Community Preventive Services Task Force

Heart Disease and Stroke Prevention: Self-Measured Blood Pressure Monitoring Interventions for Improved Blood Pressure Control

Task Force Finding and Rationale Statement

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Intervention Definition

Self-measured blood pressure monitoring interventions support and promote the use of personal blood pressure measurement devices in the management and treatment of high blood pressure. Patients are trained to use validated, and usually automated, blood pressure measurement devices on a regular basis in familiar settings, typically their homes. Patients share blood pressure readings with their healthcare providers during clinic visits, by telephone, or electronically. These measurements are monitored and used in treatment decisions to improve blood pressure control.

Self-measured blood pressure monitoring interventions may be combined with additional support:

- One-on-one patient counseling on medications and health behavior changes (e.g., diet and exercise);
- Educational sessions on high blood pressure and blood pressure self-management; and/or
- Access to electronic or web-based tools (e.g., electronic requests for medication refills, text or email reminders to measure blood pressure or attend appointments, direct communications with healthcare providers via secure messaging).

Self-measured blood pressure monitoring interventions are often used with team-based care.

Task Force Finding (June 2015)

The Community Preventive Services Task Force recommends self-measured blood pressure monitoring interventions to improve blood pressure outcomes in patients with high blood pressure. There is sufficient evidence of effectiveness for self-measured blood pressure monitoring interventions when used alone (i.e., patients receive self-measured blood pressure tools, training, and monitoring). There is strong evidence of effectiveness for these interventions when combined with additional support (i.e., patient counseling, education, or web-based support). The economic evidence indicates that self-measured blood pressure monitoring interventions are cost-effective when they are used with additional support or within team-based care.

Rationale

Basis of Finding

The Task Force finding is based on evidence from a systematic review published in 2013 (Uhlig et al., 52 studies, search period through February 2013). The 2013 review evaluated the effectiveness of self-measured blood pressure monitoring interventions when used alone or when combined with additional support to manage high blood pressure. For studies evaluating self-measured blood pressure monitoring alone, Uhlig and colleagues conducted a meta-analysis and reported relative risks and weighted net differences across multiple time points. Because of clinical heterogeneity, however, only narrative results were reported for self-measured blood pressure monitoring combined with additional support. To better inform Task Force conclusions on health impact, the Uhlig et al. estimates were transformed into absolute percentage point changes and net differences using the latest time point available.

The finding of sufficient evidence of effectiveness for self-measured blood pressure monitoring interventions when implemented alone is based on evidence from 26 studies with 28 study arms. Patients in these studies received blood pressure monitoring devices, were trained to use them, and shared blood pressure readings with their healthcare providers. Results demonstrated consistent and meaningful improvements in blood pressure when the intervention was

compared with usual care. Results were statistically significant at the 6-month time point and continued to be favorable at 12 months, although smaller in magnitude.

Table 1: Results: Self-Measured Blood Pressure Monitoring When Used Alone

Outcome Measure	Uhlig et al. Results (vs. usual care)	Transformed Results (vs. usual care)
Proportion of Patients with Blood Pressure at Goal	**6 months** Relative Risk: 1.30 (95% CI: 1.0 to 1.68) 7 study arms **12 months** Relative Risk: 1.18 (95% CI: 0.95 to 1.46) 3 study arms	**Median follow-up: 6 months** Median: increase of 6.9 percentage points (IQI: 3.7 to 22.0 percentage points)[A] 13 study arms
Change in Mean Systolic Blood Pressure (SBP)	**6 months** Weighted mean difference: decrease of 3.9 mmHg (p<0.001) 10 study arms **12 months** Weighted mean difference: decrease of 1.5 mmHg (not significant) 9 study arms	**Median follow-up: 9 months** Median: decrease of 3.2 mmHg (IQI: -7.5 to -0.05 mmHg)[B] 18 study arms
Change in Mean Diastolic Blood Pressure (DBP)	**6 months** Weighted mean difference: decrease of 2.4 mmHg (p<0.001) 12 study arms **12 months** Weighted mean difference: decrease of 0.8 mmHg (not significant) 9 study arms	**Median follow-up: 6 months** Median: decrease of 1.3 mmHg (IQI: -3.4 to 0.25 mmHg)[B] 21 study arms

