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# Central Venous Pressure Reference Points Measured on Post-Mortem Subject

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# CENTRAL VENOUS PRESSURE REFERENCE POINTS MEASURED ON POST-MORTEM SUBJECTS

by

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A Thesis in Partial Fulfillment
of the Requirements for the Degree
Master of Science in the Field of Nursing

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Each person whose signature appears below certifies that he has read this thesis and that in his opinion it is adequate, in scope and quality, as a thesis for the degree Master of Science.

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# Chapter 1

## INTRODUCTION

Measurement of central venous pressure (CVP) has become an important adjunct in the treatment of critically ill patients, and as such has become a standard procedure in the intensive care unit. Nurses are responsible for the monitoring of CVP and must be aware of the meaning and significance of changes in this measurement.

Although it is the trend of the CVP readings in relation to the initial baseline reading which is significant clinically, a false baseline reading will yield a misleading clinical picture at the outset. Needed therapy may be delayed or withheld due to this misinformation. A person tending toward hypovolemia or shock may not receive required intravenous therapy due to a falsely high series of CVP measurements. On the other hand, consistent inaccurate low readings might be the cause for adding unnecessary fluid to the body. Addition of excess fluid could lead to fluid volume overload, particularly if the heart and kidneys are unable to compensate for the extra volume.

The baseline reading as well as successive readings may be inaccurate simply due to the misplacement of the extrathoracic reference point.

Theoretical Framework

The CVP reflects the interaction between right ventricular competency, blood volume and vascular tone.[1,2,3] CVP varies directly with vascular tone and blood volume and inversely with right ventricular competency.[4] CVP is therefore one valuable guide for fluid volume replacement.[2]

Clinical investigators generally agree that CVP normally ranges somewhere between three and ten centimeters of water pressure. It is also generally agreed that a CVP above fifteen or twenty centimeters water pressure suggests an incompetent pump in relation to the circulating blood volume.[2,3,5,6]

Because of fluid dynamics the average venous pressure in the right atrium will be found at the midatrial level. Therefore in measuring CVP the extrathoracic reference point should represent the midportion of the right atrium. It is necessary then to locate an extrathoracic reference point which most accurately represents the mid right atrium or bears a constant and known relationship to it. Many authorities recognize the midaxillary line at the fifth intercostal space as representing the level of the right atrium of a patient in the supine position. And in fact, the midaxillary line currently is clinically accepted and widely used.[1,4,3,7,8]

There is often a need to make frequent CVP determinations on seriously ill patients. A patient may be comfortably positioned on his side and within fifteen minutes need to be placed again in a supine position in order to take a CVP reading.

Jereos[9] pointed out that hemodynamically the CVP should be the same in both the supine and lateral positions. Therefore, if appropriate external reference points could be determined, readings could be made in either position. However in a study on ten patients she was unable to demonstrate that CVP values were the same for both the supine and lateral positions. In her study the values for the lateral positions as opposed to the supine position corresponded to the most frequently reported normal range of CVP values, three to ten centimeters water; whereas the values for the supine position, six and one-half cms. to fifteen cms., were generally higher than the normal range. The extrathoracic reference point used in Jereos' study for the supine position was a point intersecting the midaxillary line and the fifth intercostal space. The extrathoracic reference point used for the lateral position was a point at the fourth intercostal space within the right sternal border.

## Statement of the Problem

The results of Jereos' study give rise to two important questions: 1) Does the extrathoracic reference point for the patient in the supine position, midaxillary at the fifth intercostal space, accurately represent the mid right atrium? 2) Does the extrathoracic reference point for the patient in the lateral or side-lying position, fourth intercostal space within the right sternal border, accurately represent the mid right atrium?

Review of Literature

Jereos[9] postulated that the extrathoracic reference point of the supine position, the midaxillary at the fifth intercostal space, may in fact more consistently approximate a location posterior to the right atrium rather than the mid portion. She suggested that an error of three to four centimeters in the external reference point may be responsible for giving falsely high CVP values of patients in her study in the supine position. Due to the inconsistent findings and questions raised by Jereos' study, it seems appropriate to review the literature on extrathoracic reference points.

One method commonly used for measuring CVP is that described by Lyons, Kennedy and Burwell[10] in 1938. In their study of cadavers they reported that the posterior border of the heart lies ten centimeters ventral from the dorsal surface. They found the anterior border of the right atrium to be four to five centimeters from the anterior border of the thorax, and the posterior border of the right atrium was eight to ten and one-half centimeters from the posterior border of the thorax. They believed that in adults the thickness of the vertebrae and other structures posterior to the heart is less variable than the thoracic diameter. Consequently, Lyons, et al. maintained that an acceptable reference point should be defined in relation to the posterior surface of the chest on which the heart lies, and not the anterior

surface of the chest to which the heart is not firmly attached. When taking CVP measurements on ninety normal subjects using ten centimeters ventral from the dorsal surface as their reference point, Lyons et al. had a pressure range between five and fifteen centimeters of water.

Debrunner and Buhler[11] did a comparative study on twenty-six patients using a series of various reference points on each patient in an attempt to help define a reliable reference point for accurate measurement of CVP. The tip of the catheter on all twenty-six patients was placed in the superior vena cava directly cephalad to the right atrium as determined radiologically. Zero to eight centimeters water pressure was accepted as the normal range for the CVP values. The CVP values varied considerably between one method and another and could not be compared to one another. Debrunner and Buhler attributed the wide differences in pressure values to the different reference points used.

Debrunner and Buhler made appropriate corrections for the distance from the zero reference point to the tip of the catheter, and then found that six of the seven methods investigated fell within the range of zero to eight centimeters water. Of the seven methods studied, the method of Lyons, Kennedy and Burwell yielded false high pressure values, five to thirteen centimeters water. Debrunner and Buhler cautioned that a series of false high CVP values could give false impressions regarding the blood volume of patients in shock.

