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Research Article

Where should we Place Fluid Filled Transducers for Accurate Measurement of Invasive Pressures?

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Abstract

Critical care medicine is becoming more and more precision based. This is exemplified by the myriad of devices, especially in hemodynamic monitoring, which are trying to make critical care more objective. Common to many such devices is the utilization of fluid filled transducer systems to monitor various parameters like central venous pressure, arterial blood pressure etc.

These devices are windows into the physiological status of the patient and hence they need to be accurate. The accuracy in many of the commonly used devices like arterial lines, depends very much on the correct placement of the transducer in the phlebostatic axis. In this study the authors investigated whether the transducer was placed at the right level laying insights into a very common and correctable problem.

Keywords: *Transducers; Invasive Pressures*

Introduction

Fluid filled systems with disposable transducers are used extensively in the ICU for the purpose of monitoring many physiological pressures which includes central venous pressure, arterial pressure, pulmonary capillary pressure, intraortic balloon pump measures, systolic pressure variation, intrabdominal pressure etc. The transducer is a soft silicone diaphragm attached to a Wheatstone bridge which is responsible for conversion of pressure change to an electric resistance in the circuit which is thus viewed as a waveform giving us values and figures.

Proper placement of the transducer (i.e. in the 4th intercostal space in the midaxillary line) is of paramount importance as we are aware that a 10 cm difference in the placement from the original will result in a variation of 7.4 mm of Hg leading to bigger errors in derived measurements as well as measurements like PCWP and CVP [1,2].

There many methods of placing the transducer

- On a pole beside the patient at the level of the phlebostatic axis (as very often done with iabp)
- On the bed railing
- On the arm of the patient
- On the foot end of the patient as seen sometimes in neuro anaesthesia
- On a manifold secured to a pole.

There are no practice guidelines clearly explaining the method to ensure the proper placement of the transducer. Many intensive care units locate this point arbitrarily hypothesizing that the error may not be significant. Very few units use a "carpenters measure" to ensure the proper positioning of the line, which in the authors opinion should be the right way of locating the phlebostatic axis.

By means of this study we tried to find the error in measurement of pressures when the transducer was placed arbitrarily on a pole versus when placed with the help of carpenters measure also called as the spirit level.

Critical care patient needs intense monitoring of haemodynamics and with the help of modern technology in place it has extended to various monitoring like continuous invasive arterial line monitoring, central venous pressure monitoring, pcwp monitoring, intra-abdominal monitoring, intra-aortic balloon pump etc. For all these kinds of hemodynamic indices the use of pressure transducers are common. The transducer changes one form of energy to another, therefore it converts kinetic energy produced by changes in the pressure to the electrical energy. For monitoring purpose every medical personnel is trained to place this transducer at phlebostatic axis which is With the head of bed at 60 degrees or less, is located at the fourth intercostal space at the mid-anterior-posterior diameter of the chest wall. This is the location of the right atrium, where the tip of a CVP catheter would lay. The ways of placing the transducer differs from ICU to ICU. They can be either placed on the arm of the patient or attached to the side stand or there are various placing holders like true clip holders. The wrong placement of it can lead to differences in the monitoring and may lead to errors in management. Therefore, it is an utmost important prerequisite to be followed during handling and monitoring with these monitoring kits. In this study we used Spirit level measure routinely used by the carpenter to actually measure the exact level of phlebostatic axis and then monitored the arterial bp.

Objectives of the Study:

1. To compare measured pressure between two methods of placement viz - Arbitrary vs guided (with carpenters spirit measure).
2. To compare the spirit measure method with direct placement by securing the transducer on the arm with the help of a cotton tape.

Method

This study was conducted in a 30 bedded tertiary care institute where nurses were instructed to place the transducer on the pole immediately after placing the arterial line. All of the nurses were trained to locate the phlebostatic axis (4^{th} intercostal space in the mid axillary line). However, none of them were given a carpenters spirit level. 90 patients were studied leading to a total of 90 measurements. Nurses in our ICU are trained and licensed from standard recognized institutes from all over India.