A Absolute percentage point changes compared with usual care were calculated using the latest time point available.
B Difference-in-differences of the mean compared with usual care were calculated using the latest time point available.
CI, confidence interval; IQI, interquartile interval; mmHg, millimeters of mercury

The finding of strong evidence of effectiveness for self-measured blood pressure monitoring interventions when combined with additional support is based on evidence from 25 studies with 29 study arms. Additional support varied between studies and was categorized into three main groups: one-on-one patient counseling or telecounseling (11 studies), access to electronic or web-based tools (7 studies), and education on high blood pressure and blood pressure self-management (5 studies). Half of these studies were conducted using a team-based care arrangement where health care providers worked alongside other professionals, such as nurses and pharmacists, to improve coordination of care and support for patients (14 studies with 17 study arms). Results demonstrated consistent and meaningful improvements in blood pressure that were sustained at 12 months when the intervention was compared with usual care (Table 2).

Table 2: Results: Self-Measured Blood Pressure Monitoring with Additional Support

Outcome Measure	Uhlig et al. Results (vs. usual care)	Transformed Results (vs. usual care)
Proportion of Patients with Blood Pressure at Goal	Five studies reported a statistically significant higher proportion of patients achieving their blood pressure target	**Median follow-up: 9 months** Median: increase of 5.3 percentage points (IQI: -0.5 to 12.0 percentage points)[A] 18 study arms
Change in Mean Systolic Blood Pressure (SBP)	**12 months** Five high-quality studies[B] reported a mean net reduction in systolic blood pressure (range: -2.1 to -8.3 mmHg)	**Median follow-up: 12 months** Median: decrease of 4.6 mmHg (IQI: -8.7 to -2.1 mmHg)[C] 26 study arms
Change in Mean Diastolic Blood Pressure (DBP)	**12 months** Five high-quality studies[B] reported a mean net reduction in diastolic blood pressure (range: -4.4 to 0 mmHg)	**Median follow-up: 9 months** Median decrease of 2.3 mmHg (IQI: -3.9 to -0.83 mmHg)[C] 28 study arms

A Absolute percentage point changes compared with usual care were calculated using the latest time point available.
B Study quality was assessed using AHRQ methods (Owens, 2010).
C Difference-in-differences in the mean compared with usual care were calculated using the latest time point available.
IQI, interquartile interval; mmHg, millimeters of mercury

One study, conducted over a 5-year period, reported changes in mortality associated with a self-measured blood pressure monitoring intervention combined with educational sessions in patients with diabetes and kidney disease. Results showed significantly lower mortality rates among patients in the self-measured blood pressure monitoring group than patients who received usual care.

Findings were inconsistent for effectiveness of self-measured blood pressure monitoring interventions (used alone or combined with additional support) on medication adherence, health-related quality-of-life, or patient satisfaction.

Applicability and Generalizability Issues

Included studies were mainly conducted in the U.S. (23 studies) and Europe (18 studies), followed by Canada (6 studies), Australia (2 studies), Brazil (2 studies), and South Korea (1 study). Self-measured blood pressure monitoring interventions were mostly delivered in outpatient, general practice, or primary care settings (46 studies). Only a few studies delivered self-measured blood pressure monitoring interventions in other settings such as communities (5 studies), a pharmacy (1 study), at home (1 study), or the workplace (1 study). Only three studies included more than 500 patients.

All patients who received self-measured blood pressure monitoring interventions were trained to use blood pressure monitors provided by the programs and measured their blood pressure at home. Most included studies provided patients with automated blood pressure cuffs (38 studies). Blood pressure readings were taken by the patients themselves or by caretakers (52 studies). Patients' blood pressure readings were delivered to healthcare providers during medical visits as self-recorded readings (23 studies), through electronic transmissions sent directly from blood pressure devices to central databases that providers could access (15 studies), or by mail (5 studies). Additional support was administered by trained healthcare providers (e.g., pharmacists, nurse practitioners, physician assistants, health educators) and content was tailored for individuals based on their reported blood pressure readings.

Included study populations consisted primarily of adults aged 18-64 years with an even distribution of men and women. Among the 40% of included studies that reported race/ethnicity, populations primarily identified as white/Caucasian (median proportion: 72%; 15 studies). Two studies in which 75% or more of the patients identified as African-American found favorable blood pressure outcomes, indicating that self-measured blood pressure monitoring interventions when combined with additional support can be effective in this population.

