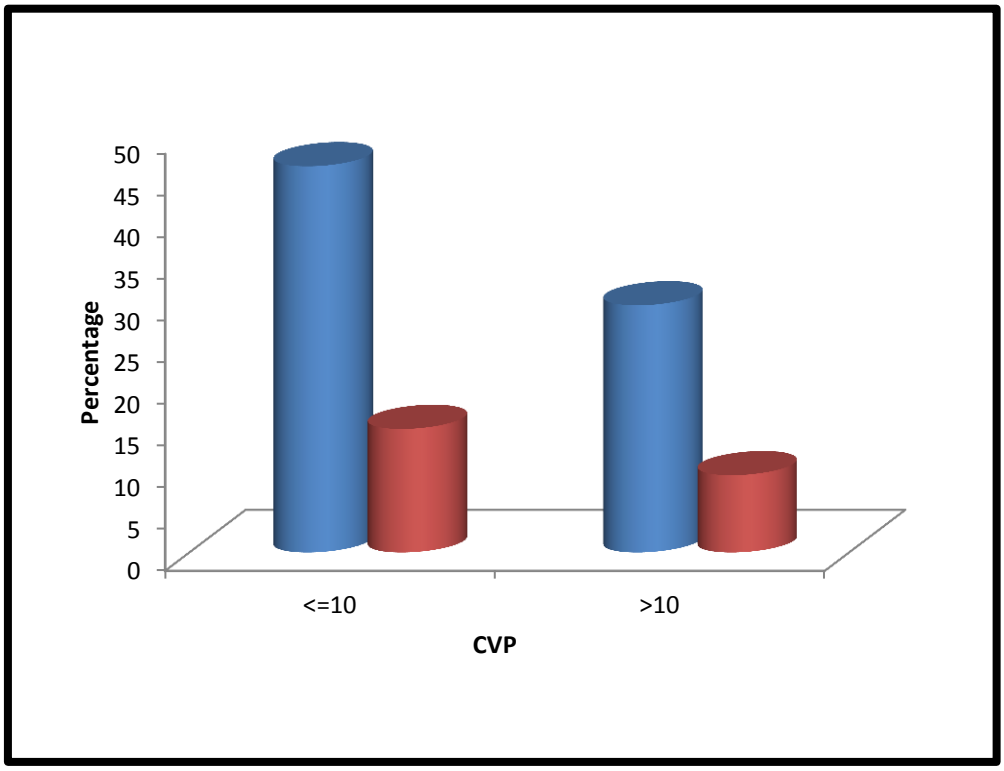
Graph 1: Bar diagram of age distribution

Table 2: Gender distribution of patients studied

Gender	Total	CVP	
		<=10	>10
Male	41(75.93%)	25(46.3%)	16(29.63%)
Female	13(24.07%)	8(14.81%)	5(9.26%)
Total	54(100%)	33(61.11%)	21(38.89%)

P=0.971, Not Significant, Chi-Square Test

In the study,41% of patients were male and 13% were female. There was no significant association of mean CVP with demographic variable with sex.

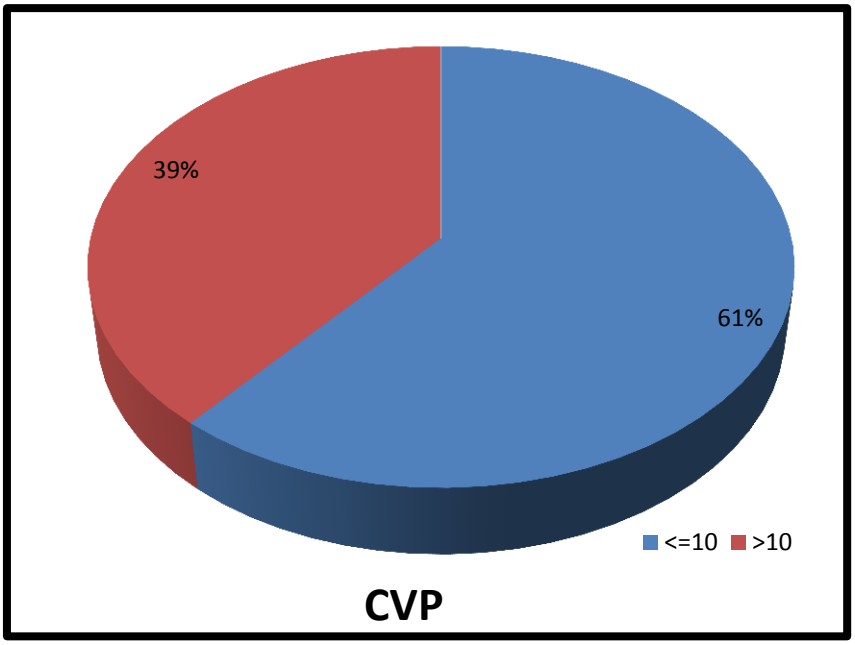


GRAPH 2: Bar diagram of gender distribution

Table 3:Distribution of CVP at baseline in patients studied

CVP	No. of patients	%
<=10	33	61.1
>10	21	38.9
Total	54	100.0

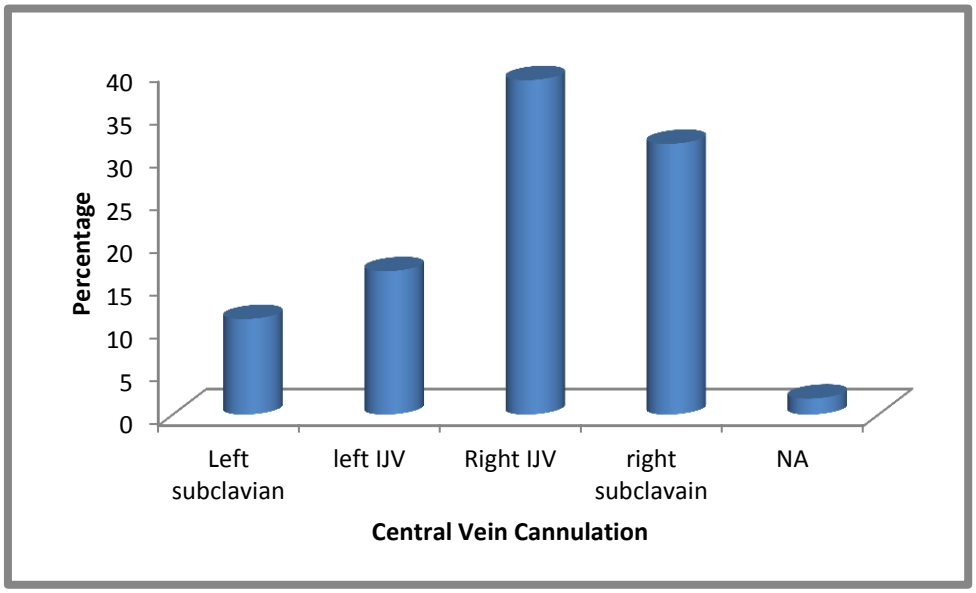
In the study, a total of 33 patients are in Group A(CVP<=10) and in Group B(>10) 21 patients are studied.



GRAPH 3 :Bar diagram of distribution of CVP at baseline in patients studied

Table 4: Central vein cannulation of patients studied

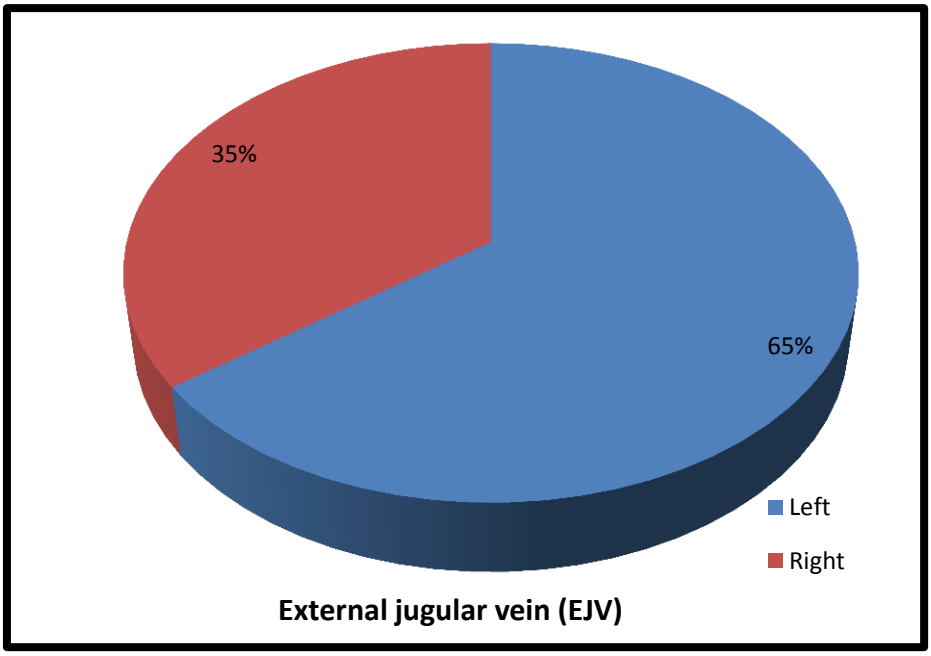
Central Vein Cannulation	No. of patients	%
Left subclavian	6	11.11
left IJV	9	16.67
Right IJV	21	38.89
right subclavain	17	31.48
NA	1	1.85
Total	54	100.00



