Binary Hypertension Classification Using a Calibration-Free Optical Blood Pressure Measurement Technique at Home

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BACKGROUND

Undiagnosed hypertension remains a leading cause of premature death worldwide. Automated office blood pressure measurement (AOBP) using inflatable cuff-based technology is associated with convenience limitations and inaccuracies, including white-coat hypertension with normal ambulatory or home blood pressures (BP) [1]. We aimed to identify the presence or absence of elevated BP among participants using a smartphone-based cuffless BP measurement technique at home.

METHODS

For this internal validation study, 21 Teladoc employees performed daily blood pressure (BP) reading "sessions", defined as a set of readings (all within 30 minutes) taken from two devices: (1) an FDA-approved **BodyTrace BP monitor**; and (2) **OptiBP**, an Android mobile application driven by a cuffless pulse wave analysis algorithm for smartphone-derived photo-plethysmography (PPG) signals **[FIGURE 1].**

Based on BP monitor readings (without reference to OptiBP readings), each session was **dichotomously labeled** as "True" if the mean **systolic BP ≥ 130 mmHg** or the mean **diastolic BP ≥ 80 mmHg**, and "False" otherwise.

Separately, OptiBP readings for each session were converted (without calibration or reference to BP monitor readings) into **continuous prediction scores** (0.0 to 1.0), indicating the likelihood of those same mmHg thresholds being reached, based on a previously published algorithm [2, 3].

RESULTS

Users varied in the number of successful readings per session, with a median of 3 cuff readings and 3 OptiBP readings **[FIGURE 2]**. Accordingly, we examined **receiver operating curves** (ROC; i.e., binary labels vs. prediction scores) and associated **confusion matrix metrics** (i.e., binary labels vs. binary predictions), after first limiting to sessions with combinations of 1+, 2+, or 3+ reading pairs **[TABLE 1]**.

This analysis revealed that sessions with 3+ readings from each device (BP monitor and OptiBP) had the highest ROC area under the curve (AUC) (= 0.848) **[FIGURE 3]**. Binarizing model-derived prediction scores at the threshold that minimized the distance between the ROC curve and the top left corner of the ROC plot (= 0.451) yielded a corresponding sensitivity of 0.833, specificity of 0.795, and precision of 0.755.

CONCLUSION

These results highlight the potential for calibration free, smartphone-based cuffless blood pressure measurements to be part of a strategy to improve hypertension screening and identify individuals at risk of high blood pressure, particularly when regular in-clinic visits are infeasible.

We report **good agreement** between a traditional **cuff-based BP monitor** and a novel, PPG-based **smartphone app** in the ability to detect **elevated BP** in a home-based setting — without prior device calibration.