Pederson and Husby[12] in a study of the choice of zero levels for CVP measurement, showed that when using the reference point of Lyons, Kennedy and Burwell the distance from the catheter to the zero level increased considerably in patients with large anterior posterior chest diameters. Consequently when using the method of Lyons, et al. as the anterior posterior chest diameter increased the CVP readings were proportionately much higher.

Pederson and Husby attempted to devise a method of measuring CVP in such a way as to take into account the variability of the chest size. It was their belief that the distance of the zero level from the anterior and posterior surfaces of the chest is a function of the anterior posterior diameter of the chest measured posteriorly from the fourth interspace. They chose as an arbitrary zero level the midpoint between the superior and inferior vena cavae openings. In a study of eighteen patients fluroscopy and angiography were used to estimate the level of their chosen reference point. They found their zero level to be forty-three percent of the anterior posterior diameter of the chest measured posteriorly from the sternum at the level of the fourth interspace. They also demonstrated that using as a reference point the middle of the chest depth or one-half the anterior posterior diameter, resulted in a one to two centimeter increase in the CVP readings. In their patients one-half the depth of the chest was slightly anterior to the posterior border of the right atrium.

Martin Robson[13] in his study of thirty patients chose as an arbitrary zero point the level of the tip of the catheter on the anterior wall of the vena cava, two centimeters from the entrance to the right atrium. His reference point was one and one-half centimeters anterior to that of Pederson and Husby and was found to be thirty-seven percent of the anterior posterior diameter of the chest measured posteriorly from the fourth costochondral junction. The mean CVP of twenty-three patients using thirty-seven percent of the anterior posterior diameter was 6.2 centimeters water.

Even though it is difficult to compare CVP values from one method of zero point determination to another, the literature does suggest that those methods which take into account variability in chest size give a higher correlation between external reference point zero and the midatrial level, than selection of zero levels by other criteria.

## Chapter 2

## METHODOLOGY

Measurements were taken on twenty cadavers during post-mortem examination to determine the reliability of two specific reference points for measuring CVP. The fifth intercostal space intersecting the midaxillary line was the extrathoracic reference point chosen to represent the right atrium of patients in the supine position. The fourth intercostal space within the sternal border was the extrathoracic reference point chosen to represent the right atrium for patients in a side-lying or lateral position.

The cadavers were made available through the Department of Pathology at a Western medical center. The cadaver measurements were supervised by the pathologists at the institution. The time of the post-mortem examinations ranged from immediately after death to seventy-two hours after death.

The sample of twenty included both sexes and ranged in age from twenty-six to ninety-one years. Those who were known to have enlarged hearts as determined by the pathologist's initial statement were excluded from the study. Those cadavers whose pectoralis major and latissimus dorsi muscles could not readily be palpated were eliminated from the study. Those cadavers with a deformed thorax or spinal column were eliminated as well. Measurements were made with the heart still intact and expanded with blood.

Procedure

With the cadavers in a supine position, the lateral and anterior posterior chest diameters were measured at the level of the fourth intercostal space at the sternum with a centimeter caliper and recorded. (See Table I; Columns A & B) A point which represented one-half the anterior posterior diameter was indicated by a mark on the subject's lateral chest wall. (See Table I, Column C)

The midaxillary reference point was then located in the following manner: the anterior axillary line or the border of the pectoralis major muscle was outlined with a genetian violet skin marker. The posterior axillary line or the border of the latissimus dorsi muscle was outlined in the same manner. To find the midaxillary line, one-half the distance between the anterior and posterior axillary lines was measured at the level of the third intercostal space of the anterior chest wall. One-half the distance between the posterior and anterior lines was indicated with a skin marker. A carpenter's level was used to advance the midaxillary line to the fifth intercostal space. This point then represented the extrathoracic reference point of the supine position, and was marked accordingly. An attempt was not made to locate the midaxillary at the fifth intercostal space initially because breast tissue made it difficult to locate the muscle borders.

A point at the fourth intercostal space within the right

sternal border was chosen as the reference point on the anterior chest wall.

The distance between the midaxillary reference point and the mark representing one-half the anterior posterior diameter of the chest was calculated and recorded. (See Table I, Col. D) This was done to obtain data on how closely correlated the one-half anterior posterior diameter was to the midaxillary.

Having determined the two extrathoracic reference points, an eleven inch aluminum probe was carefully inserted at the midaxillary reference point. To insure that the angle of insertion was perfectly level, a small carpenter's level was attached to one end of the probe. The probe was inserted seven and one-half inches into the thoracic cavity. Immediately following the maneuver, a seven inch probe, an aluminum spike, was inserted through the chest at the fourth intercostal space within the right sternal border.

Following insertion of both probes the sternal plate was cut and lifted out, leaving the heart and thoracic cavity in view. Using a caliper, the distance from the anterior border to the posterior border of the right atrium was measured. (See Table I, Col. E) The distance from the anterior border of the right atrium to the point of insertion of the bicycle probe ($P_s$) coming from the midaxillary reference point was measured and recorded. (See Table I, Col. F) Using the caliper again, the lateral diameter of the right atrium

was measured. (See Table I, Col. H) The distance from the medial border of the right atrium and the point of insertion of the aluminum probe ($P_1$) was measured and recorded. (See Table I, Col. I)

The measurements (Table I, Columns E,F,H,I) were taken in order to have the necessary information to determine the distance of the points of insertion to the mid right atrium. (Table I, Columns G and J)

## Chapter 3

## RESULTS

Measurements were taken on twenty cadavers to determine the reliability of two specific reference points; the midaxillary at the fifth intercostal space for the supine position, and the fourth intercostal space within the right sternal border for the side-lying position.