GRAPH 4: Bar diagram of different sites of central vein cannulations

TABLE 5: EJV of patients studied

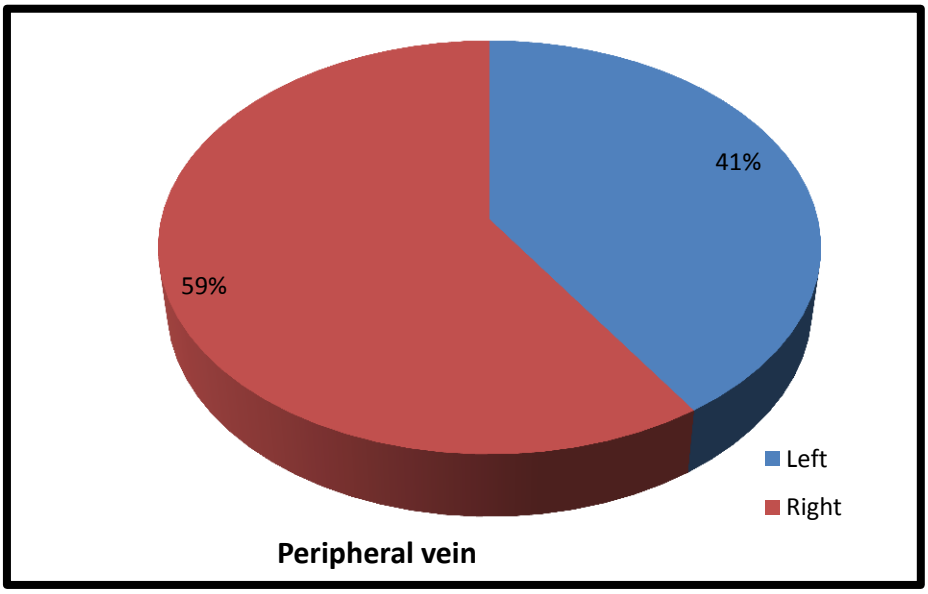
External jugular vein (EJV)	*No. of patients*	*%*
Left	35	64.9
Right	19	35.1
Total	54	100



GRAPH 5: Bar diagram of different sites of External jugular vein cannulations

TABLE 6: Peripheral vein of patients studied

Peripheral vein	*No. of patients*	*%*
Left	22	40.7
Right	32	59.3
Total	54	100

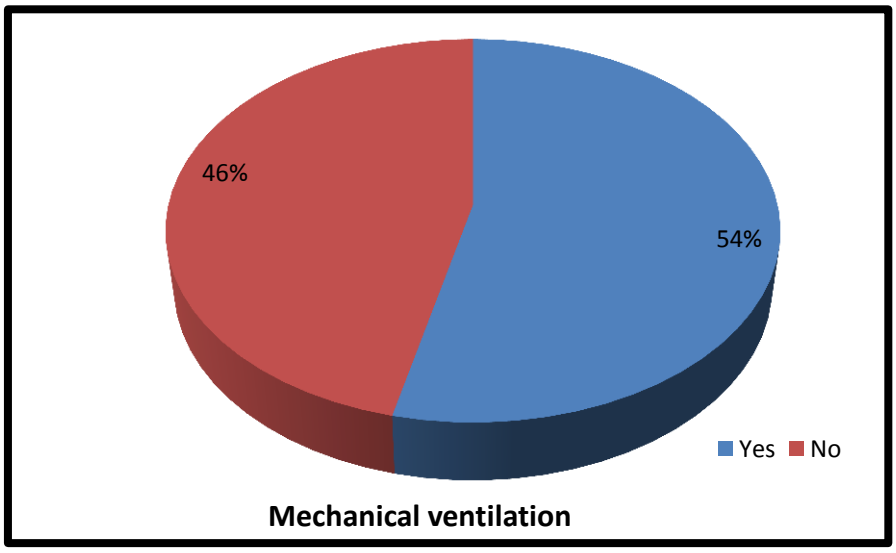


GRAPH 6: Bar diagram of different sites of Peripheral vein cannulations

TABLE 7: MECHANICAL VENTILATION AMONG PATIENTS STUDIED

Mechanical ventilation	*No. of patients*	*%*
Yes	29	53.70
No	25	46.30
Total	54	100.00

Out of 54 patients, 29 patients were on mechanical ventilation



GRAPH 7: Bar diagram of patients on mechanical ventilation

.

TABLE 8: Assessment of CVP in patients studied

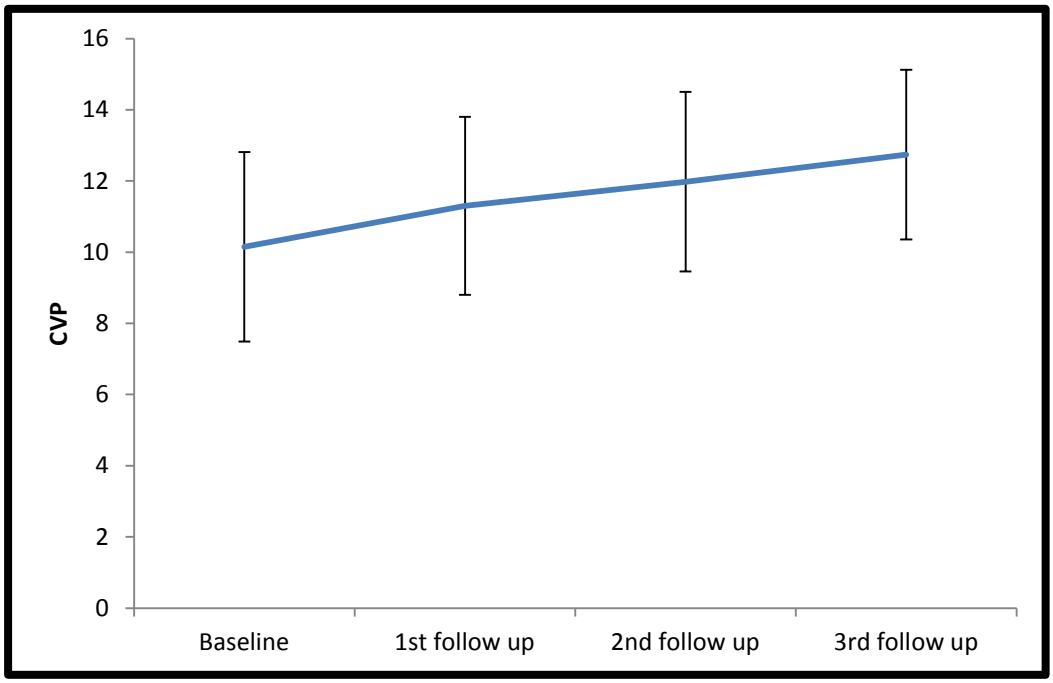
CVP	Min-max	Mean ±SD	Difference	T value	P value
Baseline	4.0-16.0	10.15±2.66	-	-	-
1st follow up	6.0-17.0	11.3±2.5	1.14815	11.862	<0.001**
2nd follow up	6.0-18.0	11.98±2.52	1.83333	13.165	<0.001**
3rd follow up	7.0-18.0	12.74±2.38	2.59259	16.229	<0.001**

Student t test (Two tailed test, independent)

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value: 0.01<P ≤ 0.05)

** Strongly significant (P value: P≤0.01)



GRAPH 8: Line diagram of CVP assessment among patients studied

TABLE 9: EJVP assessment of patients studied

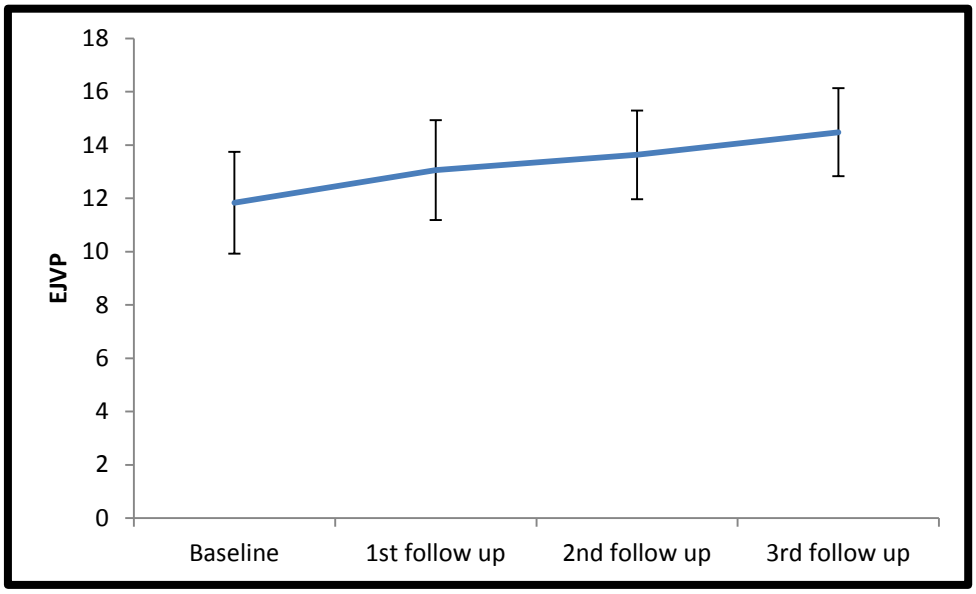
EJVP	Min-max	Mean ±SD	Difference	T value	P value
Baseline	7.0-16.0	11.83±1.91	-	-	-
1st follow up	9.0-18.0	13.06±1.87	1.18519	8.780	<0.001**
2nd follow up	10.0-18.0	13.63±1.66	1.74074	10.261	<0.001**
3rd follow up	11.0-19.0	14.48±1.65	2.42593	13.590	<0.001**

Student t test (Two tailed test, independent)

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value: 0.01<P ≤ 0.05)

