Hypertension Research
https://doi.org/10.1038/s41440-020-0431-3

ARTICLE

Effectiveness of a patient-centered medical home model of primary care versus standard care on blood pressure outcomes among hypertensive patients

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Received: 21 November 2019 / Revised: 18 February 2020 / Accepted: 24 February 2020

Abstract

Patients with hypertension and other comorbidities have complex health care needs that are challenging to manage in primary care. However, there is strong evidence suggesting that patient-centered approaches in primary care are effective in managing complex multimorbidity. We aim to evaluate the effectiveness of a patient-centered medical home model called 'WellNet' versus that of standard care on blood pressure (BP) outcomes among hypertensive patients. We used a cohort study design with a comparison group and case-series design to assess the 'between-group' and 'within-group' effectiveness of the WellNet program delivered across six general practices in Sydney, Australia. The treatment group included 447 eligible patients who provided consent and who received general practitioner-led care with the integration of care coordinators. The comparison group included 5237 matched patients receiving usual care at four geographically comparable general practices. To assess changes over time, paired, and independent samples *t*-tests were used to determine significant differences. In addition, analysis of covariance (ANCOVA) was used to identify any significant differences after adjusting for potential covariates. The adjusted model showed significant reductions in systolic BP (−3.4 mmHg; 95% CI −5.1, −1.7; p value < 0.001) in the treatment group at follow-up. However, no significant mean change was observed in diastolic BP. The proportion of patients within the recommended range was found to be significantly higher in the treatment group than in the comparison group (13.6% versus 6.4%). WellNet patients experienced statistically significant and clinically meaningful improvement in BP during the follow-up. The findings of this study may be beneficial to both patients and providers in terms of improved health outcomes and delivery of care, respectively.

Keywords Collaborative care · Patient-centered medical home · Blood pressure · Hypertension · Chronic care model

Introduction

Hypertension persists as one of the leading causes of death and disability worldwide despite major advances in medical treatment and technologies [1, 2]. In Australia, it is estimated that one in three adults (34%) aged 18 years or older has high blood pressure (BP) (BP ≥ 140/90 mmHg or on antihypertensive medication), which is 6% higher than the average prevalence among high-income countries [3–5]. There is sound evidence suggesting that uncontrolled hypertension is a major risk factor for cardiovascular diseases (CVDs), including ischemic heart disease, stroke, heart failure, and chronic renal diseases [2, 6]. In addition to its health burden, hypertension is associated with a significant economic burden in terms of productivity-adjusted life years and its impact on the health care system, which accounted for direct costs of up to $1.8 billion in 2009 [7, 8]. In addition, data from general practices also indicate that hypertension is the most commonly reported problem (8 cases per 100 encounters) managed at the primary care level in Australia [9]. While hypertension is associated with significant health and economic ramifications, it is fortunate

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Published online: 01 April 2020

that the condition is largely preventable through targeted interventions, which in turn could lead to better health outcomes and reduced health care expenses [10].

The treatment of hypertension requires a multimodal and holistic approach combining lifestyle modifications including dietary changes, physical activity, smoking cessation, and reduction in alcohol consumption with strong adherence to antihypertensive therapy [11, 12]. However, care delivery for the management of hypertension and its associated comorbid conditions is often fragmented, lacking continuity of care and integration, even among high-income countries, including Australia [13, 14]. Conversely, studies have shown that coordinated and collaborative approaches in primary care are effective in the management of hypertension and other associated comorbidities [15, 16]. Recent reviews and meta-analytic studies suggest that multidisciplinary team-based (MDT) care targeting patients through patient-tailored goal setting, education, and self-management improved BP levels and increased the proportion of patients with controlled BP [17–19]. Therefore, it is vital to implement strategies and interventions that provide patient-tailored management of hypertension and other comorbid conditions under the care of collaborative teams of health care providers.

The patient-centered medical home (PCMH) model has been well-recognized as one of the effective primary care models for managing patients with chronic illnesses and multimorbidity [20, 21]. The PCMH model typically includes a general practitioner (GP), as part of an MDT, working in conjunction with patients to provide comprehensive, continuous, coordinated, and patient-centered care that promotes self-management while improving long-term patient engagement [22, 23]. There is increasing advocacy and a growing body of evidence, primarily from the United States, suggesting that PCMH models of primary care are more effective than usual care in improving clinical outcomes in patients, including elevated BP [24–26]. However, in Australia, PCMH models have not been evaluated given the country's health care setting and funding models. Therefore, the aim of this study is to evaluate the effectiveness of a PCMH model of primary care versus standard care on BP outcomes among hypertensive patients from several general practices in Sydney, Australia.