Table I lists the measurements for all twenty cadavers in this study. The first measurements taken were the cadavers' lateral and anterior posterior chest diameters, as listed in columns A and B respectively. One-half the chest anterior posterior diameter is listed in column C. Column D represents the measurements from the one-half chest anterior posterior point to the midaxillary extrathoracic reference point. This measurement (Col. D) was taken to measure possible correlation between these two points in relation to the mid right atrium. Column E represents the anterior posterior diameter of the right atrium. Column F represents the distance between points of insertion of the probe inserted at midaxillary reference point ($P_s$) and the anterior border of the right atrium. (See Figure 1). Column G is the transgeneration from columns E and F. The figures in Column G were derived from the formula 1/2E-F, therefore representing the distance from the mid right atrium to the midaxillary reference point. A negative sign indicates a measurement

posterior to the mid right atrium. Column H represents the measurements of the transverse diameter of the right atrium. Column I represents the distance between the point of insertion of the sternal probe to the medial border of the right atrium. (See figure 2) An "I" value with a positive sign means the tip of the probe was located to the right of the medial border of the right atrium. An "I" value with a negative value means the tip of the probe was located to the left of the medial border of the right atrium. Column J represents the transgeneration from columns H and I. The measurements in Column J were derived from the formula I-1/2H, therefore representing the distance of the sternal reference point to the mid right atrium. A negative sign indicates a measurement to the left side of the body from the mid right atrium. A positive sign indicates a measurement to the right side of the body from the mid right atrium.

Midaxillary Reference Point

Results of this study revealed that there was a significant difference between the midaxillary reference point and the mid right atrium ($p < .001$). In all twenty cadavers the midaxillary probe was below the mid right atrium. (See Table I, Column G) The estimate of this difference is -2.9 centimeters ± .55 centimeters (S.E.). The 95% confidence interval is thus equal to -3.45 cms. to -2.35 cms.

The one-half anterior posterior measurement above the dorsal surface (10.6 cms. $\pm$.33, $\bar{x} \pm$ S.E.) was not significantly

Figure 1

Lateral View of Right Atrium

E = Right atrial anterior posterior diameter

F = Point of insertion away from anterior border

G = Distance from mid right atrium to midaxillary (1/2-F)

O = Level of mid right atrium

X = Point of insertion

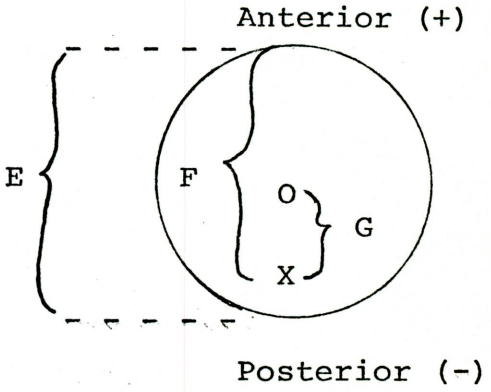



Figure 2

Anterior View of Right Atrium

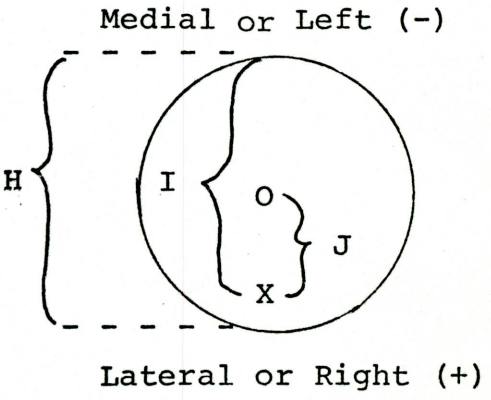
H = Right atrial transverse measurement

I = Point of insertion away from medial border

J = Distance from mid right atrium to sternal probe (I-1/2H)

O = Level of mid right atrium

X = Point of insertion



different from the midaxillary reference measurement above the dorsal surface (9.85 cms. $\pm$ .31, $\bar{x} \pm$ S.E.). There was also a significant correlation between these two points (r=.848). (See Figure 3) These two measurements were significantly different ($p<.05$) from the mid right atrium measurement above the dorsal surface (12.8 cms. $\pm$ .46, $\bar{x} \pm$ S.E.). (See Figure 4) By graphical illustration both estimates of the mid right atrium are seen to be low. (See Figures 5 and 6)

Sternal Reference Point

This study demonstrated no significant difference between the sternal reference point and the mid right atrium ($p>.05$). However, due to the high variability of the data (SD of 2.55 cms.), there is reason to suggest that this test is not conclusive. It is further noted that when choosing any one patient (x) from the population one can be 95% sure that the mid right atrium will fall within 5.36 centimeters of the sternal reference point.

