Background: In 1990, we developed a Dual Monitor Protocol with simultaneous, same arm blood pressure (BP) measurements and postural challenges to test the accuracy and reliability of 24-hr ambulatory blood pressure monitors (ABPMs). ABPM differences with mercury (Hg) column. ABPMs in the lab were used to adjust for ABPM inaccuracies during 24-hr field tests. We found in 15 normotensive, 14 hypertensive and 11 primary alcohol-dependent hypertensive Acutrack II ABPMs had excessive inter-device variability, far above levels of agreement than observers using a Hg column and problems assessing diastolic (DBP) and systolic pressures (SBP) that provoked patient misclassifications (up to 73% DBP, up to 20% SBP incorrect classification).

Purpose: Our goals were to determine the accuracy and reliability of popular oscillometric ABPMs, the Oscar 2 (SunTech Medical, Morrisville, NC) and SunTech 90207/90217 (Spacelabs Healthcare, Snoqualmie, WA), by using a modification of our Dual Monitor Protocol.

Hypotheses: Oscillometric ABPMs ultimately rely upon auscultation to derive sample-specific, static equations similar to a nomogram. Like a beam projecting out from a flashlight, mean arterial pressure (MAP), estimated from peak cuff pressure oscillations, is used to predict SBP and DBP. As with auscultatory ABPMs, we predicted that the Oscar and Spacelabs oscillographic ABPMs will have a lower agreement compared to observers using a Hg column, making them susceptible to measurement errors and patient misclassifications.

Methods: In the lab, simultaneous, same arm BPs were assessed in 10 subjects by two observers using an Hg column and Thinskape (SunTech) software, and using an oscillographic ABPM by Oscar 2 and Spacelabs 90207/90217. In the postural challenges, we used a controlled laboratory setting, the Oscar oversampled the Hg column (SBP 7/10) and the Spacelabs 70% (7/10) of observers’ SBPs by > 5 mm Hg (Table 1). The ABPMs either overestimated (both Oscar and Spacelabs 30, 3/10) or underestimated (Oscar 10%, 1/10; Spacelabs 20%, 2/10) observers’ DBPs. The Oscar underestimated 20% (4/20) of BPs based on HAH ACC & 20% on ESH guidelines. The Oscar overestimated the observers’ Hg column SBP by 8.8 mm Hg, 95% of measurements (< 2 SD) 24.2 mm Hg above to 6.5 mm Hg below the observers (20.7 mm Hg range) (Figure 1). The Oscar overestimated the observers’ DBP by a 1.2 mm Hg, but exhibited extreme variability with 95% of DBPs 17.8 mm Hg above to 15.4 mm Hg below observers (33.2 mm Hg range) (Figure 2). The Spacelabs overestimated the observers’ SBP by 5.4 mm Hg, with 95% of SBPs 19.9 mm Hg above to 9.0 mm Hg below the observers (28.9 mm Hg range) (Figure 3). The Spacelabs overestimated the observers’ DBP by 1.4 mm Hg, but with wide variability, 95% of DBPs were 14.4 mm Hg above to 12.0 mm Hg below observers (36.1 mm Hg range) (Figure 4). The Oscar overestimated the Spacelabs (5% for Spacelabs underestimated the Oscar) SBP by an average of 3.4 mm Hg with 95% of SBPs oversampled 18.1 mm above to 11.3 mm Hg below to the Spacelabs (29.4 mm Hg range) (Figure 5). The Oscar underestimated the Spacelabs DBP by less than 1 mm Hg (0.2 mm Hg), but for 95% of DBPs was 10.3 mm Hg below to 9.9 mm Hg above the Spacelabs (20.2 mm Hg range) (Figure 6). The Oscar overestimated the Spacelabs DBP by 3.5 mm Hg (95% CI: 0.7 to 7.3 mm Hg) for supine (P < 0.05), 4.7 mm Hg (95% CI: 1.6 to 7.8 mm Hg) for supine (P < 0.01), and 3.8 mm Hg (95% CI: 0.6 to 6.2 mm Hg) for supine (P < 0.05). For standing measures, the Spacelabs underestimated (A~L<0.05) the Oscar’s DBP by 1.0 mm Hg, but with wide variability, 95% of DBPs were 10.4 mm Hg above to 9.4 mm Hg below the Oscar (20.2 mm Hg range) (Figure 7). The Oscar overestimated the Spacelabs SBP by 1.0 mm Hg (95% CI: 1.0 to 2.0 mm Hg) for supine (P < 0.01), but underestimated the Spacelabs DBP by 4.9 mm Hg (95% CI: 0.6 to 9.1 mm Hg) for standing (P < 0.05). For supine measures, the Spacelabs overestimated (P < 0.05) the Oscar’s DBP by 6.4 mm Hg (95% CI: 1.2 to 11.7 mm Hg) (Figure 8). For standing measures, the Spacelabs underestimated (A~L<0.05) the Oscar’s DBP by 1.0 mm Hg, but with wide variability, 95% of DBPs were 10.4 mm Hg above to 9.4 mm Hg below the Oscar (20.2 mm Hg range) (Figure 9).

Summary & Conclusions: Oscars and Spacelabs oscillographic ABPMs are erratic in estimating individual BPs, have a low level of agreement and can differ clinically and statistically from observers using a Hg column in a controlled laboratory setting. Over 70% (Spacelabs) and 90% (Oscar) of SBPs can be overestimated by 5 or more mm Hg, misclassifying patients, especially those near entry thresholds. These inaccuracies become increasingly important with new US guidelines shifting the definition of hypertension to lower levels. Over- and underestimations vary with posture. Our results, though in a small number of mostly (70%, 7/10) normotensive subjects, do not provide confidence in 24-hr measurements during a time when patients are active and assume multiple postures. At the very least, US and international protocols for validating ABPMs must develop more stringent standards and require postural testing; and while we have difficulties in our trust in ambulatory BP monitors.

Figure 1: Oscar vs. Spacelabs SBP differences for baseline tests.

Figure 2: Oscar vs. Spacelabs DBP differences for baseline tests.

Figure 3: Oscar vs. Spacelabs SBP differences for baseline tests.

Figure 4: Oscar vs. Spacelabs DBP differences for baseline tests.

Figure 5: Oscar vs. Spacelabs SBP differences for postural tests.

Figure 6: Oscar vs. Spacelabs DBP differences for postural tests.

Figure 7: Oscar vs. Spacelabs SBP differences for postural tests.

Figure 8: Oscar vs. Spacelabs DBP differences for postural tests.

Figure 9: Oscar vs. Spacelabs SBP differences for postural tests.