Methods

Program description and study design

The 'WellNet' program was developed by Sonic Clinical Services and commenced service delivery in October 2016. WellNet is a 12-month chronic disease management (CDM) program that is built upon the principles of PCMH and other best-available primary care models. The WellNet program is designed to deliver MDT care that is not only coordinated but also tailored to the individual health care needs of the patient according to the level of risk and complexity of chronic conditions. Further details of the program design are reported elsewhere [27].

We used a case-series design to evaluate the effectiveness of the WellNet program in improving clinical and self-reported outcomes among primary care patients enrolled in six general practices in Northern Sydney, Australia. Written informed consent was obtained from the participants who enrolled in the 12-month study.

Participants

Treatment group

Patients were enrolled in the WellNet study between December 2016 and October 2017. A complete description of participant eligibility, recruitment methods, matching analyses, and data collection are reported elsewhere (John et al., 2019, unpublished article). Out of 698 patients who attended the initial assessment, 688 were eligible to enroll in the program. Patients living in nursing homes and those with severe cognitive impairment or terminal illness were excluded. A total of 52 patients declined to participate in the study, resulting in 636 (92.4%) patients who provided consent. Of the 636 patients, 447 (70.2%) who were either diagnosed with hypertension or on antihypertensive medication were included in this study (Fig. 1).

Comparison group

Four general practices that provided standard GP care and that were within close geographical proximity and/or had similar socio-economic characteristics to the WellNet practices were chosen. Comparison group data were extracted from the SCS GP electronic databases and were provided in a de-identified form for analysis. Patients who visited these practices during the program recruitment period were identified ($n = 20{,}476$) and were effectively matched with the use of the Coarsened Exact Matching (CEM) procedure based on the following variables:

(1) Age;
(2) Sex;
(3) Diagnosis of chronic condition (0/1), cardiovascular disease (CVD), respiratory disease, diabetes, musculoskeletal disorder, cancer, and mental illness;
(4) Number of chronic conditions.

Subclass or strata groups without at least one treatment and one comparison patient were excluded. CEM in turn