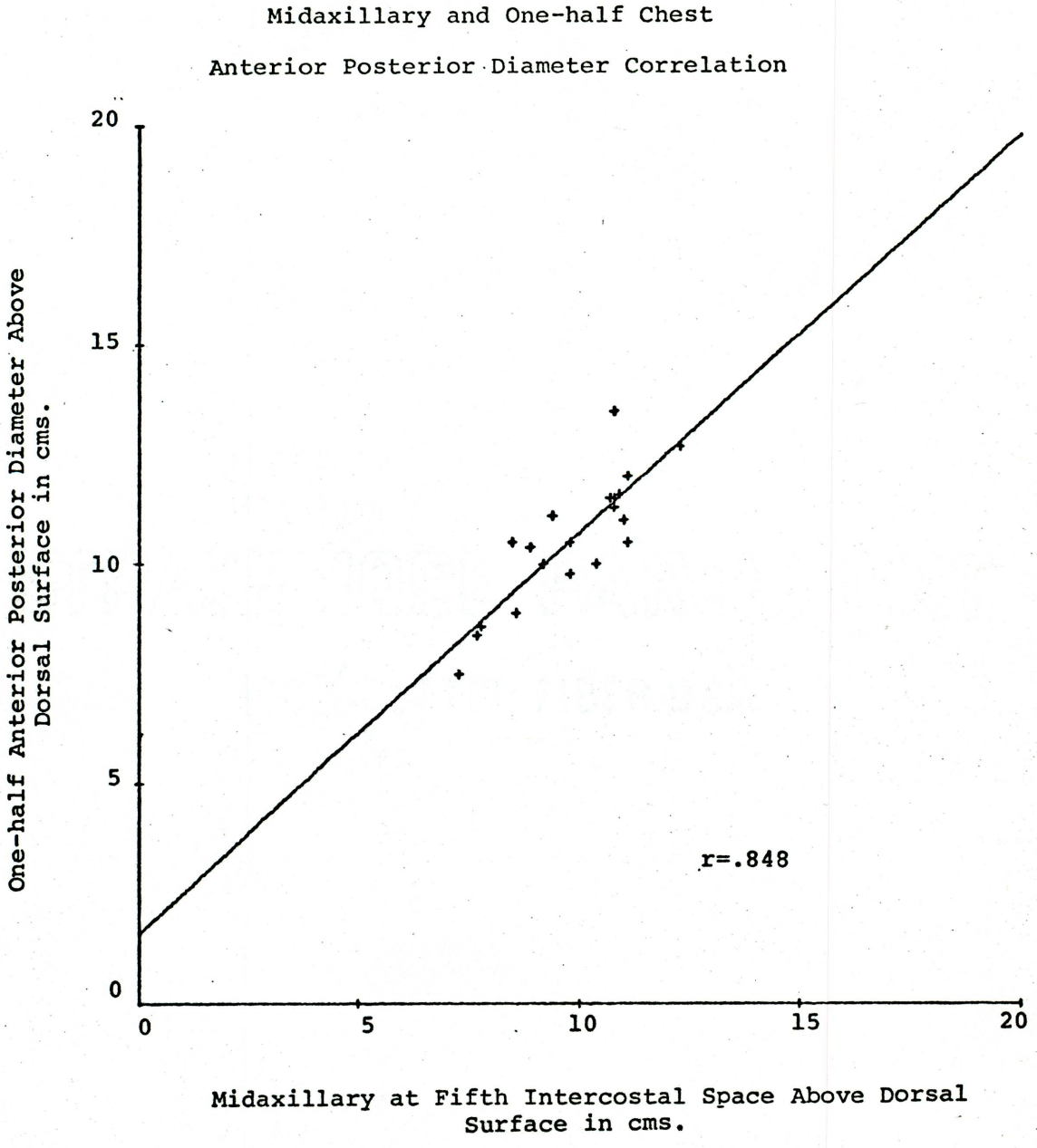

Midaxillary and One-half Chest
Anterior Posterior Diameter Correlation
One-half Anterior Posterior Diameter Above Dorsal Surface in cms.
20
15
10
5
0
0
5
10
15
20
r=.848
Midaxillary at Fifth Intercostal Space Above Dorsal Surface in cms.

Figure 3

Figure 4

Sampling Distributions of Mean Distance Above the Dorsal Surface of Midaxillary at Fifth Intercostal Space, One-half Anterior Posterior Chest Diameter and Mid Right Atrium.