** Strongly significant (P value: P≤0.01)



GRAPH 9: Line diagram of EJVP assessment among patients studied

TABLE 10: PVP assessment of patients studied

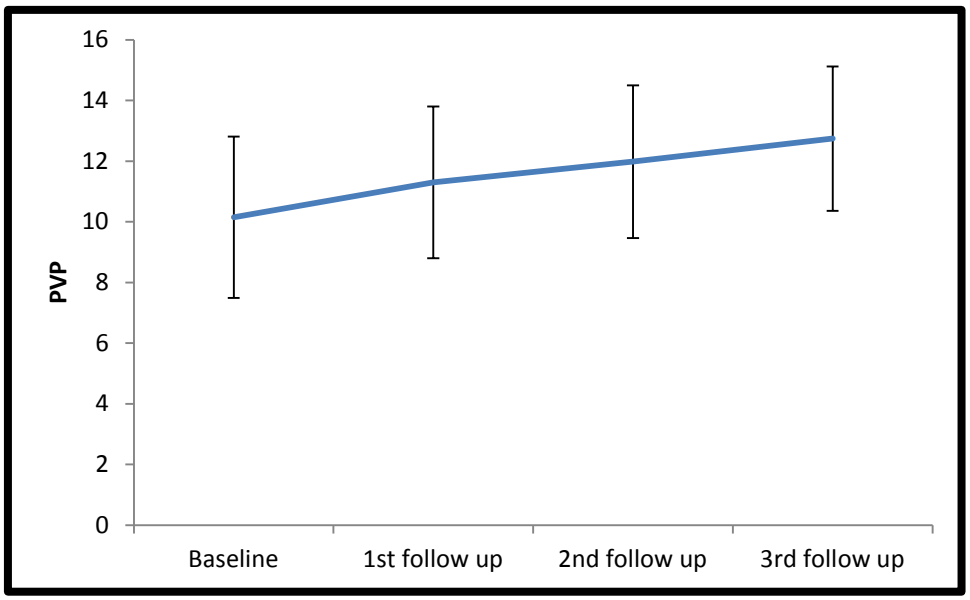
PVP	Min-max	Mean ±SD	Difference	T value	P value
Baseline	5.0-17.0	12.15±2.12	-	-	-
1st follow up	8.00-18.00	13.70±2.16	1.181	8.780	<0.001**
2nd follow up	8.00-19.00	14.26±2.13	1.740	10.261	<0.001**
3rd follow up	9.0-19.00	14.94±1.94	2.426	13.590	<0.001**

Student t test (Two tailed test, independent)

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value: 0.01<P ≤ 0.05)

** Strongly significant (P value: P≤0.01)



GRAPH 10: Line diagram of PVP assessment among patients studied

TABLE 11: Pearson correlation among CVP and EJVP

Pair (CVP vs EJVP)	**r value**	*P value*	*Mean*	
			CVP	*EJVP*
At baseline	0.673	<0.001**	10.15	11.83
At 1st follow up	0.675	<0.001**	11.29	13.05
At 2nd follow up	0.543	<0.001**	11.29	13.62
At 3rd follow up	0.611	<0.001**	12.74	14.48

Pearson correlation co-efficient ranges between -1 to 1

-1 - Perfect negative correlation,

0 - no correlation

1 -Perfect Positive correlation

The Pearson correlation was applied between CVP and EJVP at baseline and followed by three fluid boluses .Both were found to be positively correlated and it was highly significant

Significant figures

+ Suggestive significance (P value: $0.05<P<0.10$)

* Moderately significant (P value: $0.01<P \leq 0.05$)

** Strongly significant (P value: $P \leq 0.01$)

TABLE 12: BLAND ALTMNAN PLOT STATISTICS 0F CVP AND EJVP

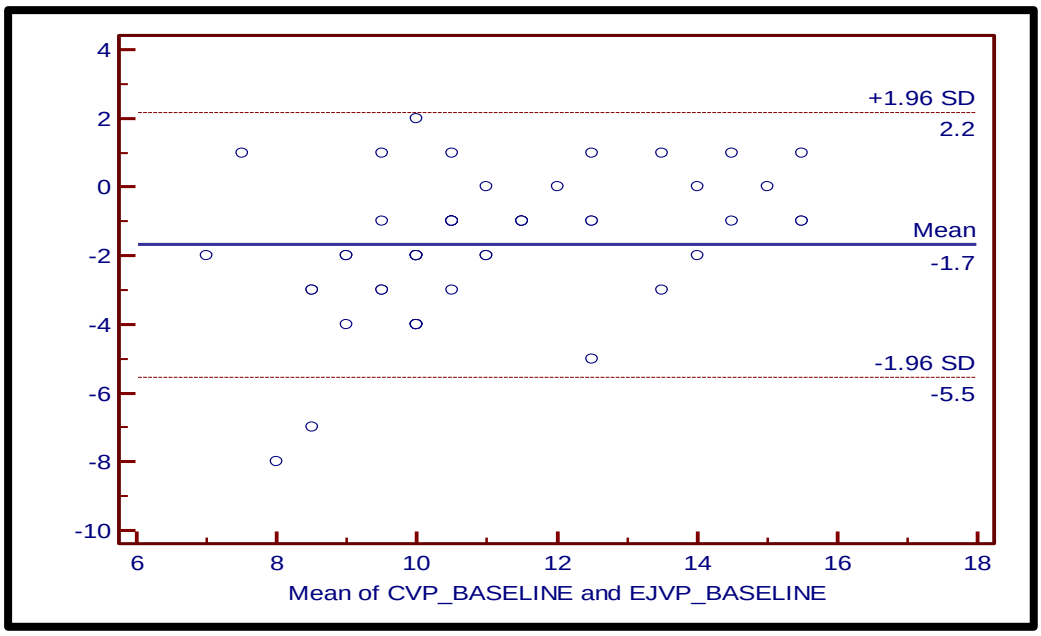
CVP vs EJVP				
	Baseline	**1st follow-up**	**2nd follow up**	**3rd follow up**
NO OF PATIENTS	54	54	54	54
Mean Difference	1.68	1.76	2.33	1.74
SD-diff	1.97	1.85	2.18	1.89
Mean diff-1.96SD	-5.5	-5.4	-6.6	-5.5
Mean Diff+1.96SD	2.2	1.9	1.9	2.0
T value	6.287	6.979	7.863	6.749
P value	<0.001**	<0.001**	<0.001**	<0.001**
95% CI	1.14-2.22	1.25-2.26	1.73-2.93	1.22-2.26

+ Suggestive significance (P value: 0.05<P<0.10)

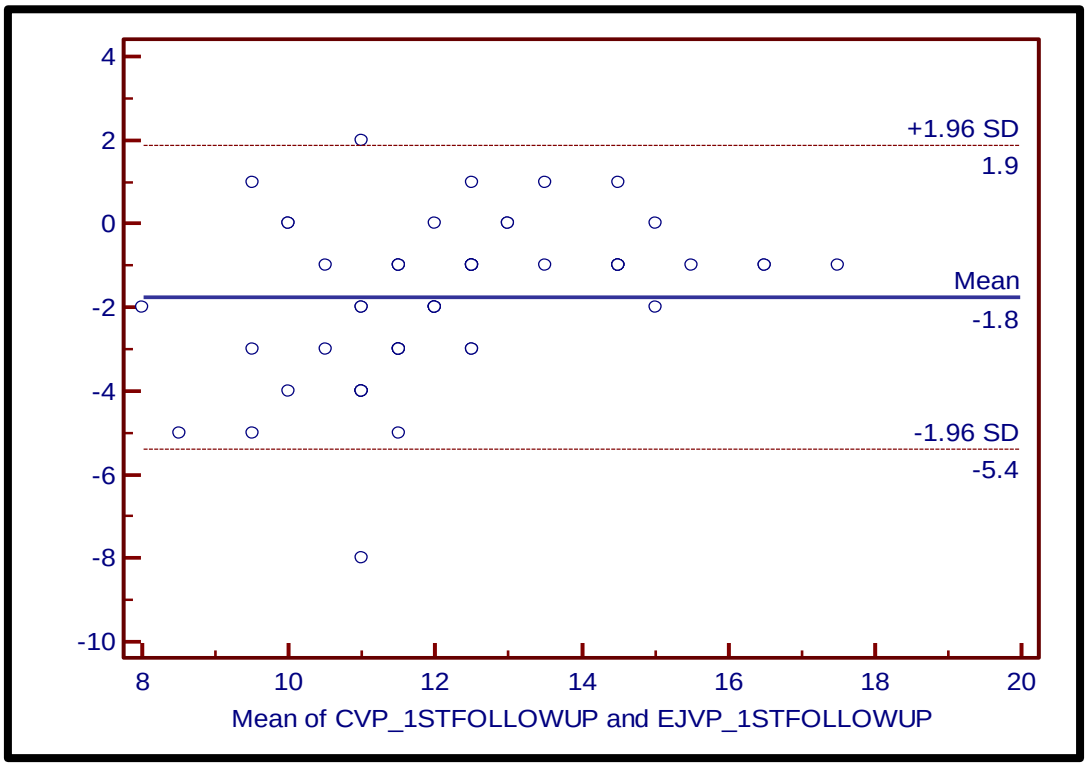
* Moderately significant (P value:0.01<P ≤ 0.05)

** Strongly significant (P value : P≤0.01)

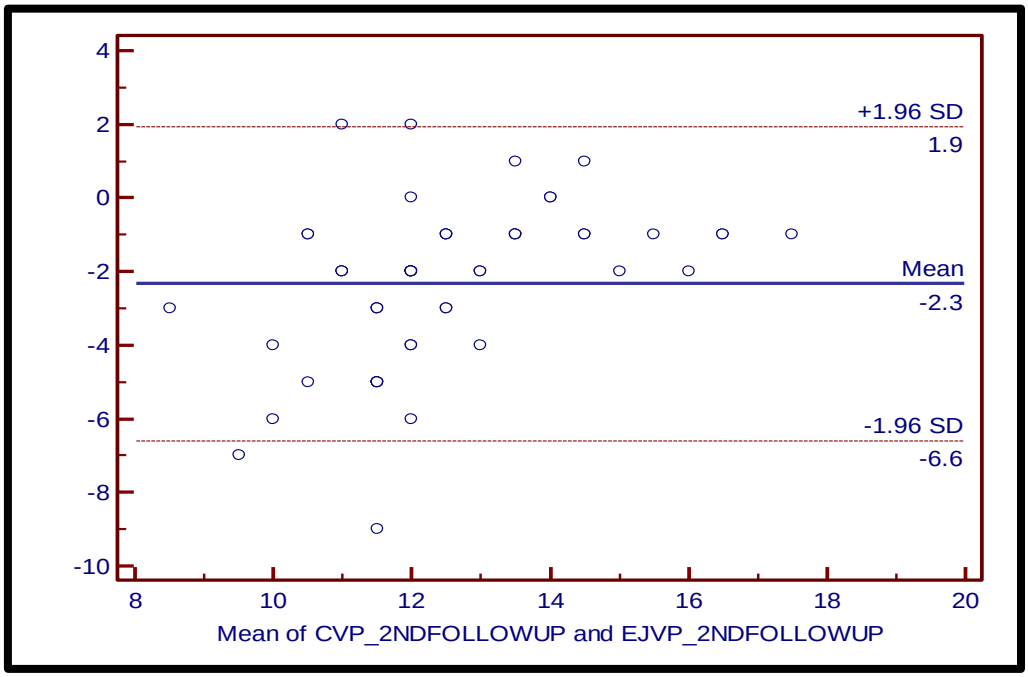
The **Bland–Altman** method calculates the mean difference between two methods of measurement (the 'bias'), and 95% **limits of agreement** as the mean difference (2 SD) [Precisely (1.96SD)]. The agreement_is better when the range is small between these two limits.