Smartphone-based BP measurements could be part of a strategy to **improve access to screening** for hypertension, helping to identify individuals with elevated risk of high blood pressure **when in-clinic visits are not feasible**.
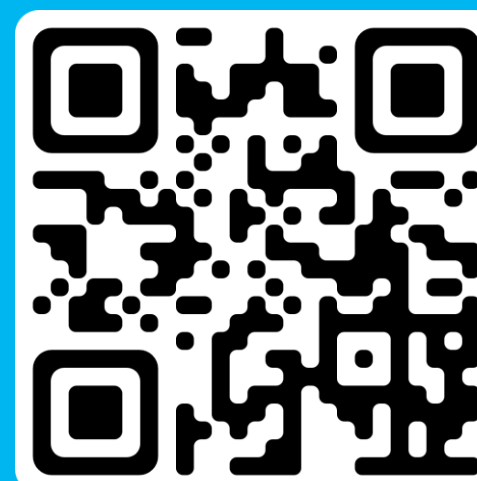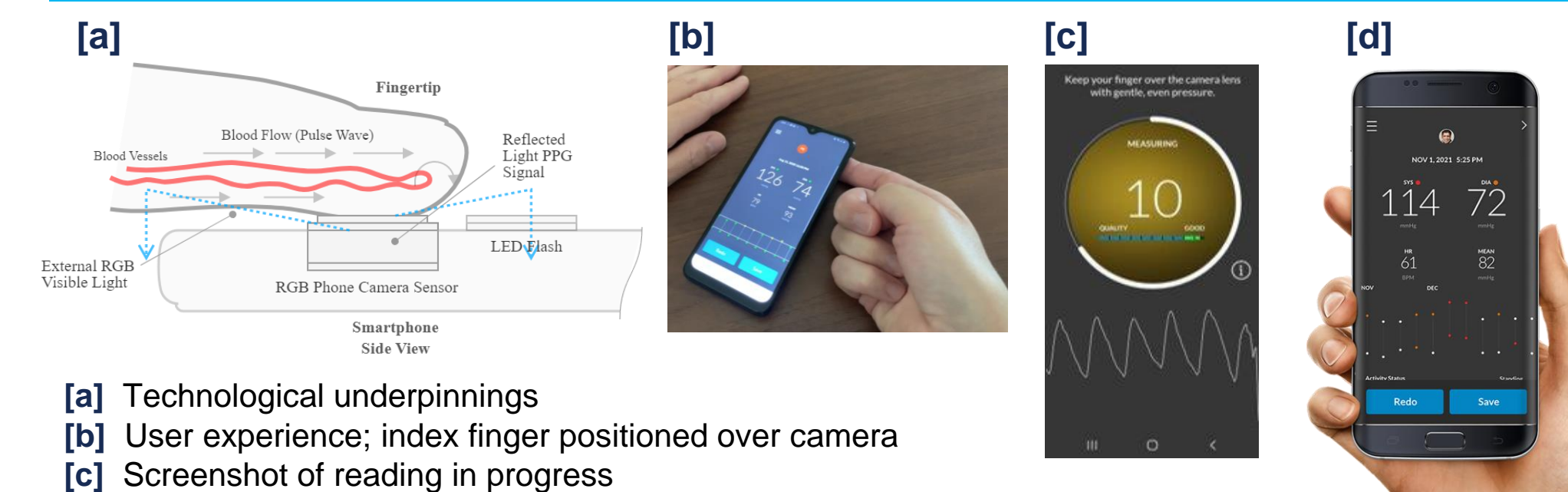
ACC.23 TOGETHER WITH **WCC**

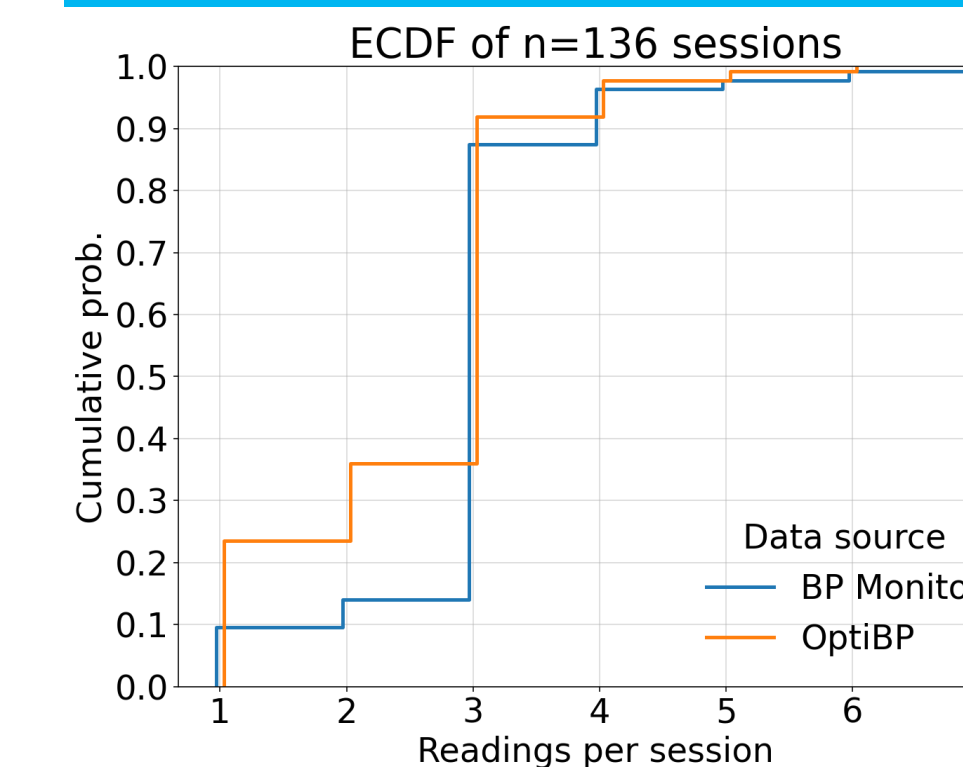### FIGURE 1: OptiBP technology highlights