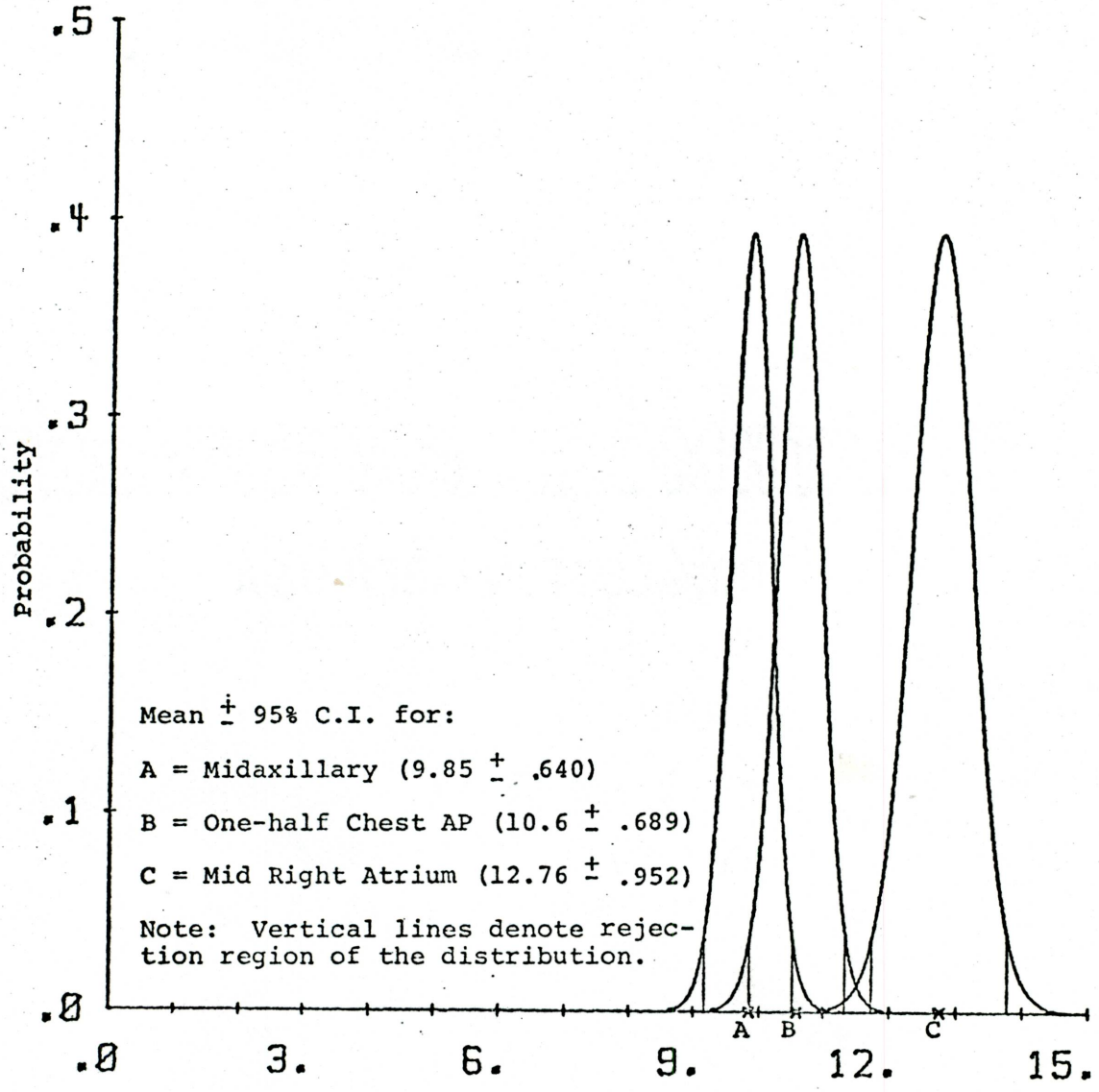


Figure 5
Accuracy of Midaxillary Extrathoracic Reference
Point to Mid Right Atrium

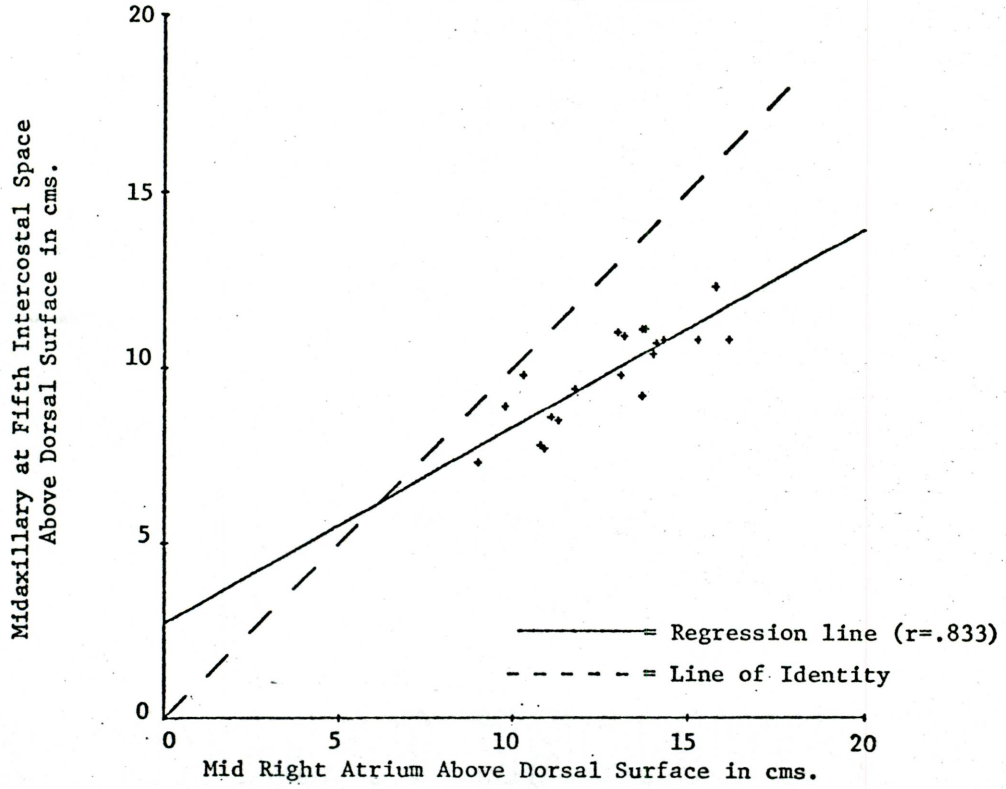
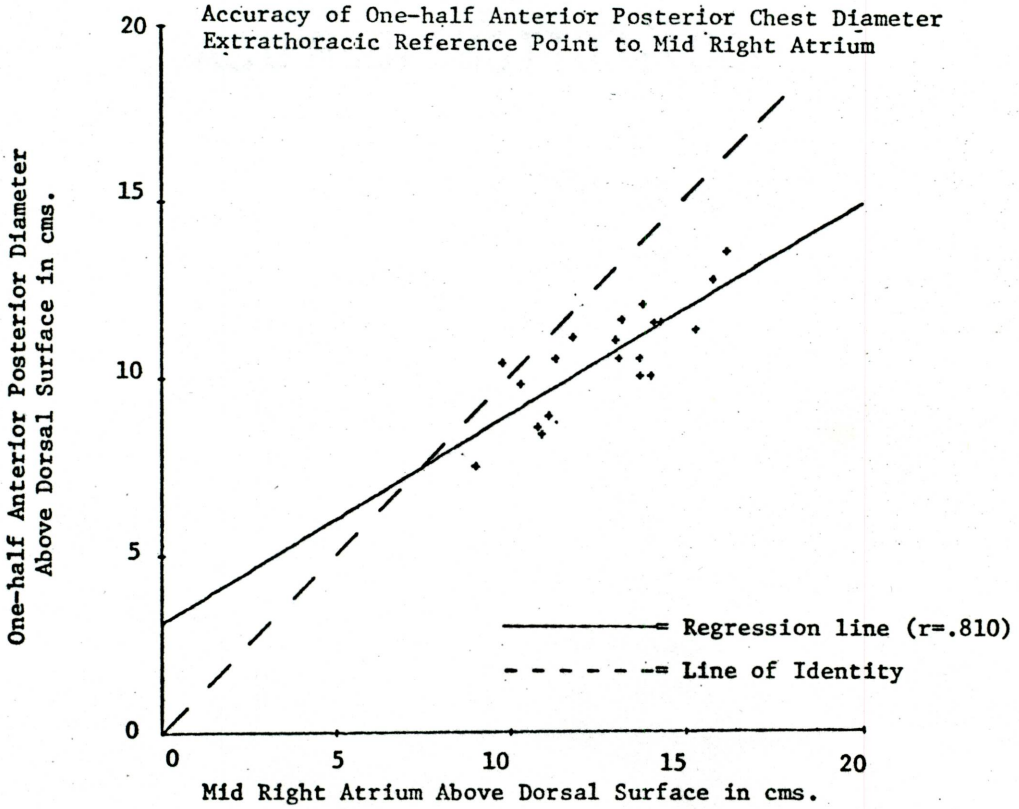



