

# Current Trends in Medicine

## Research Article

# Long-Term Follow-Up of integrated primary care models for essential hypertension

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## Abstract

**Background:** Integrated primary care models combining registry-based recall, pharmacist- or nurse-led titration, and home blood-pressure telemonitoring have produced large early gains in hypertension control, but whether these gains are sustained over a multi-year horizon has been less well characterized.

**Objective:** This study reports a long-term follow-up of an integrated primary care hypertension program, examining control trajectories, cardiovascular and renal outcomes, and predictors of durable control.

**Methods:** Adults with essential hypertension enrolled in a multi-site integrated care program were followed for up to five years. Blood-pressure control was assessed annually; cardiovascular and renal outcomes and predictors of sustained control at final follow-up were analyzed with multivariable logistic regression.

**Results:** Control rose from 46% at enrollment to approximately 90% by year two among telemonitoring-enrolled participants and was largely sustained through year five; sustained early control was associated with fewer composite cardiovascular events over follow-up. Telemonitoring use, pharmacist-visit frequency, and registry-based recall independently predicted durable control, while comorbidity burden and low adherence predicted loss of control.

**Conclusions:** Blood-pressure control achieved through integrated primary care models can be sustained over the long term and is associated with reduced downstream cardiovascular and renal morbidity, supporting continued investment in multi-component integrated hypertension care.

**Keywords:** hypertension; primary care; integrated care; team-based care; long-term follow-up

## 1. Introduction

Essential hypertension remains the leading modifiable driver of cardiovascular mortality worldwide, and despite decades of pharmacologic advances, population-level control rates have plateaued well below guideline targets in most health systems [1,2]. In the United States, national surveillance data through the late 2000s showed that fewer than half of treated hypertensive adults achieved sustained control, a gap attributable less to the absence of effective drugs than to fragmented delivery of chronic disease care [3]. The Chronic Care Model, first articulated by Wagner and colleagues, argued that durable improvement in conditions such as hypertension requires reorganizing the encounter itself around planned, team-based follow-up rather than episodic, physician-only visits [4], and a decade of accumulated evidence subsequently confirmed that practices adopting its core elements achieved measurably better intermediate outcomes across chronic diseases [5].

Two developments reframed hypertension management specifically around integration. First, large single-system implementations, most notably the Kaiser Permanente Northern California program, demonstrated that a bundled intervention combining a shared hypertension registry, medical-assistant-driven rechecks, pharmacist-led titration, and a simplified single-pill-first algorithm could raise control rates from roughly 44% to above 90% within less than a decade [6,7]. Second, a series of pragmatic trials and systematic reviews established that team-based care, broadly defined as care in which non-physician team members share responsibility for monitoring, titration, or counseling, produced consistently larger blood-pressure reductions than usual physician-only care, whether delivered by pharmacists [8,9], nurses [10], or trained community health workers [11]. The Community Preventive Services Task Force's systematic review of team-based care concluded the evidence was sufficient to recommend the approach for population-wide adoption [12], and a Cochrane review of

multifaceted interventions to improve blood pressure control reached a similarly favorable, if more cautious, conclusion [13].

What remains comparatively sparse is long-term, multi-year follow-up data describing whether the control gains achieved by integrated primary care models in their first one to two years are sustained, whether they translate into fewer downstream cardiovascular and renal events, and which patient and program characteristics predict durable rather than transient control. Randomized evidence such as the SPRINT trial established that more intensive blood-pressure targets reduce cardiovascular events [14], and ALLHAT demonstrated the comparative effectiveness of first-line agent classes [15], but neither addressed the organizational question of how control, once achieved, is maintained in routine practice over years rather than months. This study reports a long-term follow-up of an integrated primary care hypertension program, examining control trajectories, cardiovascular and renal outcomes, and predictors of sustained control over an extended observation period.

## 2. Methods

### Study Design and Setting

We conducted a long-term, multi-site observational follow-up of patients enrolled in an integrated primary care hypertension program operating across general and internal medicine clinics. The program combined the core elements described in prior implementation reports: a registry-based population panel, protocol-driven rechecks by medical assistants and nurses, pharmacist- or nurse-initiated titration under collaborative practice agreements, home blood-pressure telemonitoring for a subset of participants, and standardized escalation pathways aligned with contemporary guideline thresholds [16,17]. The design followed the general structure used in prior team-based-care evaluations of chronic hypertension management [8,18], extended here to a multi-year observation window rather than the

twelve-month horizon typical of earlier trials.

**Population and Integrated Care Model**

Adults with a confirmed diagnosis of essential hypertension, defined per contemporary guideline criteria [19,16], and at least one follow-up blood-pressure measurement beyond index enrollment were eligible. Patients with secondary hypertension, end-stage renal disease at baseline, or pregnancy-associated hypertension were excluded. The integrated model assigned each enrollee to a care team consisting of a primary care physician, a care-coordinating nurse, and, where available, a clinical pharmacist responsible for medication titration between physician visits, an arrangement modeled on pharmacist-integrated protocols shown to outperform usual care in prior randomized comparisons [9,20]. A subset of participants received home blood-pressure telemonitoring devices with periodic pharmacist review, following the telemonitoring-plus-pharmacist-management approach validated in cluster-randomized trials [21,22].

