The Cuff or the Catheter

Here's the scenario. You've been called to a patients' room to fix their arterial line because it's been reading 20 - 30 points higher or lower than the NBP cuff pressure reading? You look up at the monitor and see that there's a beautiful, text-book quality, arterial waveform on the monitor that doesn't change when you manipulate the position of the patients hand. The line draws and flushes without flaw. A complete visual inspection reveals no kinks in the tubing, no loose connections, and no leaks. The next thought that probably crosses your mind is there's probably nothing wrong with the arterial line reading at all. It's the non-invasive cuff that's not reading correctly. Now the REAL challenge begins. Trying to convince a Critical Care RN of this reality…

Usually when there is a significant difference between an arterial line blood pressure reading and a non-invasive blood pressure cuff reading the nurse has the option of which reading to use. More often than not the reading that gets used is the non-invasive reading. It's been my experience that most critical care RN's are more comfortable treating the numbers computed from a non-invasive cuff than measured results from an arterial line measurement. There seems to be a natural fear of the technology in an arterial line measurement. This has been an ongoing argument for as long as I've been practicing as a Respiratory Therapist. (Hint: That's a very long time).

Okay, so let's get down to the dirt. Does this in-fact have an effect on patient care? It absolutely does, especially if the patient is being treated based on the numbers obtained from a blood pressure measurement. What if an arterial line measurement shows the blood pressure to be 200/105 and a NBP cuff reads the blood pressure to be 125/85, and the RN is more comfortable with the NBP numbers (which happens more often than not). A patient who is close to dangerously hypertensive will not get treated and is now at risk arterial rupture. This can cause a devastating CVA (stroke). Who's fault would it be? It would be best if we could simply avoid this type of situation in the first place, but how can we accomplish that?

Perhaps the solution to this '*real*' patient care issue is in the education. In the hospital setting there are several different types of non-invasive blood pressure measurement devices in use. While it's true that most healthcare professionals know how to use these devices it's also true that most healthcare professionals only have a limited understanding of how these devices actually function. They simply know that they put a cuff around the arm of their patient, push the button to activate the device, the

cuff inflates and deflates, and their blood pressure appears on the digital display. Where do those numbers come from? Exactly what is the machine doing when the cuff is inflating and deflating? Where do the numbers come from? Most of them simply do not know. We're going to dig into those very questions.

Non-invasive blood pressure measurement is, for the most part, is safe, easy, and painless but it is not without its complications. The two most common types of non-invasive blood pressure measuring devices seen in the hospital setting are auscultatory and oscillometric method devices.

Auscultatory Devices:

Auscultatory devices are those that use an inflatable cuff and a stethoscope. The inflatable cuff is positioned around the upper arm at about the same vertical height as the heart and inflated to a pressure that exceeds the systolic blood pressure. The stethoscope is placed over the brachial artery while the cuff is slowly deflated. The examiner listens for the sound of the blood pulsating in the brachial artery. The pressure at which this first starts is the systolic blood pressure. The cuff continues to slowly deflate. The pressure at which the pulse is no longer heard in the brachial artery is the diastolic blood pressure.

What Affects the Numbers:

- **Cuff Size**:
  - A cuff that is too small will measure the blood pressure to be incorrectly high.
  - A cuff that is too large will measure the blood pressure to be incorrectly low.
- **Peripheral Edema**:
  - If there is a moderate amount of peripheral edema in the arm that is being used to measure blood pressure the measured blood pressure can actually be unpredictably measured high. This is because sound travels much better through water. However, the density of the limb (fat, muscle) will also have an effect on the numbers in either direction.
- **Cuff Fitting Too Loosely**: A blood pressure cuff that it fitted too loosely will measure the blood pressure as being inaccurately too high.
- **Cuff Positioned Improperly**: The center blood pressure cuff should be positioned directly over the brachial artery. A poorly positioned cuff will measure the blood pressure inaccurately high.
- **Cuff Inflated Too Slowly**: If the cuff is inflated too slowly will cause venous congestion in the area. Venous congestion will cause the Korotkoff sounds to be faint which will cause the systolic reading to be incorrectly low and the diastolic reading to be incorrectly high. This combination of incorrect readings will also give the incorrect appearance of a narrow pulse pressure.

Oscillometric Devices:

This technology has actually been around since the late 1800's. Oscillometric devices are a little more complicated because they don't actually "listen" for the sounds of turbulent blood flow (Korotkoff sounds) in the brachial artery. Oscillometric devices work by actually measuring the oscillations in the inflated cuff that are created by oscillations from within the brachial artery (the brachial pulse). A transducer within the system then converts the pressures to the numbers you see on the monitor. Often in clinical practice is an electronic version of an Oscillometric device. It uses an inflatable cuff, a pressure transducer to observe the pressure oscillations within the cuff, and computer electronics to interpret them. The cuff is inflated to a pressure that exceeds the systolic blood pressure. The pressure is then gradually decreased over a period of about 30 seconds until it is at a level below the diastolic blood pressure. During the time when the pressure in the cuff exceeds systolic, or is below diastolic, the cuff pressure is constant because there is no blood flow. During the time when blood flow is present the pressure within the cuff is monitored by the pressure transducer. This pressure varies in cyclic synchrony with the cyclic expansion and contraction of the brachial. The systolic and diastolic blood pressure values are 'computed' by the raw data received from the pressure transducer during blood flow presence. Yes, I said the numbers are 'computed', they are not actually measured. This is an important point to keep in mind when treating patients by the numbers.

While it's true that these devices actually require less clinical skill to use the limitations of these devices must also be completely understood. Unfortunately, in clinical practice, these limitations are most often misunderstood and more often completely unknown.

These devices must be calibrated periodically to maintain accuracy. It must also be understood that there are several clinical circumstances that will have a significant impact on the measured result. If you are indeed treating your patient by the measured numbers you MUST be completely familiar with these circumstances and their effect on the measurements. Here are some of the more common causes of inaccurate measurements:

- The size of the cuff is important 100% of the time in patient care. A cuff that is too small for the patients arm WILL result in a pressure that is inaccurately high, and a cuff that is too large for the patients arm WILL result in a pressure that is inaccurately low.
- A cuff that is too tight or too loose will ALWAYS render an inaccurate blood pressure measurement.
- Other conditions that will OFTEN render inaccurate measurements are;
    - Certain heart diseases
    - Cardiac arrhythmia
    - Poor circulation

- Arterial sclerosis
- Preeclampsia
- Pulsus alternans
- Pulsus paradoxus

There are several other technologies available that measure and compute blood pressure, each with varying results. There are no two different types of devices that will consistently render significantly similar results so it is critically important that you become very familiar with the devices you are using with your patients, and keep their limitations in mind. AND, above all remember this; One of the most important things we do in healthcare is take "care" of patients, who are real LIVE human beings. At the very least they have a right to our very best at all times. After all, if the cards were turned wouldn't you want the same?