Figure 6
Accuracy of One-half Anterior Posterior Chest Diameter
Extrathoracic Reference Point to Mid Right Atrium



# Chapter 4

# DISCUSSION

## Midaxillary Reference Point

Results of this study showed that the point at the fifth intercostal space at the midaxillary line was consistently posterior to the mid right atrium. This finding is consistent with the method described by Lyons[10] which measured the posterior border of the right atrium.

In subsequent studies[11] Lyon's method was shown to yield high CVP values compared with most other methods. Pederson and Husby[12] demonstrated that when using Lyon's method for measuring CVP, that as the anterior posterior chest diameter increased the CVP readings were proportionately much higher. Pederson and Husby concluded that the zero level of forty-three percent of the anterior posterior diameter, measured posteriorly from the sternum at the level of the fourth interspace, most accurately represented the mid right atrium. They also demonstrated that using as a reference point the middle of the chest depth or one-half anterior posterior diameter resulted in a one to two centimeter increase in the CVP readings. In their patients one-half the depth of the chest was slightly anterior to the posterior border of the right atrium.

Robson[13] concluded that the extrathoracic reference point, thirty-seven percent of the anterior posterior diameter,

measured posteriorly from the fourth costochondral junction, accurately estimates the mid right atrium. They concluded that the CVP catheter tip in their studies was placed one and one-half centimeters anterior to that of Pederson and Husby.

Jereos[9], when using the midaxillary reference point, recorded CVP values ranging from six and one-half to fifteen centimeters in the supine position, with a mean of eleven and one-half centimeters. The values for CVP in the lateral positions more nearly corresponded to the most frequently reported range of CVP values, three to ten centimeters, with a mean of 8.29 cms. of water for the right lateral position, and a mean of 6.34 cms. water for the left lateral position.

It can be seen from Table III that the present study, using the methodology previously described compares favorably to the study of Debrunner and Buhler[11] using a radiographic methodology. The tip of the catheter in Debrunner's study was situated in the superior vena cava cephalad to the right atrium.

Although it is the trend of the CVP readings in relation to the initial baseline reading which is significant clinically, a false baseline reading will yield a misleading clinical picture at the outset. The baseline reading as well as successive readings may be inaccurate simply due to misplacement of the extrathoracic reference. In this study it was found that on the average the midaxillary line represented a point 2.9 centimeters posterior to the mid right atrium.

Distance of Reference Points from
Mid Right Atrium and Catheter Tip

| Reference Point | Distance from Mid Right Atrium in Centimeters | Actual Distance from Catheter in cms. (Debrunner & Buhler, 1969) |
|---|---|---|
| Midaxillary | -2.91 | Not Studied |
| One-half AP of Chest | -2.16 | -2.50 |
| 10 cms. Ventral from Dorsal Surface | -2.76 | -3.38 |
| 3/5 Thoracic Diameter Measured from Dorsal Surface | - .097 | -0.35 |
| Dorsal Surface | -12.8 | -13.3 |

TABLE III

If the midaxillary point is used as an extrathoracic reference point for CVP measurement one should be aware that the readings will be approximately three centimeters higher than actual values.

If an external reference point is desired which accurately represents the mid right atrial level, the results of this study indicate that three-fifths the anterior posterior chest diameter measured from the dorsal surface (See Table III) would consistently bear such a relationship in adults with a normal chest configuration. Previous studies are in accord with this conclusion.[9,11,12,13] The anterior axillary line might be a more readily identifiable point which would also bear a high correlation with the mid atrial level. Further study is needed to verify this. The Medical Skills Library film produced by Hoffman-LaRoche Inc. recently recommended that the anterior axillary line be used as a zero point to approximate the level of the right atrium when measuring CVP.[14]

Sternal Reference Point

The variability of the data in this study in regard to the sternal reference point raises a question as to its value for use in the side-lying position. This may partially explain the great variance Jereos[9] found for side-lying values even though the means reported were 6.34 cms. water for the left lateral position and 8.29 cms. water for the right lateral position which would appear to be within the normal

expected range.

It was felt that the high variability of these data could be explained by means of pathophysiological or anatomical phenomena as cardiac hypertrophy, tumor mass, adhesion, pleural effusion, pneumonia and others. A systematic study of all cadavers in which there was greater than 2.5 centimeters deviation to the left or right of the midatrial point was performed. There was no evidence that the factors cited above affected the variability of the data.

Frequent turning of patients is physiologically important in the prevention of respiratory and circulatory complications. It was hoped that an accurate and reliable method could be found for taking CVP measurements in the lateral position to encourage frequent turning of patients who must have their CVP monitored, and to obviate the need to turn the patient repeatedly to the supine position only for the purpose of CVP measurement. Regrettably the basis for such a convenient method was not supported by the findings of this study.