[a] Technological underpinnings
[b] User experience; index finger positioned over camera
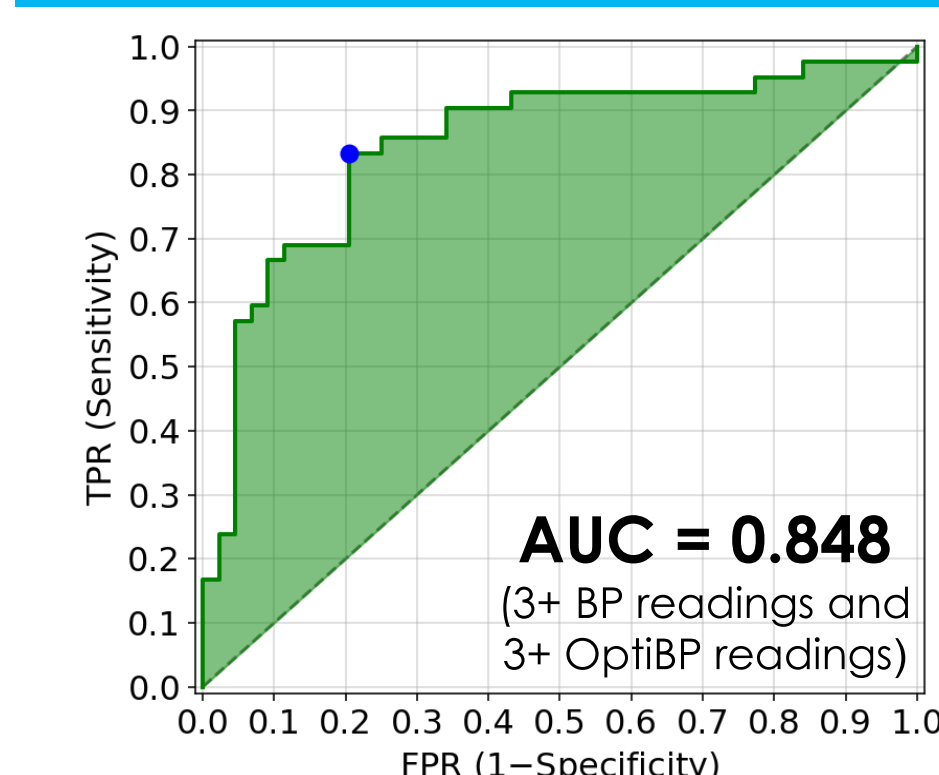[c] Screenshot of reading in progress
[d] Reading results displayed to user

FIGURE 2: Readings per session

ECDF of n=136 sessions

Empirical cumulative distribution functions (ECDFs) of the number of BP monitor readings (in blue) and OptiBP app readings (in orange), across all sessions.

FIGURE 3: Example ROC curve

AUC = 0.848
(3+ BP readings and 3+ OptiBP readings)

ROC curve associated with device agreement given 3+ readings from each device, per session. The blue dot is the point on the curve closest to the top left corner.

TABLE 1: Statistical analysis

Data thresholds		Data metrics			ROC metrics				
BP monitor readings per session	OptiBP app readings per session	Unique individuals	Total sessions	Elevated BP in cuff readings	ROC AUC	ROC curve threshold (thr)	TPR @ ROC thr	FPR @ ROC thr	Precision @ ROC thr
1+	1+	21	136	54.4%	0.810	0.451	0.811	0.258	0.845
1+	2+	17	104	48.1%	0.800	0.451	0.780	0.222	0.745
1+	3+	15	87	49.4%	0.830	0.451	0.814	0.205	0.780
2+	1+	20	123	50.4%	0.811	0.451	0.806	0.246	0.741
2+	2+	16	103	47.6%	0.816	0.451	0.796	0.222	0.745
2+	3+	14	86	48.8%	0.848	0.451	0.833	0.205	0.775
3+	1+	18	117	47.9%	0.803	0.451	0.804	0.246	0.722
3+	2+	15	101	46.5%	0.808	0.451	0.787	0.222	0.739
3+	3+	14	86	48.8%	0.848	0.451	0.833	0.205	0.775

Key metrics of agreement between the traditional BP monitor and the OptiBP smartphone app, when thresholding / filtering by the number of successful readings on each device, per session.

REFERENCES

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DISCLOSURE INFORMATION