On observation it was noticed that nurses used some form of arbitrary measurement like

1. Using a scale to locate corresponding point on the pole
2. Using a non flexible tape measure for the same
3. Arbitrarily estimating the position of the transducer by "eyeballing".

After doing so this was again double checked by an independent intensive care unit Resident medical officer.

Measurement of Systolic blood pressure, diastolic blood pressure and Mean arterial blood pressure were noted. Subsequently a second independent resident medical officer was appointed to use a carpenters spirit measure to modify the location of the transducer and then note the readings of the blood pressure.

Also, the error in cm of the placement of the transducer was also noted. The transducer was then secured on the mid-arm of the patient by way of a cotton tape and the readings were noted. Errors were considered to have occurred when the difference between the systolic

blood pressure and diastolic blood pressure with the actual (as measured after using a carpenter's measure) was greater than 10 mm of hg or map > 5 mm of hg. This figure was chosen as such changes would warrant alteration in treatment.

Results

We compared the difference in the readings when the levels are changed according to the spirit level measure as compared to that placed by the nurse. It was found was that out of 90 number of patients which were studied 49 number of times the transducer was placed at the wrong level, (leading to alteration in measured parameters). This corresponded to an error of 54.40%. There was a mean variation of 13 mm hg in the systolic pressure and 10 mm hg in the diastolic blood pressure. The mean arterial pressure was showed a variation 12 mmhg.

It was noted that placement of the transducer on the arm closely mirrored the actual measured blood pressure measured after placing transducer with the help of a carpenters measure.

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Discussion

Fluid filled transducer systems are responsible for converting pressure to electric resistance and produce a reading and a wave from for correct understanding of physiological pressures. The set up of the transducer along with a non compliant tubing involves zeroing and leveling at the phlebostatic axis. Zeroing is the process where the transducer reads the atmospheric pressure as the zero value. Leveling is placement of the transducer at a level that we consider to be zero on the patient and this has been conventionally at the level of the phlebostatic axis. This position corresponds roughly to the right atrium and the aortic root [1]. For every 10 cm below the phlebostatic axis the arterial line will add 7.4 mm Hg of pressure. It is this leveling that thus becomes a vital part of the monitoring of pressures and correct interpretation of patient condition.

Many monitoring devices like central lines, swanz ganz catheter, intra cranial pressure monitors, intraabdominal pressure monitors, therapeutic devices like intra-aortic balloon pump, etc. all use the fluid filled transducer systems. Accurate data acquisition will depend on accurate placement of the transducer of the fluid filled transducers. This is the key aspect of modern anaesthetic and critical care practice. Inaccurate placement of the transducer will lead to erroneous reading and thus inappropriate treatment.

A study that included 391 nurses from two university affiliated hospitals in the united states concluded that a general lack of knowledge of nurses when tested via an 18-item questionnaire that evaluated ABP physiology, technical aspects of ABP monitoring, and ABP waveform interpretation. Numerous such studies have demonstrated general knowledge deficit in principles of hemodynamic monitoring [3,4]. It is highly possible that nurses and healthcare workers might not even understand or know the importance of the correct placement of the transducer in the phlebostatic axis and the alteration of measurements if not done so.

Hence it is imperative to ensure at least correct acquisition of data as this is a sort of "preventable" error.

There are practice guidelines that explain where the transducer has to be placed (phlebostatic axis). However, there are no guidelines emphasizing the" right way "to do the same or how this has to be done.

The results of our study demonstrate that any other methods of levelling the transducer, other than using a carpenters spirit level, may lead to erroneous readings.

Conclusion

Monitoring like arterial blood pressure monitoring is a scientifically and clinically validated method that helps us in our pursuit of good patient care and real time monitoring. Our study clearly demonstrates that significant errors are seen when the transducers are placed on a pole besides the patient especially when the levelling has not been done with the help of a carpenters measure. Hence our study draws some important conclusions:

1. If transducer needs to be placed on the pole a spirit level (carpenters measure) should be used to locate the right level.
2. Securing the transducer to the arm level is also an acceptable method to prevent erroneous readings.

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