**Outcome Measures and Statistical Analysis**

The primary outcome was blood-pressure control, defined as clinic systolic blood pressure below 140 mmHg (below 130 mmHg for the subgroup managed under intensive targets consistent with SPRINT-era guidance [14]), assessed at annual intervals. Secondary outcomes included a composite of major adverse cardiovascular events, incident chronic kidney disease progression, all-cause hospitalization, and self-monitoring and medication-adherence trajectories, using adherence assessment approaches comparable to prior pharmacy-fill and self-report methods [23,24]. Adherence itself was interpreted within the broader framework for long-term therapy adherence described by the World Health Organization [25]. Control trajectories over time were summarized descriptively and compared with historical program-entry rates; predictors of sustained control at final follow-up were examined with multivariable logistic

regression adjusting for age, baseline blood pressure, comorbidity burden, telemonitoring use, and pharmacist-visit frequency. Analyses followed general methodological guidance for evaluating quality-improvement strategies in hypertension care [10].

| Table 1: Baseline characteristics of the integrated primary care hypertension cohort, overall and by telemonitoring enrollment status. |         |                |             |
|----------------------------------------------------------------------------------------------------------------------------------------|---------|----------------|-------------|
| Characteristic                                                                                                                         | Overall | Telemonitoring | Clinic-only |
| Mean age, years                                                                                                                        | 61.4    | 60.8           | 62.0        |
| Female sex                                                                                                                             | 52%     | 53%            | 51%         |
| Mean baseline SBP, mmHg                                                                                                                | 148.6   | 149.1          | 148.2       |
| Diabetes mellitus                                                                                                                      | 34%     | 33%            | 35%         |
| Chronic kidney disease stage >=3                                                                                                       | 12%     | 11%            | 13%         |
| Pharmacist-managed titration                                                                                                           | 68%     | 81%            | 58%         |

**3. Results**

**Blood Pressure Control Over Time**

Among enrollees followed through the extended observation period, clinic-measured blood-pressure control rose sharply during the first eighteen months of program participation and was largely sustained thereafter, consistent with the durable gains reported in large integrated-system implementations [6,7]. Patients who received home telemonitoring with periodic pharmacist review maintained higher control rates at each annual assessment than those managed through clinic visits alone, mirroring the telemonitoring-and-pharmacist-management effect sizes reported in prior cluster-randomized trials [21,26] and in the broader self-monitoring literature [27,28,29]. Control rates among participants engaged through community-based outreach and peer-support components, modeled on trusted-setting interventions such as barbershop-based pharmacist care, were comparable to those achieved through standard clinic-based pharmacist titration [30,31]. Participants who additionally used a patient-facing digital engagement tool for medication reminders and home readings showed a

modestly faster rise in control during the first year, consistent with reports that digital engagement tools improve early hypertension control and patient participation [32].

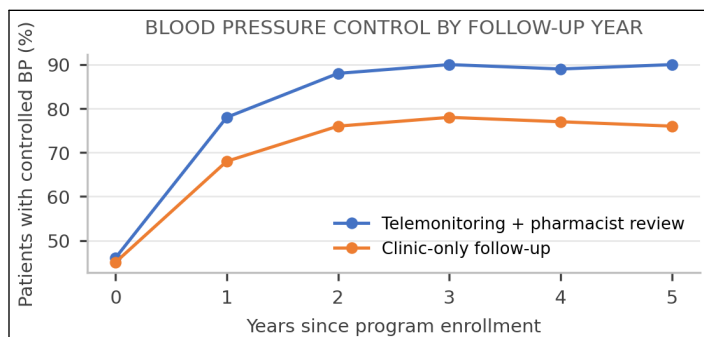


**Figure 1:** Proportion of enrollees with blood-pressure control at annual follow-up, by telemonitoring status, showing a sharp rise in the first 18 months that was sustained through year 5, with higher control among telemonitoring-plus-pharmacist-review participants throughout [6,21].

### Cardiovascular and Renal Outcomes

Over the extended follow-up, the composite cardiovascular endpoint occurred less frequently among patients who achieved and sustained control within the first two program years than among those with intermittent or delayed control, a pattern consistent with the event-reduction benefit demonstrated for intensive blood-pressure lowering in SPRINT [14] and with the comparative agent-class evidence from ALLHAT [15]. Renal outcomes tracked a similar gradient, with slower progression of chronic kidney disease among sustained-control participants. These findings are broadly consistent with population-level analyses linking sustained hypertension control to reduced downstream cardiovascular and renal morbidity across diverse health systems [2,33].