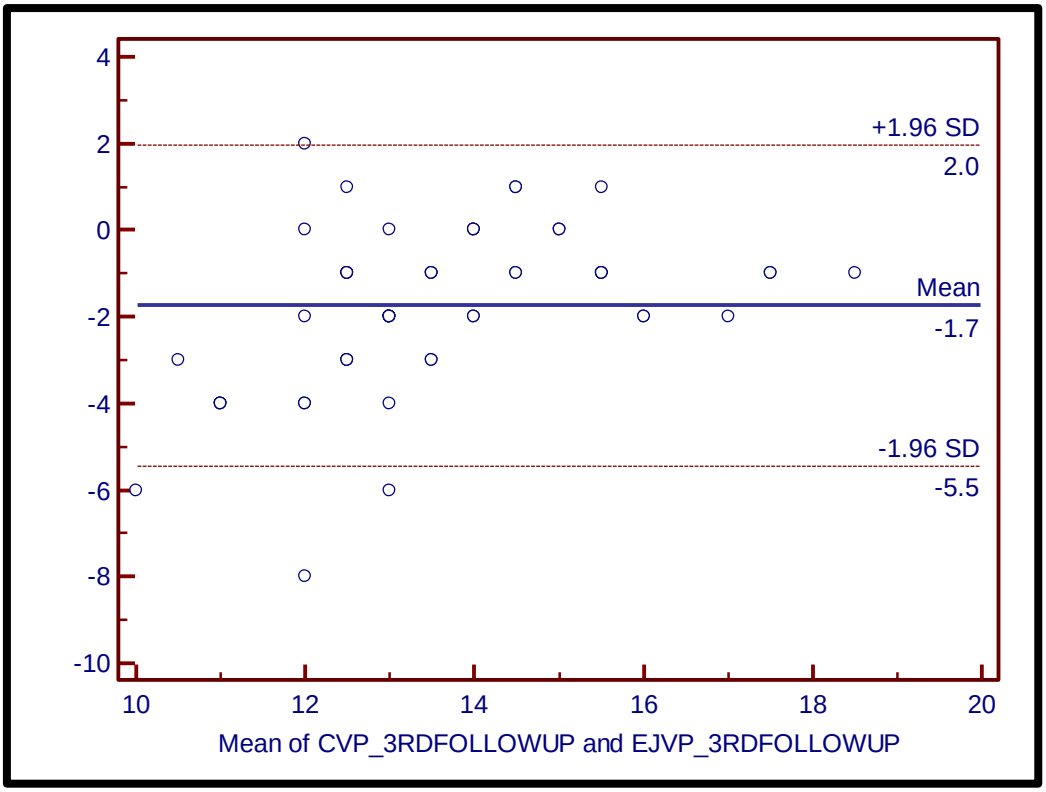
GRAPH 11: Bland and Altman plot linking CVP and EJVP at baseline



GRAPH 12: Bland and Altman plot linking CVP and EJVP at 1st follow up



GRAPH 13: Bland and Altman plot linking CVP and EJVP at 2nd follow up



GRAPH 14: Bland and Altman plot between CVP and EJVP at 3rd follow up

TABLE 13: Pearson correlation between CVP and PVP

Pair (CVP vs PVP)	**r value**	*P value*	*Mean*	
			CVP	***PVP***
At baseline	0.780	<0.001**	10.15	12.52
At 1st follow up	0.612	<0.001**	11.29	13.71
At 2nd follow up	0.554	<0.001**	11.29	14.26
At 3rd follow up	0.549	<0.001**	12.74	14.95

+ Suggestive significance (p value: 0.05<P<0.10)

* Moderately significant (p value: 0.01<P ≤ 0.05)

** Strongly significant (p value: P≤0.01)

The Pearson correlation was applied between CVP and PVP at baseline and followed by three fluid boluses .Both we found to be positively correlated and it was highly significant

TABLE 14: BLAND ALTMNAN PLOT STATISTICS OF CVP AND PVP

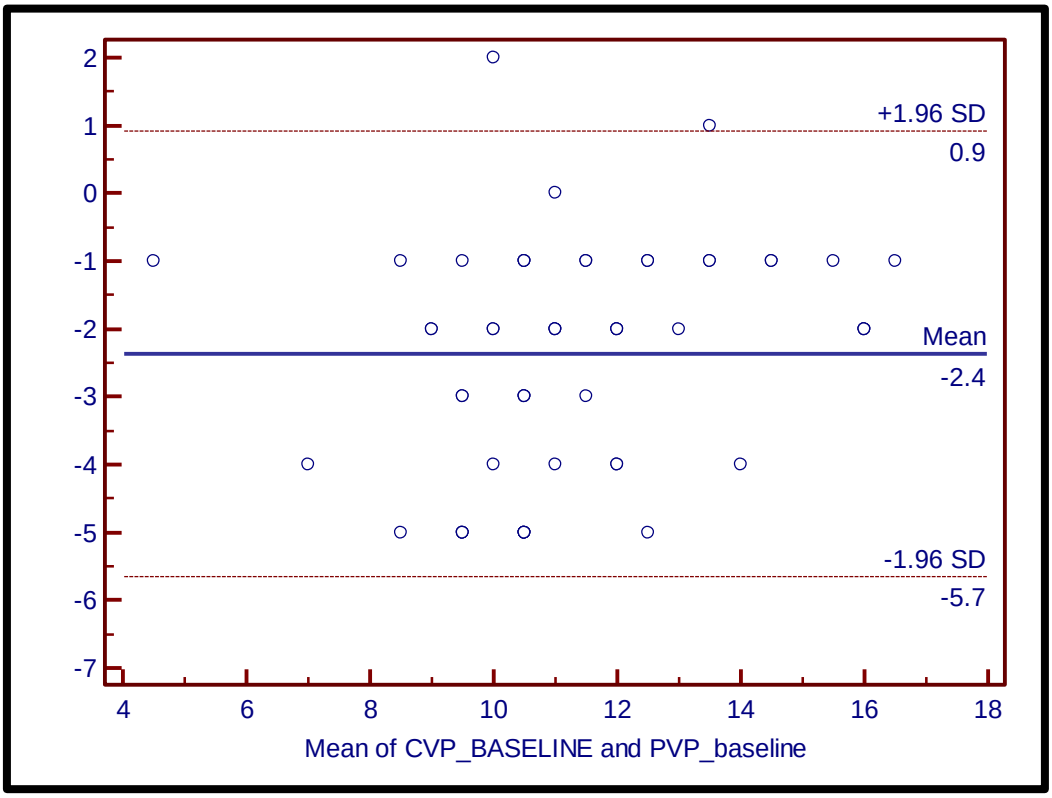
CVP vs PVP				
	Baseline	**1st follow-up**	**2nd follow up**	**3rd follow up**
NO OF PATIENTS	54	54	54	54
Mean Difference	2.37	2.40	12.50	2.20
SD-diff	1.67	2.07	2.09	2.08
Mean diff-1.96SD	-5.7	-6.5	-7.30	-6.30
Mean Diff+1.96SD	0.9	1.7	1.40	1.90
T value	10.403	8.510	43.762	7.76
P value	<0.001**	<0.001**	<0.001**	<0.001**
95% CI	1.91-2.82	1.84-2.97	11.93-13.07	1.63-2.77
Total	120			

+ Suggestive significance (P value: 0.05<P<0.10)

