

# Comparison of calf and brachial blood pressures in infants: Is there a difference between calf and brachial blood pressures?

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*The standard of care is to obtain a noninvasive blood pressure (NIBP) measurement from the right upper arm. However, in the pediatric population it is common practice to take blood pressure (BP) measurements from the calf/upper ankle. Nurses commonly take calf NIBPs for many reasons, but there is little evidence to support calf BPs as a reliable site for BP measurement. Furthermore, there is conflicting evidence. Some studies suggest no difference between the calf and the upper arm BPs, whereas others conclude great variability between the two. The purpose of this study was to demonstrate the reliability of calf BPs, by showing no difference between brachial and calf BP measurements in neonates and infants  $\leq 1$  year old. From July 2008 to December 2008, a convenience sample of 52 subjects admitted to the Neonatal and Infant Critical Care Unit were enrolled into the study. Limb selection was not randomized. Three BPs were taken from the arm and 3 BPs were taken from the calf. Data were analyzed using a mixed analysis of variance ( $P = 0.05$ ). The difference was not significant for systolic ( $P = 0.6159$ ) or mean BP ( $P = 0.1298$ ), but it was significant for diastolic ( $P = 0.0263$ ). The authors concluded that these results support the current practice of bedside nurses and contribute to the limited knowledge on this topic. Because there was a difference in the diastolic BPs, further investigation is needed. (J Vasc Nurs 2014;32:139-143)*

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*Poster presentation*

**School of Nursing Research Symposium:** Azusa Pacific University, Azusa, California, April 12, 2012.

*Poster presentation*

**Florida Magnet Research:** Naples, Florida, February 10-13, 2010.

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The standard of care is to obtain a noninvasive blood pressure (NIBP) measurement from the right upper arm.<sup>1</sup> However, in the pediatric population it is common practice to take blood pressure (BP) measurements from the calf/upper ankle. Nurses commonly take calf NIBPs to minimize disturbance to the neonate/infant, when other extremities are not available, or when it is more convenient. Although calf BPs are commonly taken, there is little evidence to support calf BPs as a valid and reliable site for BP measurement. Important clinical decisions are made from NIBPs, for example, titrating vasopressors or administering a medication. Therefore, the reliability of calf BP measurement needs to be determined.

A review of literature showed conflicting evidence. Park and Lee<sup>2</sup> found little difference in calf and brachial BPs, but their sample population consisted of neonates <3 days old. Axton et al<sup>3</sup> found no difference in calf and brachial BPs, but suggest a baseline measurement from each extremity to use for comparison. Andriessen et al<sup>4</sup> demonstrated a correlation between noninvasive wrist BP and intra-arterial pressure in preterm infants. Alternatively, Kunk and McCain<sup>5</sup> suggest that calf BPs should only be taken from infants who are <5 days old because there were significant differences in calf and brachial BPs after 7 days of life. Kunk and McCain<sup>5</sup> theorized the differences were caused by a decrease in lower peripheral blood flow or a patent ductus arteriosus. Crapranzano et al<sup>6</sup> concluded that calf BPs should not replace brachial BPs. There was great variability between the 2 measurements in healthy infants and children; the calf BPs were usually lower. Schell et al<sup>7</sup> found significant differences in calf and arm BPs in pediatric intensive care unit patients. Similarly, studies in the adult population also suggest that calf BPs should not be used.<sup>8-10</sup>