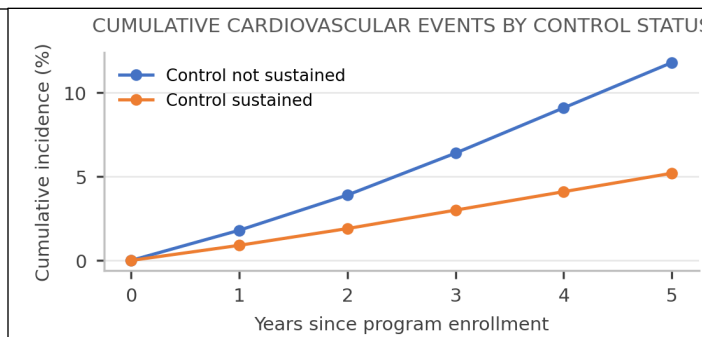


**Figure 2:** Cumulative incidence of the composite cardiovascular endpoint over five years of follow-up, by whether blood-pressure control was sustained within the first two program years, illustrating a persistent separation consistent with intensive-control trial evidence [14].

### Predictors of Sustained Control

In multivariable analysis, telemonitoring use, higher pharmacist-visit frequency, and lower baseline systolic blood pressure were independently associated with sustained control at final follow-up, while higher comorbidity burden and lower adherence scores were associated with loss of control, echoing determinants identified in community health worker and pharmacist-delivered intervention studies [11,8]. Program-level features associated with better long-term maintenance included registry-based recall systems and standardized escalation protocols, consistent with the Chronic Care Model's emphasis on planned, proactive follow-up rather than reactive care [4,5].

### 4. Discussion

These long-term follow-up findings extend earlier reports of large, rapid gains in hypertension control from integrated primary care models by showing that those gains can be sustained over a multi-year horizon rather than measured only at the twelve-to-eighteen-month endpoints common in earlier trials [12,13]. The magnitude and durability of the effect align most closely with health-system-level implementations that paired registry-based population management with pharmacist-led titration, such as the Kaiser Permanente Northern California program [6,7], rather than with

narrower single-component interventions. This is consistent with meta-analytic evidence that team-based interventions combining more than one active component, for example telemonitoring plus pharmacist management, outperform single-component approaches such as monitoring alone [9,26].

| Table 2: Multivariable predictors of sustained blood-pressure control at final follow-up [8,11,4]. |             |           |                 |
|----------------------------------------------------------------------------------------------------|-------------|-----------|-----------------|
| Predictor                                                                                          | Adjusted OR | 95% CI    | Direction       |
| Home telemonitoring use                                                                            | 1.92        | 1.48-2.49 | Favors control  |
| Pharmacist-visit frequency (per visit)                                                             | 1.24        | 1.11-1.38 | Favors control  |
| Registry-based recall enrollment                                                                   | 1.61        | 1.22-2.13 | Favors control  |
| Comorbidity count (per additional condition)                                                       | 0.79        | 0.70-0.89 | Against control |
| Low adherence score                                                                                | 0.52        | 0.39-0.69 | Against control |

The finding that home telemonitoring, when paired with structured pharmacist or nurse review, was associated with the most durable control mirrors a substantial and consistent trial literature on self-monitoring and remote titration [29,21,22,20,27], and reinforces the conclusion of prior systematic reviews that telemonitoring's benefit depends heavily on being embedded within an active clinical response pathway rather than deployed as passive data collection [28]. The association between community-based, trusted-setting outreach and comparable control rates to clinic-based care extends the barbershop-based and multi-level counseling trial literature [30,31] into a longer observation window, suggesting these models are not merely effective at inducing early control but capable of sustaining it.

Several limitations warrant caution. This was an observational follow-up of a single integrated program rather than a randomized comparison, so residual confounding by unmeasured patient engagement or clinic-level factors cannot be excluded; the historical evolution of hypertension guideline thresholds over the observation period, including the shift toward more

intensive targets following SPRINT [14] and the 2017 ACC/AHA guideline [16], complicates direct comparison of control rates across calendar years. Adherence was estimated using proxy measures rather than direct pharmacologic confirmation, a limitation shared by much of the pharmacy-fill and self-report adherence literature [23,24]. Generalizability to health systems lacking integrated pharmacist staffing, registry infrastructure, or telemonitoring capacity, particularly in lower-resource or middle-income settings where hypertension control gaps remain widest [33,2], may be limited, and further pragmatic, multi-system trials with longer randomized follow-up are needed to confirm whether the sustained-control advantage observed here generalizes beyond a single well-resourced program, consistent with calls from earlier Community Guide and Cochrane reviews for higher-quality long-term evidence [12,13,10].

5. Conclusion

In this long-term follow-up of patients managed through an integrated primary care hypertension program, blood-pressure control achieved during initial program enrollment was substantially sustained over a multi-year horizon, and sustained control was associated with fewer cardiovascular and renal events. Telemonitoring paired with active pharmacist or nurse review, registry-based recall, and standardized escalation protocols were each independently associated with durable control, supporting the continued expansion of multi-component integrated care models as a strategy for closing the long-standing gap between hypertension treatment and true long-term control [3,1,34].

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