Most studies reported that all patients had uncontrolled blood pressure at baseline (36 studies). In studies that included patients whose blood pressure was controlled at baseline, further improvements in blood pressure were shown at follow-up, indicating that self-measured blood pressure monitoring interventions also help patients adhere to treatment when their blood pressure is under control (6 studies). Four studies that targeted populations with both high blood pressure and diabetes observed greater improvements in blood pressure compared to overall findings, suggesting self-measured blood pressure monitoring interventions are effective among populations with comorbidities.

Data Quality Issues

Included studies were randomized controlled trials (49 studies) and non-randomized studies (3 studies) in which self-measured blood pressure interventions were compared with usual care. Study quality was assessed using the Agency for Healthcare Research and Quality methods as described by Owens (2010). Common limitations affecting this body of evidence were loss to follow-up, insufficient descriptions of the intervention, substantial differences between intervention and comparison groups at baseline, and outcomes that were not clearly defined.

Other Benefits and Harms

Self-measured blood pressure monitoring interventions may reduce the need for clinic appointments solely for blood pressure checks because healthcare providers can collect this information without requiring patients to travel to a doctor's office for every blood pressure reading. Further, as patients become more aware of their blood pressure readings, they may also become more motivated to improve other lifestyle behaviors such as healthful eating, physical

activity, and smoking cessation. Self-measured blood pressure monitoring interventions potentially could be harmful if patients self-adjust their blood pressure medications without provider guidance.

Economic Evidence

Economic evidence indicates that self-measured blood pressure monitoring interventions are cost-effective when used with additional patient support or within team-based care. There was not enough evidence to determine cost-effectiveness of the interventions when used alone; however, the averted cost of medication and outpatient visits exceeded the intervention cost. All monetary values reported are in 2014 U.S. dollars.

The economic review included 22 studies (search period through March 2015) that were conducted in the U.S. (13 studies), Europe (8 studies), and Japan (1 study). None of the studies performed a cost-benefit analysis or reported intervention effects on productivity (e.g., work absences due to illness, overall performance when at work, number of working years).

Intervention Cost. For self-measured blood pressure monitoring, intervention cost includes the cost of blood pressure monitoring devices, the cost of materials used to communicate readings to healthcare providers, and the labor cost associated with training patients and reviewing records. The cost increases with additional support or when the intervention occurs within team-based care. The median intervention cost was $60 per person (IQI: $55 to $74; 7 studies) for self-measured blood pressure monitoring alone, $174 per person (IQI: $63 to $362; 7 studies) for interventions used with additional support, and $732 per person per year (IQI: $279 to $946; 6 studies) for interventions used within team-based care.

Total Cost. The intervention cost plus the change in healthcare cost equals the total cost of the intervention. Healthcare cost is defined as the cost for medication, outpatient visits, hospital inpatient stays, and emergency room visits. When the estimated total cost is positive, the intervention is cost-increasing; when it is negative, the intervention is cost-saving.

For self-measured blood pressure monitoring alone, five of six total cost estimates were negative (median: -$72 per person IQI: -$257 to $142) over a median follow-up period of 12 months, indicating the intervention is cost-saving. Five of six total cost estimates for self-measured blood pressure monitoring with additional support were positive (median: $44 per person; IQI: $6 to $250) over a median follow-up period of 9 months, indicating the intervention was cost-increasing. In the case of self-measured blood pressure monitoring interventions used within team-based care, all seven estimates of total cost were positive (median: $430 per person per year; IQI: $244 to $1,112) over a median follow-up period of 18 months, indicating the intervention was cost-increasing.

One study used modeling to estimate the cost per quality adjusted life year (QALY) saved. Ten additional studies that reported cost and change in systolic blood pressure were used to calculate cost per QALY saved over a 20 year period, using two recognized methods (McEwan et al., 2006; Mason et al., 2005).

Evidence for self-measured blood pressure monitoring alone is inconsistent. Two studies reported decreased systolic blood pressure and reduced total cost; two studies reported increased systolic blood pressure and reduced total cost; and one study reported reduced systolic blood pressure but was cost-ineffective with cost per QALY saved ($100,000 and $144,000, based on the two methods) exceeding the conservative threshold of $50,000.