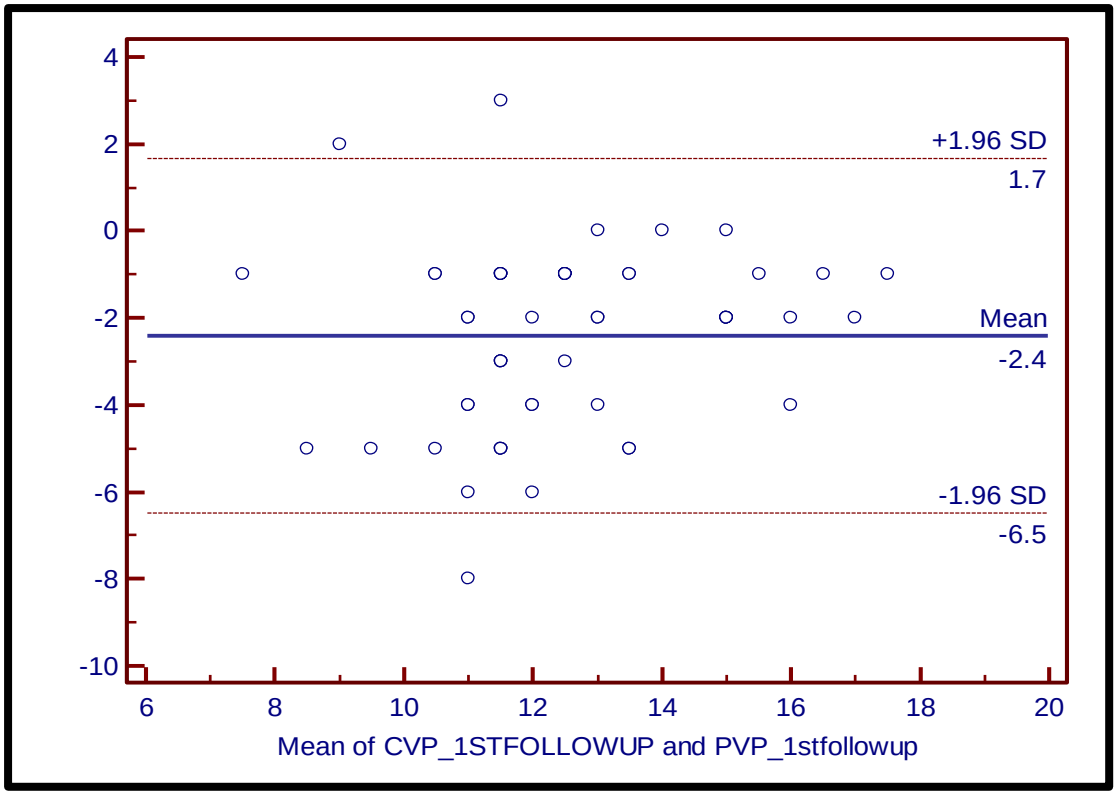
* Moderately significant (P value:0.01<P ≤ 0.05)

** Strongly significant (P value : P≤0.01)

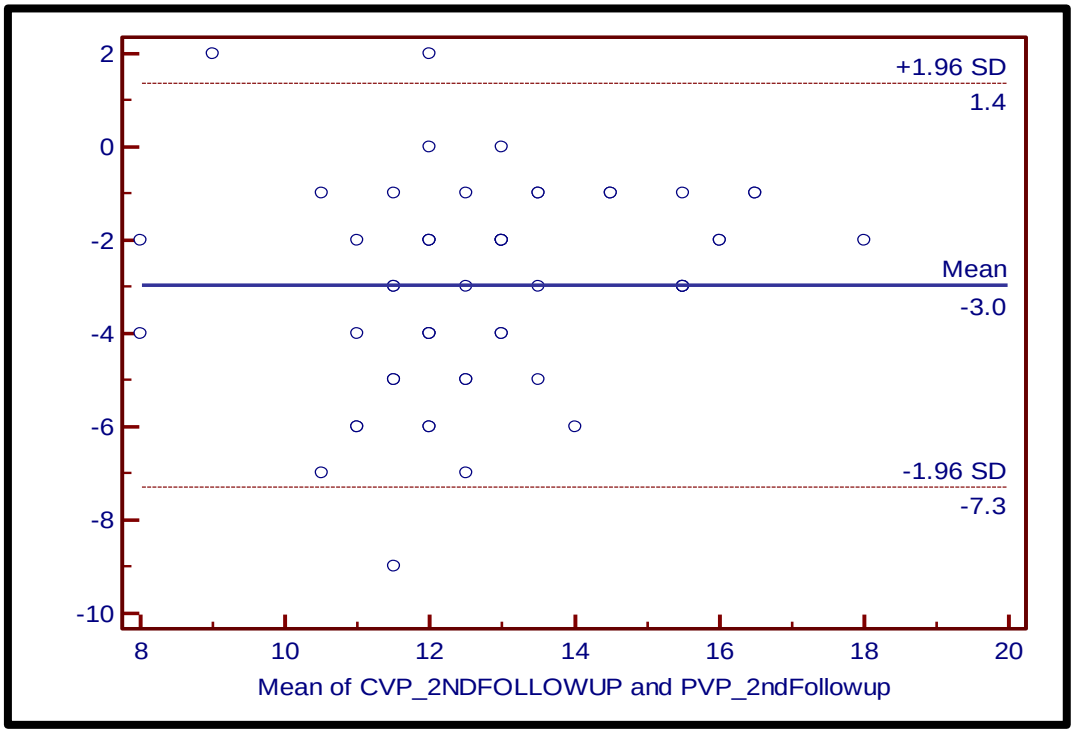
The **Bland–Altman** method calculates the mean difference between two methods of measurement (the 'bias'), and 95% **limits of agreement** as the mean difference (2 SD) [or precisely (1.96SD)]. The smaller the range between these two limits the betterthe agreement.



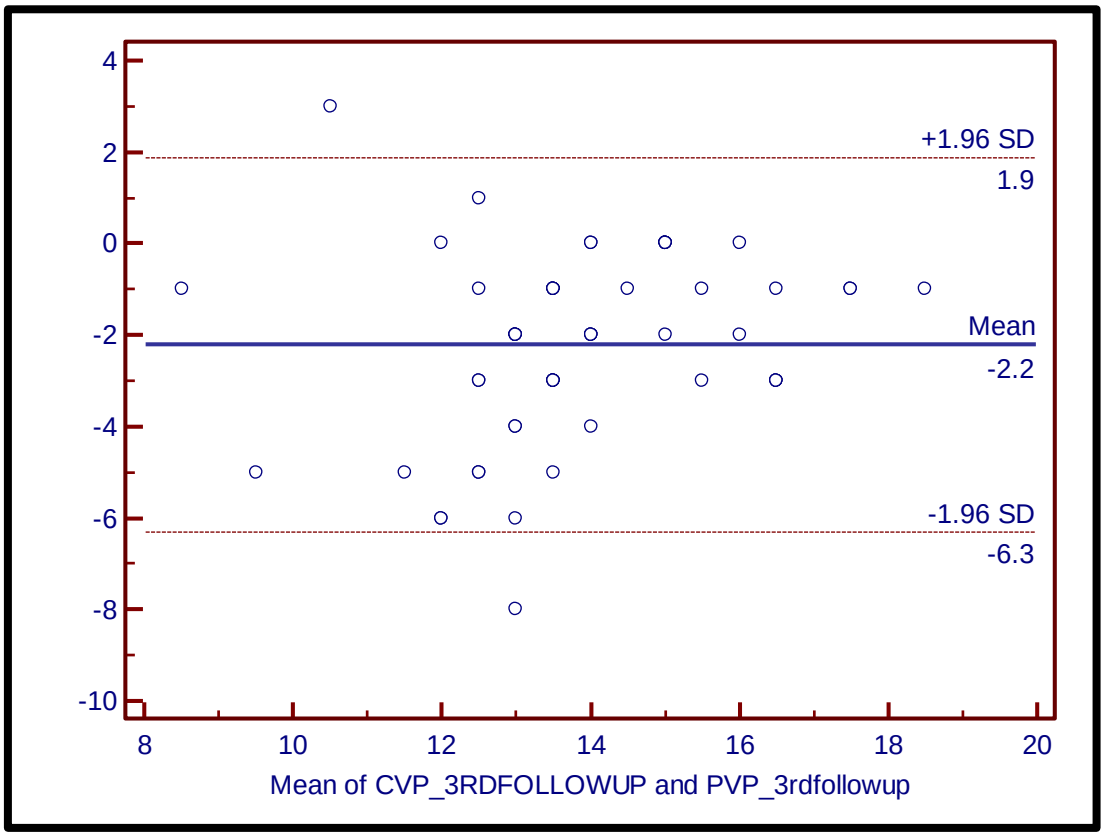
GRAPH 15: **Bland and Altman plot between CVP and PVP at baseline**



GRAPH 16: Bland and Altman plot between CVP and PVP at 1st follow up



GRAPH 17: **Bland and Altman plot between CVP and PVP at 2nd follow up**



GRAPH 18: **Bland and Altman plot between CVP and PVP at 3rd follow up**

TABLE 15: COMPARISON between CVP, PVP and EJVP in GROUP A (GROUP ≤10)

	N	MEAN	SD
CVP	24	7.88	1.27
EJVP	24	10.83	1.36
PVP	24	11.17	1.78

The overall mean CVP was 7.88cmH20 which was significantly lower than that of EJVP which was 10.83cmH20 and PVP which was 11.17cmH2O.

TABLE 16: Comparison between CVP, PVP and EJVP in GROUP B (GROUP >10)

	N	MEAN	SD
CVP	31	11.90	1.93
EJVP	31	12.58	1.96
PVP	31	13.52	2.06

The overall mean CVP was 11.90cmH20 which was lower than that of EJVP which was 12.58 cmH20 and PVP which was 13.52cmH2O.

