Abstract Title: Automated Transducer Leveling System for Pressure Measurements

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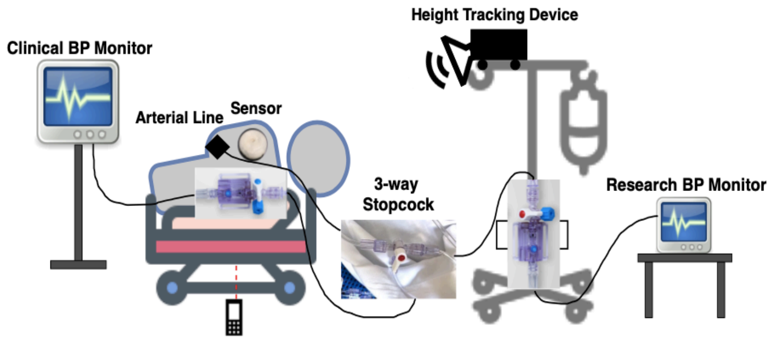
Background: Accurate invasive pressure measurements depend on the alignment of the pressure transducer with the patient's phlebostatic axis (level of the right heart) which is typically done by visually estimating the phlebostatic axis and manually moving the transducer which is on an IV pole near the patient. When the patient's position changes, the provider must remember to correspondingly move the transducer. There is currently no warning system or way to remind a provider to make this adjustment. Failure to align the pressure transducer with the patient's phlebostatic axis can lead to inaccurate pressure measurements, initiation of inappropriate treatment, and can cause patient harm. We compared invasive blood pressure measurement estimates obtained with our novel automated height tracking system to blood pressure measurements obtained by the clinical monitor.

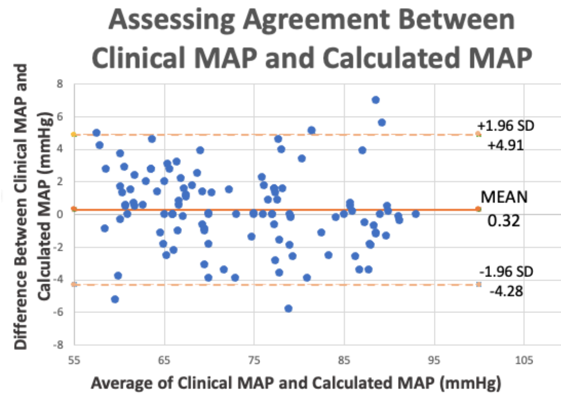
Methods: We created a novel automated height tracking system consisting of a wireless sensor that attaches to the patient's chest and a detector device with a wireless speaker that can determine the sensor's height using inaudible sound waves. The automated height tracking system maintains the pressure transducer in a stationary position, estimating the blood pressure with hydrostatic force adjustments based on continuous height measurements. We obtained paired height measurements in the intensive care unit (ICU) using a laser distance meter (laser level height) and the automated height tracking system (estimated height) while changing the patient's bed height to 10 random heights over the range of 50 cm. We also obtained paired invasive blood pressure measurements using the clinical monitor with the transducer taped to the patient's chest (clinical blood pressure) and a second research monitor with a stationary transducer (research blood pressure). We then compared the clinical blood pressure and research blood pressure measurements by adjusting for the height difference to account for hydrostatic forces between the stationary transducer and the sensor (multiplied by a 0.77 conversion factor for cmH2O to mmHg).

Results: A total of 120 paired height and blood pressure measurements were collected from 9 post-cardiac surgery patients in the ICU. Each session consisted of 10 paired height measurements. The mean ± SD for the height difference between the heights measured by the laser distance meter (laser level height) and the automated transducer leveling system (estimated height) was 0.7 cm ± 1.0 cm. The mean ± SD for the mean arterial pressure difference between the clinical and calculated blood pressure measurements based on the laser level height measurements was 0 mmHg ± 3.0 mmHg. The mean ± SD for the mean arterial pressure difference between the clinical and calculated blood pressure measurements based on the estimated height measurements was 0.6 mmHg ± 3.3 mmHg.

Discussion: Our novel automated height tracking system is able to detect changes in the patient's position and determine the height difference between the transducer and the patient's chest obviating the need for the provider to remember to manually adjust the transducer height. This new system demonstrates high accuracy and precision and could be incorporated into clinical care pending integration into existing monitors. This innovation has the potential to improve patient care and safety as well as decreasing provider workload, limiting the potential for human error.



Clinical BP Monitor
Height Tracking Device
Arterial Line
Sensor
3-way
Stopcock
Research BP Monitor



Assessing Agreement Between
Clinical MAP and Calculated MAP
Difference Between Clinical MAP and Calculated MAP (mmHg)
Average of Clinical MAP and Calculated MAP (mmHg)
+1.96 SD
+4.91
MEAN
0.32
-1.96 SD
-4.28
8
6
4
2
0
-2
-4
-6
-8
55
65
75
85
95
105