Related Observations

Initially those cadavers whose hearts were hypertrophied, as determined by the pathologist's initial statement, were to be excluded from the study. However, the pathologist's initial estimate that the heart size was within normal limits was not always borne out by weighing of the heart. Cardiac weight was determined after the measurements listed in Table I were taken. Table II gives the condition of the

cadavers' hearts used in this study. Each cadaver's age, body height and weight, cardiac weight and cardiac wall thickness, autopsy findings and the latest electrocardiogram interpretation before death is listed.

The possible effects of post-mortem cardiac contraction and relaxation as discussed by Reiner[15] was not studied in this research.

# Chapter 5

## CONCLUSIONS

The results of this study revealed that the extrathoracic reference point midaxillary at the fifth intercostal space is not a valid estimate of the level of the mid right atrium, as the mean value was found to be 2.9 centimeters posterior to the mid right atrium ($p<.001$). If midaxillary at the fifth intercostal space is used as an extrathoracic reference point for CVP measurement one should be aware that the readings will be approximately three centimeters higher than the actual zero values. If the one-half anterior posterior chest diameter at the fifth intercostal space is used as an external reference point for CVP measurement one should be aware that the readings will be approximately two centimeters higher than the actual values.

The mean value for the sternal reference point was very close to the experimentally determined mid right atrial level. However, due to the high variability of the data (SD of 2.55 cms.), there is reason to suggest that this test is not conclusive, or that the sternal reference point might not be a reliable estimate of zero level for CVP readings in the side-lying position for a large proportion of patients.

## Chapter 6

## RECOMMENDATIONS

On the basis of the findings of this study, the following recommendations are made:

1. If the midaxillary at the fifth intercostal space is used as an extrathoracic reference point for CVP measurement one should be aware that the readings will be approximately three centimeters higher than the actual values.
2. Conduct a study to determine whether the anterior axillary line is correlated with the mid right atrial level in order to recommend an easily identifiable reference point for clinical use when measuring central venous pressure.
3. Conduct a study to determine a reliable and or valid extrathoracic reference point which would estimate the mid right atrium in patients with increased anterior posterior diameters.
4. Do a comparison study between cadavers with non-hypertrophied hearts and those with hypertrophied hearts.

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# APPENDIXES

TABLE I

Chest and Atrial Measurements on Twenty Subjects

| Subject | Sex | Age | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | M | 56 | 30.5 | 24.0 | 12.0 | + .9 | 5.0 | 5.2 | -2.70 | 3.40 | -2.00 | -3.70 |
| 2 | M | 77 | 31.4 | 21.0 | 10.5 | + .7 | 5.0 | 5.8 | -3.30 | 5.60 | 2.20 | -0.60 |
| 3 | M | 66 | 32.5 | 23.0 | 11.5 | + .8 | 6.0 | 6.4 | -3.40 | 4.50 | -3.40 | -5.65 |
| 4 | M | 70 | 30.2 | 20.0 | 10.0 | - .35 | 4.0 | 5.6 | -3.60 | 3.50 | 1.60 | - .15 |
| 5 | F | 75 | 31.2 | 20.0 | 10.0 | + .8 | 5.0 | 7.0 | -4.5 | 3.0 | -1.60 | -3.10 |
| 6 | F | 79 | 28.0 | 16.8 | 8.4 | + .7 | 5.4 | 5.9 | -3.20 | 4.70 | 1.40 | - .95 |
| 7 | F | 37 | 28.0 | 20.8 | 10.4 | +1.5 | 4.3 | 3.0 | - .85 | 3.85 | 5.00 | 3.10 |
| 8 | M | 91 | 29.5 | 22.5 | 11.25 | + .45 | 6.0 | 7.5 | -4.50 | 3.50 | 1.70 | - .05 |
| 9 | M | 69 | 28.5 | 22.2 | 11.1 | +1.7 | 4.3 | 4.5 | -2.35 | 3.90 | 4.70 | +2.75 |
| 10 | M | 62 | 30.8 | 23.3 | 11.6 | + .7 | 5.5 | 5.0 | -2.25 | - | - | - |
| 11 | M | 78 | 26.0 | 17.2 | 8.6 | + .8 | 4.5 | 5.2 | -2.95 | 3.50 | - .90 | -2.65 |
| 12 | F | 64 | 34.0 | 27.0 | 13.5 | +2.7 | 7.2 | 9.0 | -5.40 | 6.00 | 4.70 | 1.70 |
| 13 | M | 62 | 30.8 | 21.0 | 10.5 | - .60 | 5.0 | 5.1 | -2.60 | 3.8 | 0.1 | -1.8 |
| 14 | F | 71 | 30.5 | 23.0 | 11.5 | + .70 | 5.0 | 6.0 | -3.50 | 3.3 | 0.4 | -1.25 |
| 15 | M | 26 | 24.0 | 15.0 | 7.5 | +2.0 | 4.0 | 3.7 | -1.70 | 3.6 | -2.0 | -3.8 |
| 16 | M | 72 | 32.0 | 21.0 | 10.5 | +2.0 | 6.5 | 6.0 | -2.75 | 4.4 | 1.9 | -0.3 |
| 17 | F | 50 | 29.0 | 17.8 | 8.9 | + .3 | 4.5 | 4.7 | -2.45 | 2.9 | 1.8 | + .35 |
| 18 | M | 76 | 33.0 | 25.4 | 12.7 | + .4 | 6.5 | 6.7 | -3.45 | 3.0 | -4.6 | -6.1 |
| 19 | F | 52 | 28.4 | 19.5 | 9.8 | 0 | 4.0 | 2.5 | - .5 | 2.9 | 1.9 | + .45 |
| 20 | F | 83 | 25.5 | 22.0 | 11.0 | 0 | 5.5 | 4.8 | -2.05 | 3.7 | 1.6 | - .25 |