TAB LE 17: Correlation between CVP and PVP, CVP and EJVP in Group A and GROUP B

Pair	*EJVP*		*Difference*	*PVP*		*Difference*
	r value	*p value*	**Of CVP & EJVP**	**r value**	*p value*	**Of CVP & PVP**
CVP ≤ 10						
• At baseline	0.504	<0.001**	2.67±1.71	0.137	0.448	3.12±1.49
• At 1st follow up	0.072	0.750	3.14±1.83	0.000	1.000	3.83±1.84
• At 2nd follow up	0.386	0.192	5.08±1.89	0.093	0.763	5.31±1.97
• At 3rd follow up	0.681	0.043*	4.78±1.56	0.179	0.644	5.22±1.86
CVP >10						
• At baseline	0.831	<0.001**	1.00±0.71	0.791	<0.001**	1.48±0.81
• At 1st follow up	0.685	<0.001**	1.19±0.74	0.801	<0.001**	1.75±1.29
• At 2nd follow up	0.646	<0.001**	1.75±1.01	0.709	<0.001**	2.41±1.43
• At 3rd follow up	0.637	<0.001**	1.40±0.96	0.732	<0.001**	1.78±1.33

+ Suggestive significance (P value: 0.05<P<0.10)

* Moderately significant (P value: 0.01<P ≤ 0.05)

** Strongly significant (P value: P≤0.01)

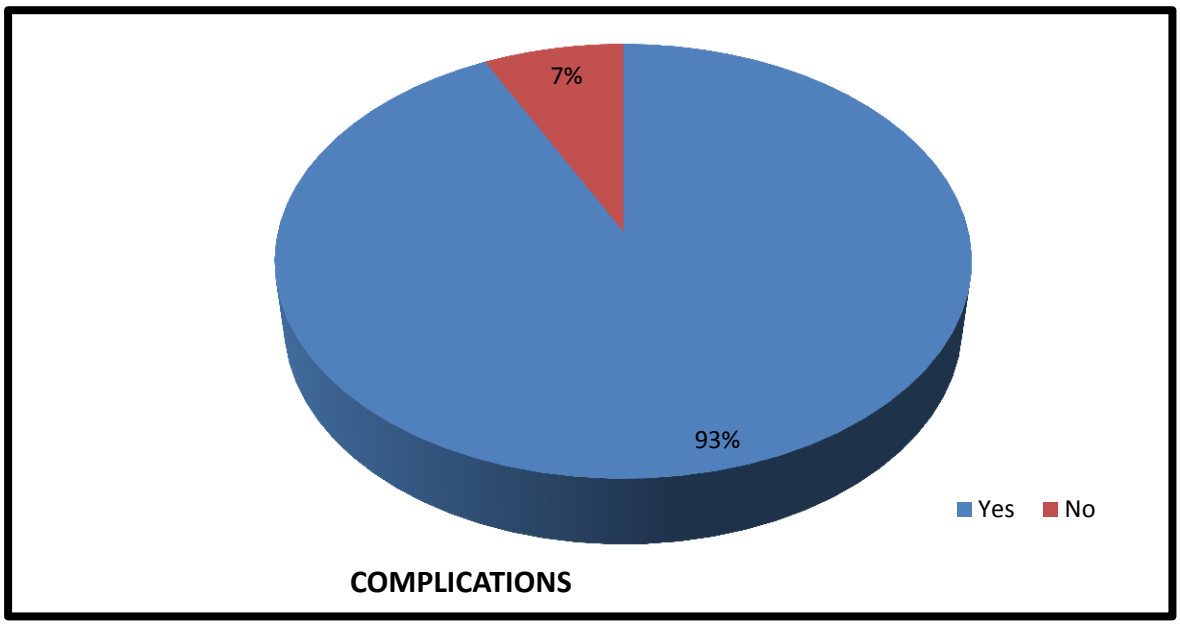
In Group A (CVP ≤ 10) mean difference between CVP with PVP and EJVP is >2cmH20 and p value is insignificant.

In Group B (CVP >10) mean difference between CVP with PVP and EJVP is <2cmH2O and p value is strongly significant and comparable.

TABLE 18: Complications of patients studied

COMPLICATIONS	*No. of patients* **(n=54)**	*%*
Yes	50	92.59
No	4	7.41
• arterial puncture	1	25.0
• Hematoma	1	25.0
• Phlebitis	2	50.0

Out of 54 patients, 2 patients developed peripheral line phlebitis, 1 person developed developed hematoma and the had arterial puncture



GRAPH 19: Bar diagram showing adverse effects

DISCUSSION

In hemodynamic ally unstable septic patients, it is important to optimize cardiac output and tissue oxygenation. Fluids remain the main line of treatment in patients with septic shock[34].

Not all patients are fluid responsive i.e. respond to fluid challenge by increasing stroke volume and cardiac output[35].

Both inadequate fluid and excessive fluid administration would result in increasing morbidity and death in critically ill patients[36]. Therefore accurate predictors of fluid responsiveness are essential for managing patients in septic shock.

For accurate prediction of fluid responsiveness ,we need to monitor other dynamic variables/parameters of fluid responsiveness such as systolic pressure variation, pulse pressure variation, stroke volume variation or echocardiographic measurement of stroke volume /cardiac output of left ventricle function or IVC (compressibility/distensibility index) variation during respiration for fluid challenge[37,38] which requires continuous arterial pressure monitoring, USG with cardiac probe and needs proficiency in using echocardiography.

Cardiac output and pulmonary artery occlusion pressure can also be measured by placing swan ganz catheter[39] and help the clinician for predicting volume responsiveness.

As the procedure is more invasive and many complications associated with pulmonary artery catheterization, the procedure is not recommended for routine use[17].

But in resource limited hospital, it would not be feasible to monitor the above mentioned parameters and would rely on CVP monitoring for guiding i.v fluids in septic patients[40].Therefore CVP still remains most routinely used parameter in

guiding septic patients for fluid resuscitation.

Main advantage of CVP is easy to measure, minimal instruments are required and it is cheap. Main drawback of measuring CVP to guide fluid resuscitation is its inability to predict a response to fluid challenge[41,37], even when the CVP is within acceptable range of 8-12cmH2O.Rather than isolated CVP value, trend of CVP measurement over time/change in response to fluid challenge may provide more reliable information regarding intravascular volume status[6].

As capillary blood flow depends on the gradient between mean arterial pressure (MAP) and central venous pressure(CVP) ,high CVP result in reduced capillary and organ blood flow.Infusing i,v fluids beyond CVP of 18 cmH2O would worsen cardiac function and impair venous return and capillary blood flow. Hence CVP would guide the clinician in optimizing fluid administration in a given patient[42].

Studies proven that a patient who is hypovoluemic with good LV function would increase CVP not more than 2mmhg and the CVP would return to baseline within 10 minutes and improvement of blood pressure for a fluid challenge of 200ml suggest the patient is fluid responsiveness.

Major obstacle for CVP measurement is the requirement for appropriate location of central line placement[43]. Nonetheless insertion of central line catheter is associated with serious complications such as venous air embolism , pneumothorax ,cardiac tamponade , arrhythmias, carotid artery puncture, perforation of right atrium, and CLABSI.Less invasive alternatives to the traditional measurement for assessing intravascular volume status have been described which includes measuring PVP and EJVP[44,45].

At present, most of the resource limited ICU's still rely on CVP monitoring using water column manometer for managing fluid resuscitation with sepsis patients[46,47]. In our study we measured EJVP, PVP and correlated pressures with CVP measured by conventional technique.

Kumar et al in 2015 studied on 50 critically ill patients on mechanical ventilation. Measurements were done between CVP and PVP using a water column manometer. The study arrived at a judgment of positive correlation between CVP and PVP with r=0.038, p=0.004 and Bland –Altman analysis showed 95% Limits of agreement to be -3.180 -11.350, whereas in patients with CVP>10 cmH2O, the correlation was better with PVP r=0.766, p<0.0001 and Bland-Altman analysis showed 95%Limits of agreement to be 95% LOA to be -1.254-5.540[3]

Munis et al concluded that the trends of PVP were parallel to the trends of CVP and that their relationship was independent of the patients. Between CVP and PVP, Analysis of variance indicated a significant relationship with p<0.001 with Pearson coefficient of 0.82[6].

Abdullah et al did a prospective study which showed that EJVP and CVP recordings were parallel and also showed strong correlation with mean difference of <2mmhg[29].

Leonard et al concluded that EJVP was an acceptable estimate of CVP with mean difference of –0.3 mmhg in supine position and also concluded that though agreement was poor in lateral position but was stronger for trend rather than absolute values[20].

Our present study was done on 54 patients , all of the study subjects were analyzed. Out of which 43 patients were male and 13 patients were female. In each patient 12 observations were made. Hence for a total of 54 patients 648 observations

were made.

We didn't appreciate any difference with regards to CVP measurements or technical difficulty with the procedure regardless of the site (IJV/subclavain) or side of central venus catheterization (right side/left side).Out of 54 patients , twenty nine patients were on mechanical ventilation.

The observationswere analyzed by dividing the patients into 2 groups on the basis of CVP measurements.

Group A is patients with CVP≤10 and Group B is patients with CVP>10. Out of 648 observations, 396 observations belonged to Group A and 252 observations under Group B.

In GROUP A

Total mean CVP was 7.38cmH20, mean EJVP was 10.83cmH20 and mean PVP was 11.17cmH20.

CVP and EJVP -mean difference was 3.9, r=0.386, p=0.192

CVP and PVP -mean difference was 4.3, r=0.137, p= 0.174

In Group A (CVP ≤ 10) mean difference between CVP with PVP and EJVP is >2cmH20 and p value is insignificant.

In GROUP B

Overall mean CVP was 11.90 cmH20, mean EJVP was 12.58 cmH20, and mean PVP was 13.52 cmH20.

CVP and EJVP-mean difference was 1.3, r=0.685, p<0.001

CVP and PVP –mean difference is 1.8, r=0.785, p<0.001

In Group B (CVP >10) mean difference between CVP with PVP and EJVP is <2cmH2O and p value (p<0.001) is strongly significant and comparable.

To evaluate the degree of agreement, Bland and Altman plots were done between CVP - EJVP and CVP –PVP with 95% limits of agreement as the mean difference (1.96SD).

ADVERSE EVENTS

Among 54 patients, 2 patients developed phlebitis at the peripheral cannula site after 2 days, one patient had accidental subclavian arterial puncture and another patient developed hematoma while inserting right sided IJV due to carotid artery puncture which was subsided by giving local compression.

CONCLUSION

The present study concludes that, there is definite correlation between CVP, EJVP and PVP in a given patient. Further concludes the difference between CVP and EJVP/PVP was minimum (<2cmH2O) when the CVP was>10cmH2O.

LIMITATIONS OF THE STUDY

1. CVP is static parameter and hence cannot accurately predict volume responsiveness in a patient with septic shock.
2. Ultrasound guided central venous catheterization will definitely reduce complications associated with catheterization.

STRENGTHS OF THE STUDY

In rural setup, where monitoring dynamic indices for assessing fluid responsiveness is not feasible, CVP/EJVP/PVP will be surrogate marker for assessing fluid responsiveness in septic patient.