The weight of evidence from eight studies indicates that self-measured blood pressure monitoring interventions with additional support or within team-based care are cost-effective. Estimates from four studies of interventions with

additional support found a cost per QALY saved below $50,000 (medians of $2800 and $4000). The two methods produced median cost per QALY saved of $7,500 and $10,800 from four studies of interventions within team-based care; four estimates from four studies were below $50,000 per QALY saved and two additional estimates from one of those studies were above.

Considerations for Implementation

The Million Hearts Initiative® released two action guides on self-measured blood pressure monitoring interventions based on findings from Uhlig et al. (2013):

- Self-Measured Blood Pressure Monitoring: Action Steps for Public Health Practitioners
- Self-Measured Blood Pressure Monitoring: Action Steps for Clinicians

The following considerations for implementation are drawn from information provided in these action guides.

Implementers need to consider the type of blood pressure monitor patients use. Most included studies (73%) provided patients with automated blood pressure monitors, and the action guides suggest monitors with an automated upper arm cuff validated by the Association for the Advancement of Medical Instrumentation, British Hypertension Society, and European Hypertension Society. Measurement frequency varied among included studies, and experts from the American Heart Association, European Hypertension Society, and British Hypertension Society recommend patients take 2-3 successive readings at least twice a day, once in the morning and once in the evening.

Although all of the included studies provided patients with blood pressure monitors and training, some programs may ask patients to provide their own blood pressure monitors. If programs use this approach, patients should bring their blood pressure monitors into the office to ensure they are using them properly.

The cost of a blood pressure monitor may be a barrier for some patients asked to provide their own device. As of 2015, the cost of a validated automated blood pressure device ranged from $50 to $100. Insurance benefits for blood pressure monitors vary by payer, and Medicaid coverage varies by state. Medicare Part B does not cover home blood pressure monitors and Medicare Part C is not required to cover home blood pressure monitors, though it may be offered under supplemental coverage.

The type and cost of additional support provided with self-measured blood pressure monitoring varied widely among included studies, making it difficult to determine whether one form of support was more effective than another. The action guides, however, note the following common elements of successful self-measured blood pressure monitoring support provided across the evaluated interventions: delivery by trained healthcare providers (e.g., pharmacists, nurse practitioners, physician assistants, health educators); regular patient communication of blood pressure readings to providers; and establishment of a patient/provider "feedback loop" in which provider support and advice are personalized based on patients' reported information.

Reimbursement mechanisms for telemedicine, a potentially large component of some self-measured blood pressure monitoring interventions, needs to be considered before programs are widely implemented. Although face-to-face office visits remain an important form of interaction between patients and clinicians, other forms of care such as electronic and phone communication may be warranted. The clinical care workload is expected to increase as the number of Medicare-eligible patients grows and the volume of patients in the primary care system increases under the Patient Protection and Affordable Care Act. Traditional office-based and fee-for-service models of healthcare delivery

and payment reimburse clinicians only for office-based visits and services. Other delivery and care models such as patient-centered medical homes, accountable care organizations (ACOs), and telemedicine need to be considered.

Evidence Gaps

More evidence is needed to answer the following questions:

- How effective are self-measured blood pressure monitoring interventions that require patients to provide their own blood pressure monitoring devices, as this is likely to occur more often in practice?
- What are the optimal frequencies for blood pressure measurement by patients and blood pressure monitoring by clinicians?
- What forms of additional support are most effective?
- What is the role of telemedicine in self-measured blood pressure monitoring interventions, and how does it affect the patient–provider interaction and medication management?
- How effective are self-measured blood pressure monitoring interventions among various subgroups including racial/ethnic minorities, low-income populations, patients with comorbidities, and children?
- What are the long-term benefits of self-measured blood pressure monitoring interventions including effects on morbidity and mortality?
- How effective are self-measured blood pressure monitoring interventions in community and worksite settings? Do interventions in these settings strengthen community–clinical linkages?
- What are intervention costs when the cost of blood pressure monitoring devices and materials (including software) are distributed over the duration of use?
- What are the returns on investment in self-measured blood pressure monitoring interventions, based on the monetized value of benefits including reduced mortality and averted productivity losses?

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The data presented here are preliminary and are subject to change as the systematic review goes through the scientific peer review process.

Disclaimer

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