A=Lateral Chest Diameter
B=Anterior-posterior (AP) Diameter
C=one-half AP Chest Diameter
D=Midaxillary ref. point to 1/2 chest AP
E=Right Atrial AP Diameter

All measurements in centimeters

F=Pt of insertion ($P_s$) away from ant. border of rt. atrium
G=Rt. mid atrium to midax. ref. pt. (1/2E-F)(-=posterior)
H=Transverse Diameter of right atrium
I=Pt of insertion in relation to the lateral border of right atrium
J=Rt. mid atrium to sternal probe ($P_1$) (I-1/2H)
(- = left of body)

TABLE II

Variables Related to Heart Size in Twenty Subjects

| Subject | Age | Body Height | Body Weight | Cardiac Weight in grams | Rt Ventricular Thickness in mm. | Lt Ventricular Thickness in mm. | Septal Thickness in mm. | Autopsy Findings | EKG Interpretation |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 56 | 5'10" | 165lbs | 370 | 4mm | 15mm | 12mm | No cardiomegaly (hypertrophy) | Acute MI |
| 2 | 77 | 5' 7" | 137 | 380 | 5 | 8 | 8 | R Ventricle 50% dilated,L vent 3X norm cap | ST-T wave changes dis effect/ischemia |
| 3 | 56 | 5'10" | 160 | 440 | 6 | 16 | 15 | No cardiomegaly | None available |
| 4 | 77 | 5'6½" | 150 | 400 | not reported | not reported | | No cardiomegaly ASHD/MI | RBBB |
| 5 | 75 | 5' 5" | 145 | 570 | 6 | 18 | 20 | Hypertrophy of Left Ventricle | Left ventricular Hypertrophy |
| 6 | 79 | 5' 2" | 105 | 390 | 5 | 18 | 17 | Left ventricular hypertrophy | None available |
| 7 | 37 | 5' 9" | 170 | 430 | 4 | 17 | Not rep. | Firm left ventricle | Normal tracing |
| 8 | 91 | 5'6½" | 145 | 390 | 7 | 18 | 16 | Firm left ventricle | Possible left hypertrophy |
| 9 | 69 | 5'11" | 140 | 350 | 6 | 18 | 15 | No cardiomegaly | Changes of Rt atrial enlargement |
| 10 | 62 | 5'11½" | 194 | 400 | 4 | 15 | Not rep. | ASHD with old MI | Nonspecific ST-T wave changes w/ LVH |
| 11 | 77 | 5' 3" | 110 | 450 | 6 | 18 | Not rep. | ASHD with old MI | Old MI |
| 12 | 64 | 5' 5" | 194 | 560 | 4 | 14 | 14 | Cardiomegaly ASHD-severe | Possible left atrial enlargement |
| 13 | 62 | 5'11" | 150 | 500 | 5 | 17 | 15 | Slight dilation of left ventricle | Left ventricular hypertrophy |
| 14 | 71 | 5' 6" | 190 | 385 | 5 | 15 | 13 | No cardiomegaly | Poss. left ventricular hypertrophy |
| 15 | 26 | 5' 1" | 100 | 240 | 3 | 14 | 13 | No cardiomegaly | Left ventricular hypertrophy |
| 16 | 72 | 5' 9" | 175 | 540 | 5 | 16 | 10 | ASHD | LBBB |
| 17 | 37 | 5' 4" | 140 | 410 | 3 | 10 | 8 | No cardiomegaly | Poss. early left vent. hypertrophy |
| 18 | 76 | 5' 8" | 170 | 580 | 6 | 17 | 17 | Left ventricular hypertrophy | Left atrial flutter |
| 19 | 52 | 5' 3" | 113 | 240 | 4 | 14 | Not rep. | No cardiomegaly | No EKG |
| 20 | 83 | 5' 2" | 110 | 350 | 5 | 14 | 15 | No cardiomegaly. | Old MI |

LOMA LINDA UNIVERSITY

Graduate School

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# CENTRAL VENOUS PRESSURE REFERENCE POINTS MEASURED ON POST-MORTEM SUBJECTS

by

Jane E. Wright

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An Abstract of a Thesis

in Partial Fulfillment of the Requirements

for the Degree Master of Science

in the Field of Nursing

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The general format of this thesis conforms to the style suggested by Heart and Lung: The Journal of Critical Care since this manuscript is being submitted for publication.

ABSTRACT

Hemodynamically the central venous pressure should be the same in both the supine and lateral positions. The accurate determination of an external zero reference level corresponding with mid right atrial level would make possible reliable measurements in either position. The purpose of this study was to help determine the reliability of two central venous pressure extrathoracic reference points; the midaxillary line as it intersects the fifth intercostal space for a supine position, the fourth intercostal space within the right sternal border for a side-lying position.

Measurements were taken on twenty cadavers during post-mortem examination to determine the relationship of these two reference points to the mid right atrium. Probes were placed in the chest wall at the two reference sites and carefully extended through to the heart. Direct measurements were then taken to determine the distance of the probes from the mid right atrium.

Results of this study revealed that there was a significant difference between the midaxillary reference point and the mid right atrium ($p<.001$). On an average the midaxillary reference point was 2.9 centimeters posterior to the mid right atrium.

The data of this study suggest there was no significant difference between the sternal reference point and the mid

right atrium ($p > .05$). However, due to the high variability of the data (SD of 2.55 cms.), there is reason to suggest that this is not conclusive and that the sternal reference point might not be a reliable estimate of the zero point for central venous pressure readings in the side-lying position for a large proportion of patients.