SUMMARY

- This prospective observational study was designed to measure and to correlate CVP, EJVP and PVP in patients with sepsis during first 24 hour of admission to ICU.
- The study was conducted on 54 patients of either sexes, above 18 years of age admitted to ICU with sepsis requiring fluid resuscitation
- Baseline peripheral venous pressure, external jugular venous pressure and central venous pressure are measured in all admitted patients with sepsis
- All the three venous pressures are repeated 3 times following every fluid challenge of 200ml in all the patients.
- For analysis , we subdivided study population into two subsets of patients ,based on CVP
- GROUP A- Patients with before fluid challenge CVP≤10cmH20
- GROUP B-Patients with before fluid challenge CVP>10cmH20
- The correlation was observed between CVP and PVP and also between CVP and EJVP among the mentioned two groups.
- This observations showed that CVP ,PVP and EJVP strongly correlated at a higher CVP(GROUP B) than that a lower CVP (GROUP A)
- The study observations suggest that, there was definite correlations between CVP/PVP /EJVP .The mean difference with CVP -EJVP and CVP-PVP was minimal when CVP was >10cmH2O.

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COMPARISON OF CONVENTIONAL CENTRAL VENOUS PRESSURE WITH PERIPHERAL VENOUS PRESSURE AND EXTERNAL JUGULAR VENOUS PRESSURE IN PATIENTS WITH SEPSIS.

PROFORMA

PERSONAL DETAILS

Name: Age: Sex: M F

Address: Date: Occupation:

Telephone no.: Hospital no:

E-mail ID:

CLINICAL FINDINGS

	Yes/No
TEMP >100^{O} F / <96.8^{0}F	
RR>20breaths/min/PaC02<32mmHg	
HR>90beats/min	
WBC>12,000/mm^3/ <4000/mm^3	
MAP <60mmhg	
TRAUMA	
HYPERTENSION	
DIABETES MELLITUS	
IHD	
COAGULOPATHY	

SYSTEMIC EXAMINATION:

- Cardio vascular system:
- Respiratory system:
- Abdomen:
- Central nervous system:

CLINICAL DIAGNOSIS :

INVESTIGATIONS :

Hb: RBC: TC: Platelets: DC: N: L: M: E: B:

BT: CT: RBS: ECG: CHEST X-RAY:

OBSERVATIONS

	BASELINE	AFTER FLUID CHALLENGE OF 2OOML		
CVP(cm of H20)				
PVP(cm of H20)				
EJVP(cm of H20)				

Signature of Guide

INFORMATION SHEET

TITLE: COMPARISON OF CONVENTIONAL CENTRAL VENOUS PRESSURE WITH PERIPHERAL VENOUS PRESSURE AND EXTERNAL JUGULAR VENOUS PRESSURE IN PATIENTS WITH SEPSIS.

I, Dr SREENIDI R Post Graduate in the department of Anesthesiology, Sri Devaraj Urs Medical College, Tamaka,Kolar. We are carrying out above mentioned study at RLJH, Tamaka, Kolar. The study has been reviewed and approved by the institutional ethical review board.

In patients with sepsis, conventional central venous pressure is used to guide fluid therapy. Unlike central venous cannulation, patients with vasofix inserted into external jugular vein and peripheral vein are less likely to encounter any serious complications. In our study, we would measure external jugular venous pressure (EJVP), peripheral venous pressure (PVP) and correlate with central venous pressure (CVP) measured by conventional technique.

Study will be conducted on 54 patients admitted to ICU with sepsis requiring fluid resuscitation. Investigations like complete blood count, bleeding time and clotting time will be performed in all patients prior to cannulation. All the cannulations are done under strict aseptic precautions and in every patient PVP, EJVP and CVP are measured. PVP measured from 16G or 18G vasofix sited in right/left cubital fossa, EJVP from 16G or 18G vasofix sited in right/left external jugular vein and CVP is measured from16 G distal port of 7 French triple lumen central venous catheter of 15cm length sited in right/left of internal jugular vein / subclavian vein. All the three pressures are measured simultaneously using water column manometer.

EJVP, PVP and CVP are recorded three times following fluid challenge of 200ml.

Side effects: Following insertion of central line, patient will be subjected for chest x-ray to rule out pneumothorax.

If the patient develops any arrhythmias, 12 lead ECG would be recorded and arrhythmias will be analyzed.

If there is suspicion of catheter related blood stream infection after 48 hours following central venous cannulation, two blood cultures will be sent. One of the samples to be taken from central line and another from peripheral site.

Participation in this study doesn't involve any added cost to the patient. There is no compulsion to participate in this study and you will not be affected with regard to patient care, if you wish not to be part of this study.

All the information collected from the patient will be kept confidential and will not be disclosed to any outsider, unless compelled by the law. The information collected will be used only for this study. I request your kind self to give consent for the above mentioned research project.

For any further clarification you are free to contact, **Dr SREENIDI R (Postgraduate in Anesthesiology); Mobile No: 8197218313, Dr SURESH KUMAR N (Professor in Anesthesiology); Mobile No: 9008222550**

INFORMED CONSENT FORM

I, Mr. /Mrs. have been explained in a language I can understand, that I will be included in a study which is comparison of conventional central venous pressure with peripheral venous pressure and external jugular venous pressure in patients with sepsis.

I have been explained about the procedure, monitoring, clinical findings and investigations performed in ICU and the same will be documented for the study purpose.

I have been explained that my participation in this study is entirely voluntary and I can withdraw from the study anytime and this will not affect my relation with my doctor or the treatment for my ailment.

I have read and received a copy of patient information sheet. I understand the information provided in this document and I have had the opportunity to ask questions about the procedure and the associated risk.

I give my consent for the above mention study as long as my details found in this study are kept confidential.

Signature of the patient:

Name:

Signature of the next of kin

Relationship to the patient

Name:

Date: Place:

KEY TO MASTER CHART

cmH2O	:	Centimeter of Water
CVP	:	Central venous pressure
EJVP	:	External jugular venous pressure
F	:	Female
HR	:	Heart Rate
IHD	:	Ischemic Heart Disease
M	:	Male
MAP	:	Mean Arterial Pressure
N	:	No
PVP	:	Peripheral venous pressure
RR	:	Respiratory Rate
SPO2	:	Peripheral Capillary Oxygen Saturation
TEMP	:	Temperature
WBC	:	White blood count
Y	:	Yes

Sl No.	IP Number	Age	Sex	TEMP>100F/<96.8F	RR>20BPM/PaCO2<32MMHG	HR>90BP	WBC>12000mm3/<4000mm3	MAP<60mmhg	TRAUMA	HYPERTENSION	Diabetes Mellitus	IHD	COAGULOPATHY	DIAGNOSIS	central vein cannulation	CVP Baseline(cmH2O)	CVP 1st(cmH20)	CVP 2ND(cmH20)	CVP 3RD(cmH20)	External jugular vein(EJV)	EJV Baseline(cmH20)	EJVP 1ST(cmH20)	EJVP 2ND(cmH20)	EJVP 3RD(cmH20)	Peripheral vein	PVP Baseline(cmH20)	PVP 1st(cmH20)	PVP 2nd(cmH20)	PVP 3rd(cmH20)	Mechanical ventilation	complications
1	624401	30	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	B/L Lower lobe pneumonia with sepsis	Left IJV	10	11	12	12	Right	11	13	14	14	Right	12	12	13	14	yes	
2	580815	56	m	yes	yes	yes	yes	yes	No	No	No	No	No	Right lower limb cellulitis with septicaemia	Right subclavian 14	11	12	12	13	left	11	12	12	13	Right	13	13	12	14	No	
3	577469	22	m	yes	yes	yes	yes	Yes	No	No	No	No	No	Acute pancreatitis with sepsis	Right IJV	15	16	16	17	Left	16	17	17	18	Right	16	17	17	18	No	
4	589152	18	F	YES	yes	yes	yes	yes	No	NO	NO	No	No	ARDS with sepsis	Right subclavian 14	12	13	14	15	Left	13	14	14	15	right	13	14	14	15	yes	
5	600166	40	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Left lower lobe pneumonia with sepsis	Right IJV	15	16	17	17	left	16	17	17	18	Right	17	18	17	18	yes	
6	594751	20	f	yes	No	yes	yes	yes	No	NO	NO	No	No	Urosepsis in septicaemic shock		8	9	10	12	Right	12	13	14	15	left	13	14	14	15	no	Phebitis
7	606369	19	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Hypoxic encephalopathy with severe metabolic acidosis with sepsis	Right IJV	8	9	9	11	left	11	12	14	15	Right	12	13	13	14	yes	
8	550779	50	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bronchopneumonia with sepsis in septic shock	Right IJV	12	13	13	14	left	12	13	14	14	left	13	14	14	15	no	
9	609398	75	m	yes	yes	yes	yes	yes	no	NO	NO	No	No	primary peritonitis with sepsis	Right subclavian 14	9	10	11	13	left	11	13	14	15	Right	10	11	13	14	no	
10	706100	73	m	yes	No	yes	yes	yes	No	NO	NO	No	NO	Acute gastroenteritis with Acute kidney injury with sepsis in septic shock	Right IJV	5	6	6	7	left	12	11	13	13	left	9	11	10	12	no	
11	580820	58	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral lower lobe pneumonia with sepsis	Left subclavian	9	11	12	13	Right	11	12	14	14	Right	11	12	13	14	Yes	
12	594750	40	m	yes	No	yes	yes	yes	No	NO	NO	No	No	Urosepsis with septic shock	Right IJV	15	14	15	15	left	14	15	14	16	left	17	16	17	18	no	
13	662103	62	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute pancreatitis with sepsis in AKI	Right IJV	10	11	11	12	left	12	13	13	14	Right	11	12	13	14	NO	
14	670164	68	M	yes	yes	yes	yes	yes	No	NO	NO	No	No	Left submandibular abscess with sepsis	Right subclavain	6	7	8	9	left	8	9	10	12	left	11	12	14	14	No	
15	674501	28	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute hepatitis with MODS with septicaemic shock	Right IJV	8	10	12	12	left	11	10	12	13	left	10	11	11	12	No	
16	669467	59	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral lower lobe pneumonia with ARDS WITH MODS in septicemic shock	left ijv	11	12	12	13	Right	9	10	10	11	Right	13	14	13	15	yes	

