Oscillometric vs Calculated MAP: Why doesn’t it always match?

**The Problem:** Mary Jones underwent a cardiac procedure this morning and is under observation for BP instability in CICU. In the cath lab, she needed vasopressors to regulate her blood pressure, and her nurse has orders to treat with vasopressors if her mean arterial pressure (MAP) drops below 60 mmHg for more than 15 minutes. Mary’s oscillometric cuff is set to measure q5 min NIBP for the first 30 minutes post procedure. Systolic (SBP), diastolic (DBP), and mean arterial pressure (MAP) values are recorded in her electronic medical record.

Mary’s nurse does a head-to-toe assessment and double-checks the last MAP value based on her usual calculation method (SBP + 2DBP) / 3. She discovers that her calculated MAP value doesn’t match the displayed MAP value. and concludes the monitor isn’t working correctly.

**The Question:** Is something malfunctioning? Can the nurse trust what she sees on the monitor? Why are these values different?

<table>
<thead>
<tr>
<th>Time</th>
<th>Systolic Pressure (SBP)</th>
<th>Diastolic Pressure (DBP)</th>
<th>Spacelabs displayed Mean Arterial Pressure (MAP)</th>
<th>Nurse-calculated MAP</th>
<th>Δ (Delta= difference in measurement values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1100</td>
<td>76</td>
<td>42</td>
<td>52</td>
<td>53.33</td>
<td>-1.33</td>
</tr>
<tr>
<td>1105</td>
<td>86</td>
<td>51</td>
<td>61</td>
<td>62.67</td>
<td>-1.67</td>
</tr>
<tr>
<td>1110</td>
<td>82</td>
<td>47</td>
<td>66</td>
<td>58.67</td>
<td>7.33</td>
</tr>
<tr>
<td>1115</td>
<td>83</td>
<td>53</td>
<td>61</td>
<td>63</td>
<td>-2.00</td>
</tr>
<tr>
<td>1120</td>
<td>84</td>
<td>49</td>
<td>59</td>
<td>60.66</td>
<td>-1.66</td>
</tr>
<tr>
<td>1125</td>
<td>87</td>
<td>52</td>
<td>62</td>
<td>64.33</td>
<td>-2.33</td>
</tr>
</tbody>
</table>
The Reality: The confusion is understandable.
True MAP can only be determined by invasive monitoring and complex calculations.\(^1\) But, most clinicians have been taught a quick way to estimate the MAP in clinical situations. The formula \(\text{MAP} = (\text{SBP} + 2 \times \text{DBP})/3\) provides a calculated approximation of the MAP. Contrary to what clinicians have learned to rely on, this calculation does not provide an accurate absolute value, but rather an estimation of MAP they can perform quickly and easily.

Defining Oscillometric MAP method: As with all noninvasive blood pressure measurements, accurate readings assume the basics of proper technique and cuff size.\(^2\) The oscillometric MAP value is based on the cuff pressure and the pulse amplitudes, and is the most accurate value displayed by the oscillometric BP method.\(^3\) There is no math estimation required. Quite simply, the mean arterial pressure is equal to the cuff pressure where maximum pulse amplitude is detected. Consider this example:

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{OSC SBP} & 145 & \text{OSC DBP} & 80 & \text{OSC MAP} & 106 \\
\text{NURSE CALC MAP} & 101.66 & \Delta & -4.33 \\
\hline
\end{array}
\]

In the above example, the OSC MAP is 106. If the nurse calculated MAP with her estimation formula, the MAP would be calculated at 101.66. Again, the potential confusion comes from the estimation calculation. The oscillometric MAP will not always match the estimated calculation.

So, how do these compare to invasive pressure readings?
Research shows that invasive BP and oscillometric BP values don’t always match, but are generally within 5 mmHg of each other, an accepted variable in medicine.\(^4,5\) In the most critical situations, patients often have invasive arterial lines in place to monitor blood pressures, and clinicians will most often use these measurements to guide treatment. But, invasive lines are removed as soon as safely possible to minimize complications and infection.
The answer: Oscillometric MAP values more closely mirror invasive pressure MAP values than SBP and DBP values.6,7 Clinicians can trust the MAP values displayed on Spacelabs monitors, and understand that these will often vary slightly from calculated MAP values using the (SBP + 2DBP / 3) estimation method.4

The Spacelabs fine print: We validate our NIBP via clinical trials. The standard governing automated noninvasive BP monitors have very explicit instructions on how to perform clinical trials to verify accuracy of devices. The required tests are to compare the device's measurements with either auscultatory or invasive measurements for adults and children, and to compare with invasive measurements for neonatal patients. Measurement of blood pressure using oscillometry (used by all automated NIBP monitors) closely matches manual auscultatory measurements for systolic and diastolic pressures. Neither noninvasive measurement method closely matches invasive blood pressures for systolic and diastolic pressures, yet auscultatory measurements have been standard clinical care for over 100 years.

As for the core question of accuracy of mean arterial pressure measurements for the three methods (invasive, auscultatory, oscillometric), Spacelabs sponsored an unpublished comparison in the 1980's that showed oscillometric mean pressure was quite a close match to invasive mean pressure. We reviewed the most recent clinical trial reports from the SL Command Module (91496) as well. The adult and pediatric portions of the clinical validation were done against the auscultatory readings. Mean pressure is not evaluated when using auscultatory measurements as the reference per the standard. The neonatal portion of the study was conducted using invasive pressures and although MAP accuracy is not part of the standard we did record the data and included it in our final report. For this study, the mean error of the MAP measurement was 0.3 mmHg, well within ANSI/AAMI/ISO accepted standards.8

References: