# Healthcare Utilization and Costs Associated with Remote Blood Pressure Monitoring in a US Integrated Healthcare System

EE249

Anna T. Novelli[1], Teresa N. Harrison[1], Rachelle A. Juan[1], Hui Zhou[1], Matthew T. Mefford[1], Janet Mora Marquez[1], Angeline L. Ong-Su[2], Jeffrey W. Brettler[3,4], Kristi Reynolds[1,4], Jaejin An[1,4]

1. Kaiser Permanente Southern California, Pasadena, CA, USA; 2. Kaiser Permanente Panorama City Medical Center, Panorama City, CA, USA; 3. Kaiser Permanente West Los Angeles Medical Center, Los Angeles, CA, USA; 4. Kaiser Permanente Bernard J. Tyson School of Medicine

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## Background

- Self-measured blood pressure (BP) monitoring at home is associated with BP reduction and improved BP control among patients with hypertension and might be a cost-effective strategy for improving BP control[1].
- In 2019, Kaiser Permanente Southern California (KPSC) implemented a remote blood pressure monitoring (RBPM) program to support management of patients with hypertension.

## Objective

To evaluate the 12-month cost-effectiveness of the RBPM program vs usual care in patients with hypertension by assessing:

- mean RBPM enrollment costs per patient
- number of healthcare encounters per patient associated with the RBPM program
- incremental effectiveness of participating in the RBPM program on BP
- incremental cost-effectiveness ratio (ICER) of the RBPM program in terms of BP reduction compared to usual care

## Methods

- **Study design:** Cost-effectiveness analysis based on RBPM data and electronic health records
- **Study population**: Adult KPSC members who were enrolled in the RBPM program between 11/2019 and 06/2022 (N= 3067).
  - Intervention group: enrolled, uploaded at least 1 BP recording. ($N_{IG}$=1853)
  - Usual care group: enrolled but abandoned the program. ($N_{UCG}$=1214)
- **Perspective:** Healthcare system perspective
- **Outcomes**:
  - Effectiveness measure: Mean BP reduction (in mmHg)
  - Healthcare use: Number of hypertension-related healthcare encounters
  - Costs: Enrollment costs and costs related to healthcare use (2020 $US)
  - ICER ($US per mmHg BP reduction)
- **Statistical analysis**: Generalized linear difference-in-differences models adjusted for demographic and clinical characteristics using inverse probability of treatment weights. Confidence intervals of incremental costs and effects and the visualization of incremental costs and effects in the cost-effectiveness planes based on bootstrap analysis (2000 replications).

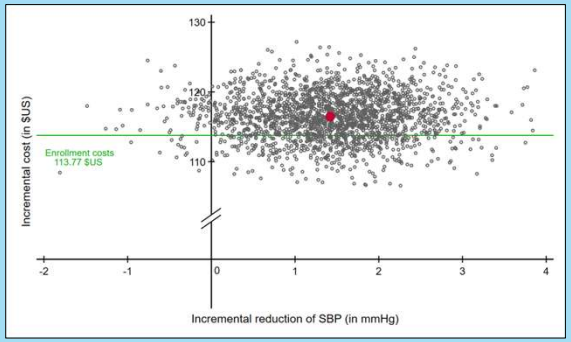


**Figure 1.** Cost-effectiveness plane showing bootstrapped, adjusted incremental costs and effects in terms of reduction in SBP. In red: point estimate for incremental cost and effect.

## Results

- **Enrollment costs** amount to 113.77 $US (**Table 1**).
- **Healthcare encounters**: Intervention group patients show small but significantly less hypertension-related in-person office visits and BP clinic visits but an increase in hypertension-related virtual encounters (**Table 2**).
- **The incremental costs** associated with utilization are small and not statistically significant (mean cost (SE)=2.70 (3.36) $US, p=0.422) (**Table 2**).
- A small **reduction in BP** can be observed (SBP: 1.42 (0.79), p=0.071; DBP: 1.58 (0.50), p<0.001). (**Table 2**).
- **ICER**s: 81.97/73.49 $US per mmHg SBP/DBP reduction (**Table 3**).
- The visualization of bootstrap analysis of incremental costs and effects shows that most data points are in the upper right quadrant of the cost-effectiveness plane = higher costs and positive effect (**Figure 1**).

## Conclusion

The RBPM program is more costly but shows small, positive effects in terms of BP reduction compared to usual care.

**Table 1.** Mean RBPM enrollment costs (in $US)

| | Per patient |
|---|---|
| **Costs for device and shipping** | 80.85 |
| Device cost | 61.03 |
| Shipping cost | 19.82 |
| **Costs for managing patients** | 32.92 |
| Identify, Reach out, schedule appointment | 6.33 |
| Enrollment in-office visit | 26.59 |
| **Total enrollment costs** | **113.77** |

**Table 2.** Mean adjusted healthcare use, utilization costs (in $US) and BP reduction (in mmHg)

| | 12-month pre-enrollment | | 12-month post-enrollment | | Difference in difference | p-Value |
|---|---|---|---|---|---|---|
| | UCG | IG | UCG | IG | | |
| **Mean (SE) number of visits** | | | | | | |
| HTN office visit | 0.12 (0.01) | 0.16 (0.01) | 0.15 (0.01) | 0.13 (0.01) | -0.05 (0.02) | 0.016 |
| BP clinic visit | 0.25 (0.02) | 0.27 (0.01) | 0.24 (0.02) | 0.17 (0.01) | -0.10 (0.03) | 0.002 |
| HTN virtual encounter | 0.15 (0.01) | 0.14 (0.01) | 0.15 (0.01) | 0.53 (0.04) | 0.39 (0.04) | <0.001 |
| **Mean (SE) costs** | | | | | | |
| HTN office visit | 14.96 (1.47) | 18.93 (1.36) | 18.25 (1.62) | 15.70 (1.18) | -6.52 (2.70) | 0.016 |
| BP clinic visit | 6.55 (0.50) | 7.22 (0.40) | 6.46 (0.54) | 4.55 (0.30) | -2.58 (0.82) | 0.002 |
| HTN virtual encounter | 4.48 (0.44) | 4.30 (0.36) | 4.35 (0.42) | 15.98 (1.14) | 11.80 (1.28) | <0.001 |
| Total utilization costs | 26.00 (1.74) | 30.46 (1.61) | 29.01 (2.02) | 36.23 (1.86) | **2.70 (3.36)** | 0.422 |
| **Mean (SE) BP** | | | | | | |
| SBP | 142.80 (0.50) | 142.80 (0.41) | 135.39 (0.51) | 133.97 (0.38) | **-1.42 (0.79)** | 0.071 |
| DBP | 80.29 (0.40) | 81.21 (0.34) | 76.39 (0.39) | 75.73 (0.31) | **-1.58 (0.50)** | 0.001 |

IG, intervention group; UCG, usual care group; HTN, hypertension; BP, blood pressure; SDB/DBP, systolic/diastolic blood pressure; Estimates, standard errors, and P values derived from generalized linear models adjusting for demographic and clinical characteristics

**Table 3.** Cost-effectiveness analysis

| | |
|---|---|
| Δ Cost (95% CI) in $US | 116.47 (109.96, 122.98) |
| Δ SBP reduction (95% CI) in mmHg | 1.42 (-0.13, 2.97) |
| ICER point estimate in $US/mmHg SBP reduction | 81.97 |
| Δ DBP reduction (95% CI) in mmHg | 1.58 (0.62, 2.54) |
| ICER point estimate in $US/mmHg DBP reduction | 73.49 |

SBP, systolic blood pressure; DBP diastolic blood pressure; ICER, incremental cost-effectiveness ratio.
95% confidence intervals are based on bootstrap analysis with 2000 replications.

Reference: 1 Shimbo D, Artinian NT, Basile JN, et al. on behalf of the American Heart Association and the American Medical Association (2020). Self-Measured Blood Pressure Monitoring at Home: A Joint Policy Statement From the American Heart Association and American Medical Association. Circulation 142:e42–e63

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