Sl No.	IP Number	Age	Sex	TEMP>100F/<96.8F	RR>20BPM/PaCO2<32MMHG	HR>90BP	WBC>12000mm3/<4000mm3	MAP<60mmhg	TRAUMA	HYPERTENSION	Diabetes Mellitus	IHD	COAGULOPATHY	DIAGNOSIS	central vein cannulation	CVP Baseline(cmH2O)	CVP 1st(cmH20)	CVP 2ND(cmH20)	CVP 3RD(cmH20)	External jugular vein(EJV)	EJV Baseline(cmH20)	EJVP 1ST(cmH20)	EJVP 2ND(cmH20)	EJVP 3RD(cmH20)	Peripheral vein	PVP Baseline(cmH20)	PVP 1st(cmH20)	PVP 2nd(cmH20)	PVP 3rd(cmH20)	Mechanical ventilation	complications
17	689393	40	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Urosepsis with septic shock	right subclavian	14	15	15	15	left	15	16	16	17	left	15	17	17	18	No	
18	688948	56	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Sepsis with MODS	Left IJV	12	14	14	15	Right	13	15	15	15	Right	14	16	15	15	yes	
19	679500	56	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	right lower lobe pneumonia with ARDS with respiratory failure with sepsis	right subclavain	13	14	15	15	left	15	15	14	16	left	14	16	17	17	no	Hematoma
20	683829	60	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral multilobar pneumonia with meningitis with sepsis with MODS	left subclavian	8	9	10	11	Right	12	13	14	14	Right	11	13	14	15	yes	
21	411903	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	right sided pneumonia with right lower limb cellulitis with sepsis in shock	right subclavian	8	10	11	12	left	10	12	13	14	Right	10	13	13	15	yes	
22	574750	40	m	yes	No	yes	yes	yes	No	NO	NO	No	No	Urosepsis with septic shock	Right IJV	15	14	15	15	left	15	16	15	16	left	17	18	17	16	No	
23	690009	59	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral multilobar pneumonia with sepsis with MODS	right IJV	14	15	15	16	left	13	14	14	15	Right	15	16	17	16	yes	
24	752660	58	M	yes	yes	yes	yes	yes	No	NO	NO	No	No	Biateral lower lobe pneumonia with sepsis with septic shock	Right IJV	8	9	9	10	left	12	14	15	16	Right	13	15	16	16	yes	
25	728150	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	left lower limb cellulitis with sepsis	left subclavian	10	11	11	12	Right	11	13	13	13	Right	13	14	15	15	No	
26	763992	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	right lower lobe pneumonia with AKI with septic shock	left IJV	9	10	11	11	Right	12	13	14	14	Right	13	14	15	15	yes	
27	696772	56	f	yes	No	yes	yes	yes	No	NO	NO	No	No	left lower limb cellulitis with sepsis	left subclavian	10	11	11	12	Right	12	13	13	14	Right	14	15	16	16	No	
28	746359	48	m	yes	No	yes	yes	yes	No	NO	NO	No	No	septic arthritis of right knee with septic shock	Right ijv	7	7	8	9	left	11	12	13	13	Right	12	15	16	17	No	
29	688918	54	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	sepsis with MODS	left ijv	11	13	14	14	Right	12	13	14	14	left	12	13	13	14	yes	
30	619501	54	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Urosepsis with septic shock	right subclavian	10	10	11	12	left	9	10	11	12	left	11	8	8	9	No	
31	610121	25	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	peritonitis with sepsis	right subclavian	7	8	9	9	left	10	11	12	13	left	12	14	14	15	No	
32	674941	28	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acut kidney injury with sepsis	Left IJV	11	12	12	13	Right	12	13	14	14	left	13	14	14	15	No	

Sl No.	IP Number	Age	Sex	TEMP>100F/<96.8F	RR>20BPM/PaCO2<32MMHG	HR>90BP	WBC>12000mm3/<4000mm3	MAP<60mmhg	TRAUMA	HYPERTENSION	Diabetes Mellitus	IHD	COAGULOPATHY	DIAGNOSIS	central vein cannulation	CVP Baseline(cmH2O)	CVP 1st(cmH20)	CVP 2ND(cmH20)	CVP 3RD(cmH20)	External jugular vein(EJV)	EJV Baseline(cmH20)	EJVP 1ST(cmH20)	EJVP 2ND(cmH20)	EJVP 3RD(cmH20)	Peripheral vein	PVP Baseline(cmH20)	PVP 1st(cmH20)	PVP 2nd(cmH20)	PVP 3rd(cmH20)	Mechanical ventilation	complications
33	744735	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral multilobar pneumonia with sepsis	Right IJV	11	12	13	13	left	12	13	13	14	Right	12	13	14	15	yes	
34	741304	48	f	yes	No	yes	yes	yes	No	NO	NO	No	No	Bilateral Acute pyelonephritis with septic shock	Right subclavian	11	12	13	13	left	12	13	14	15	left	11	13	14	14	No	
35	670202	55	m	yes	No	yes	yes	yes	No	NO	NO	No	No	Cellulitis of leg leg with septic shock	right IJV	8	9	10	10	left	12	13	14	14	Right	13	14	15	15	No	Phebitis
36	581728	20	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute pancreatitis with sepsis	Right subclavian	10	11	12	14	left	15	14	13	15	Right	15	16	17	17	No	
37	594745	22	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	left lower pneumonia with sepsis	Left IJV	8	10	10	12	Right	7	9	11	15	left	9	12	12	14	yes	
38	612704	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral multilobar pneumonia in sepsis	Right IJV	14	15	16	16	Right	14	15	17	18	Right	13	15	16	17	yes	
39	566508	55	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Left lower lobe pneumonia with sepsis	Left IJV	8	11	13	15	Right	10	12	15	17	Right	11	13	14	15	yes	
40	611971	60	m	yes	No	yes	yes	yes	No	NO	NO	No	No	AKI with sepsis with sepsis shock	right subclavian	16	17	18	18	left	15	18	18	19	left	17	18	19	19	No	arterial puncture
41	574878	24	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute pancreatitis with sepsis in septic shock	right IJV	10	11	13	15	left	11	14	13	14	Right	14	16	15	15	No	
42	611594	20	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Rodenticide poisoing with severe metabolic acidosis with shock	Right IJV	10	12	14	14	left	11	13	13	15	Right	12	13	15	16	yes	
43	620346	57	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Right sided pneumonia with sepsis	right subclavian	12	14	15	15	left	15	15	16	16	left	16	16	17	18	yes	
44	599752	46	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute pyelonephriris with sepsis	Right subclavian	11	13	11	13	Right	10	12	11	12	Right	9	10	11	12	No	
45	601905	60	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute hepatitis with hepatorenal component with MODS with septicaemic shock	Right IJV	10	12	13	14	left	11	13	13	14	Right	12	13	14	14	yes	
46	546328	35	m	yes	yes	yes	yes	yes	No	NO	NO	No	No	Acute meningoencephalitis with sepsis	right IJV	4	7	8	8	left	12	15	16	16	Right	5	8	9	9	yes	
47	505480	56	f	yes	yes	yes	yes	yes	No	NO	NO	No	No	Bilateral lower lobe pneumonia with sepsis	Right subclavian	9	10	11	11	left	11	13	13	14	left	12	14	15	16	yes	
48	620247	25	m	yes	yes	yes	yes	yes	No	No	NO	No	No	Urosepsis with septic shock	right subclavian	9	10	11	11	Right	10	11	12	13	Right	11	13	14	14	No	

Sl No.	IP Number	Age	Sex	TEMP>100F/<96.8F	RR>20BPM/PaCO2<32MMHG	HR>90BP	WBC>12000mm3/<4000mm3	MAP<60mmhg	TRAUMA	HYPERTENSION	Diabetes Mellitus	IHD	COAGULOPATHY	DIAGNOSIS	central vein cannulation	CVP Baseline(cmH2O)	CVP 1st(cmH20)	CVP 2ND(cmH20)	CVP 3RD(cmH20)	External jugular vein(EJV)	EJV Baseline(cmH20)	EJVP 1ST(cmH20)	EJVP 2ND(cmH20)	EJVP 3RD(cmH20)	Peripheral vein	PVP Baseline(cmH20)	PVP 1st(cmH20)	PVP 2nd(cmH20)	PVP 3rd(cmH20)	Mechanical ventilation	complications
49	619502	58	f	yes	yes	yes	yes	yes	No	no	NO	No	No	Right side pneumonia with sepsis with MODS	Left subclavian	9	10	11	12	right	11	13	12	14	Right	12	12	14	15	No	
50	628978	68	m	yes	yes	yes	yes	yes	No	No	NO	No	No	Acute hepatitis with sepsis in septic shock	Left IJV	13	14	14	15	Right	12	13	13	14	left	14	14	15	15	No	
51	624396	28	M	yes	yes	yes	yes	yes	No	NO	NO	No	No	Urosepsis with septic shock	Right subclavian	8	9	9	10	left	12	13	14	14	Right	13	14	15	15	No	
52	633113	40	m	yes	yes	yes	yes	yes	No	No	NO	No	No	Bilateral pneumonia with sepsis	right IJV	7	8	8	9	left	10	12	13	13	left	12	13	14	15	yes	
53	628652	30	m	yes	yes	yes	yes	yes	No	No	NO	No	No	ARDS with sepsis in septicaemic shock	left subclavian	9	10	11	12	Right	11	12	13	13	left	12	13	14	14	yes	
54	669004	65	m	yes	yes	yes	yes	yes	No	No	NO	No	No	Bilateral lower lobe pneumonia with MODS with sepsis	Right IJV	10	11	12	12	left	11	12	13	13	left	11	12	12	13	yes	