

Cuffless Blood Pressure Monitoring Using a Novel Wrist-Worn Photoplethysmography Device: Validation Against Intra-Arterial Blood Pressure

Background: Cuffless blood pressure (BP) monitoring devices with the ability to continuously and noninvasively collect data could transform the screening and management of hypertension. While some wearable devices can estimate BP, their accuracy and reliability remain limited.

Objective: To evaluate the feasibility of using a wrist-worn photoplethysmography (PPG) device (Lifeleaf®) in combination with a supervised learning algorithm to infer clinically useful BP measurements.

Methods: A total of 87 patients undergoing electrophysiology procedures were enrolled (Table 1). Time-synchronized BP data from an intra-arterial line served as the reference. These data were divided into (1) a training set to develop a convolutional neural network (CNN) and (2) a testing set to assess the algorithm's predictive performance. Data from 60 patients were used to train the model, and the remaining 27 patients were used for validation.

Results: Data from 81 of 87 patients were included in the final analysis. The mean age was 63.6 ± 10.5 years, and 69.1% were male. A total of 6,977 paired PPG and arterial BP readings were analyzed. The mean absolute deviation for systolic BP was 13.08 ± 17.22 mm Hg, and for diastolic BP, 8.42 ± 10.56 mm Hg. Subgroup analysis revealed reduced correlation in patients with BP $>140/90$ mm Hg, likely due to fewer training samples in this range.

Conclusion:

This study demonstrates the feasibility of extracting clinically meaningful BP measurements from a PPG device using a supervised learning algorithm. The use of arterial line BP as the reference standard adds methodological rigor. Future work will focus on enhancing model performance, particularly in the hypertensive cohort.

Table 1: Demographic characteristics of enrolled subjects

	Total
Number of Subjects Started	87
Number of Subjects Completed	81
Reasons for each subject not completing	Either procedure got cancelled or the subject got withdrawn for a medical reason.
Age	Mean: 63.6 SD: 10.51
Number of Females	25
Number of Males	56
Ethnicity	Ethnicity information not collected.
Race	Racial information not collected.

Table 2: Performance of systolic blood pressure against arterial line reference

BP Brackets	Count	Mean Absolute Deviation	Mean Percentage Deviation	Mean Deviation	Standard Deviation of Error
SBP < 120	5103	10.20	9.92%	-4.98	11.92
SBP 120-139	1464	15.78	12.13%	15.45	9.86
SBP 140-160	219	31.43	21.28%	31.43	11.78
SBP > 160	130	58.64	35.04%	58.64	8.83
All SBP	6977	13.08	11.29%	1.90	17.22

Table 3: Performance of diastolic blood pressure against arterial line reference

BP Brackets	Count	Mean Absolute Deviation	Mean Percentage Deviation	Mean Deviation	Standard Deviation of Error
DBP < 80	6565	7.33	11.53%	2.12	8.94
DBP 80-89	259	21.73	25.69%	21.73	6.04
DBP 90-100	75	31.18	33.70%	31.18	6.32
DBP > 100	40	33.63	31.50%	33.63	4.59
All DBP	6977	8.42	12.56%	3.52	10.56