TABLE 1

## RESULTS OF DATA ANALYSIS

| <i>Parameter</i> | <i>Loc</i> | <i>Estimate</i> | <i>Error</i> | <i>DF</i> | <i>t Value</i> | <i>Pr &gt;  t </i> | <i>Alpha</i> | <i>Lower</i> | <i>Upper</i> |
|------------------|------------|-----------------|--------------|-----------|----------------|--------------------|--------------|--------------|--------------|
| Systolic BP      |            |                 |              |           |                |                    |              |              |              |
| Standard effect  |            |                 |              |           |                |                    |              |              |              |
| Loc              | Brach      | 77.0641         | 1.7060       | 51        | 45.17          | <0.0001            |              |              |              |
| Loc              | Calf       | 76.4679         | 1.7060       | 51        | 44.82          | <0.0001            |              |              |              |
| Standard label   |            |                 |              |           |                |                    |              |              |              |
| Calf- Brach      |            | -0.5962         | 1.1810       | 51        | -0.50          | 0.6159             | 0.05         | -2.9671      | 1.7748       |
| Diastolic BP     |            |                 |              |           |                |                    |              |              |              |
| Standard effect  |            |                 |              |           |                |                    |              |              |              |
| Loc              | Brach      | 44.7500         | 1.5229       | 51        | 29.38          | <0.0001            |              |              |              |
| Loc              | Calf       | 42.1346         | 1.5229       | 51        | 27.67          | <0.0001            |              |              |              |
| Standard label   |            |                 |              |           |                |                    |              |              |              |
| Calf- Brach      |            | -2.6154         | 1.1429       | 51        | -2.29          | 0.0263             | 0.05         | -4.9099      | -0.3208      |
| Mean BP          |            |                 |              |           |                |                    |              |              |              |
| Standard effect  |            |                 |              |           |                |                    |              |              |              |
| Loc              | Brach      | 55.8462         | 1.4967       | 51        | 37.31          | <0.0001            |              |              |              |
| Loc              | Calf       | 54.2692         | 1.4967       | 51        | 36.26          | <0.0001            |              |              |              |
| Standard label   |            |                 |              |           |                |                    |              |              |              |
| Calf- Brach      |            | -1.5769         | 1.0241       | 51        | -1.54          | 0.1298             | 0.05         | -3.6328      | 0.4790       |

BP = blood pressure; Brach = brachium; Loc = location.

Limited data on calf BPs and inconsistencies in the literature reinforce the need for additional research. The purpose of this study was to demonstrate the reliability of calf BPs by showing no difference between brachial and calf BP measurements in neonates and infants  $\leq 1$  year old.

## METHODS

### Design

This prospective, quasi-experimental, descriptive study received institutional review board approval. Study procedures occurred between July 2008 to December 2008. Written parental consent was obtained for all study participants. Inclusion criteria were any neonate (preterm or term) or infant admitted to the neonatal and infant critical care unit and parental consent. Exclusion criteria were any neonate or infant with severe osteopenia, fractures, arterial or venous clots, thrombus, extremely fragile skin, no arms, or no legs.

### Participants

We collected a convenience sample of 52 patients in the Neonatal and Infant Critical Care Unit at a children's hospital in a major metropolitan city. The ages ranged from 3 to 207 days old, born at 24 to 40 weeks gestation. We enrolled 30 males and 22 females in the study.

### Instruments

BPs were measured with the Philips Agilent oscillometer (Santa Clara, CA). Oscillometers have several advantages because they require little training, have no observer bias, and are easy to use.<sup>11</sup> Oscillometers are widely used in neonatal intensive care units (NICU) and healthcare facilities and are the standard of care for BP measurement.<sup>12,13</sup> The literature supports the validity of BP measurements from the oscillometer.<sup>14</sup> Oscillometers measure BP by performing calculations from oscillations of the BP cuff.<sup>15</sup> The biomedical engineering department validated, inspected, and maintained the oscillometers used in this study. Chen et al<sup>16</sup> state that automated oscillometric devices are appropriate in measuring BPs, so long as the device is validated. Additionally, Gillman and Cook<sup>11</sup> and Nwanko et al<sup>17</sup> support the use of oscillometers in young children.

### Data collection

Three trained registered nurses performed the BP measurements. Cuff selection followed American Heart Association<sup>18</sup> guidelines that state the width of the bladder should be  $\geq 40\%$  of the circumference of the midpoint of the extremity. The same sized cuff was used for the brachial and calf BPs because the diameters of the infant's arms and legs did not vary significantly. There was no randomization in initial limb selection. Limb selection was chosen out of convenience. Extremities

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