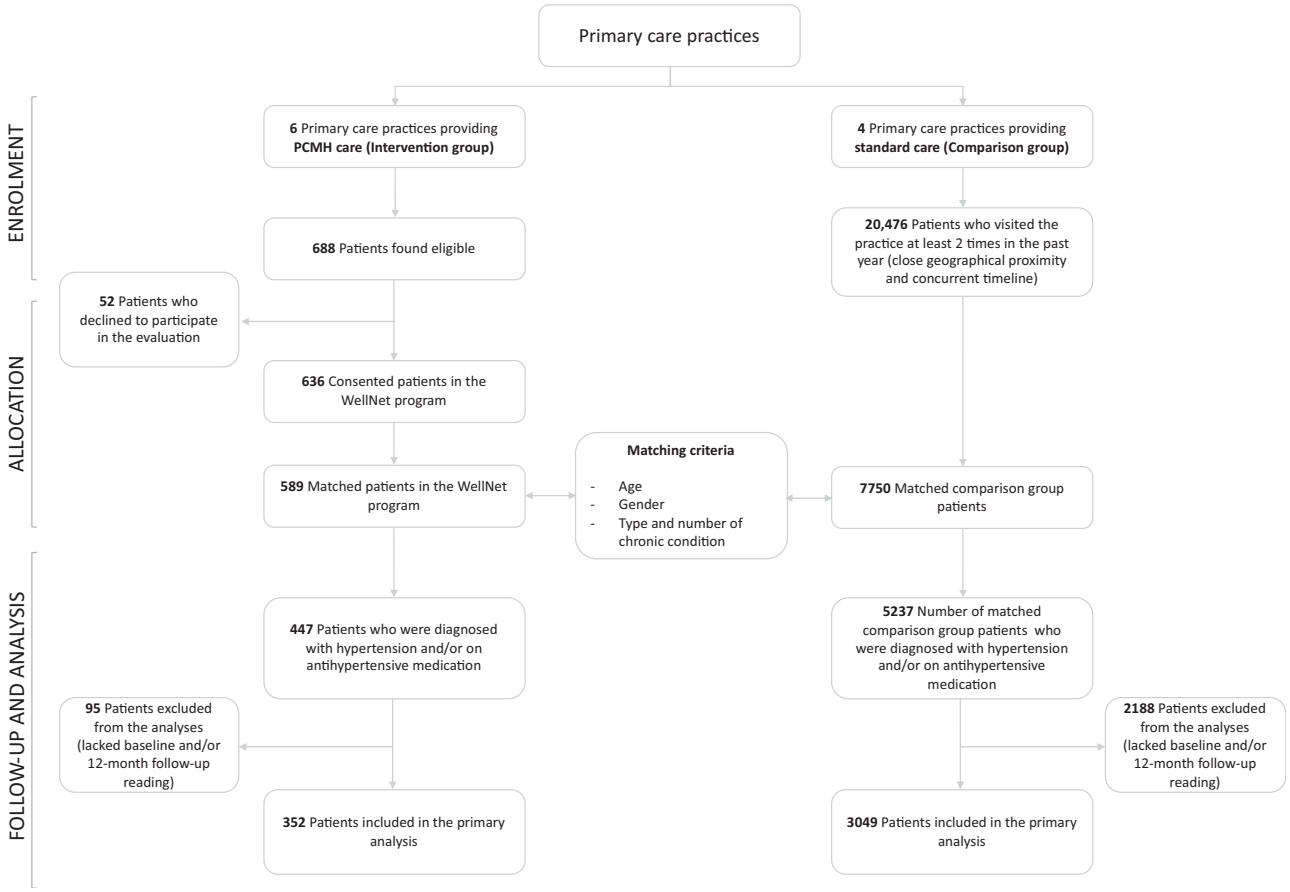

Fig. 1 Flowchart of patient participation

utilizes 'weights' to compensate for differential strata sizes to be used in the subsequent analyses [28]. This matching procedure has been shown to effectively limit selection bias and variance between the groups, thereby minimizing bias in the final model showing treatment effects [28]. Of the 7750 matched comparison group patients, 5237 patients who were either diagnosed with hypertension or on antihypertensive medication were included (Fig. 1).

WellNet's PCMH care

The WellNet program is characterized by GP-led care with the integration of trained and specialized CDM Care Coordinators (CC) within each participating primary care practice. The program comprises a total of 14 contacts, which include a combination of 7 in-person visits and 3 telephone consultations with the CC and/or the GP. Following an initial comprehensive health assessment, a WellNet care plan is generated using cdmNet, an electronic shared care planning platform. cdmNet integrates with the patients' clinical records and facilitates communication and collaboration between the health care team. Furthermore, patients are set up with 'GoShare,' which is a customizable content platform comprising a range. CC monitor patient access to GoShare and assess their understanding during consultations. Patients are also offered a mobile application called 'MediTracker,' which links directly to the clinical records held at the practice, providing access to information such as current medications, pathology results, diagnoses, and immunization status. These programs aim to empower patients to play a more active role in their health care decisions and improve self-management behaviors [29, 30].

The evaluation and management of hypertension, including the protocol for BP measurement, physical examination, laboratory investigations, and treatment strategies, followed the National Heart Foundation (NHF) of Australia guidelines [3]. BP was recorded while the patients were seated after they had relaxed for several minutes using an automated BP device that was regularly calibrated against a mercury sphygmomanometer. BP was measured on both arms, and the BP from the arm with a higher reading was recorded if there was a discrepancy of more than 5 mmHg. At least three measurements were obtained with the average of the second and third readings

Fig. 2 Chronic disease management (CDM) patient goals for hypertension over time

Hypertension: Patient Goals

Timeline	Patient Goals
Month 1–3	• Understand hypertension – read materials being sent through email/SMS • Contact Quitline re smoking cessation, if relevant • Start physical activity/plan • Create a self-management plan with GP for managing health and risk factors
Month 4–6	• Aim for weight loss, if relevant, limit alcohol intake, reduced salt diet • Continue physical activity • Continue to read educational materials, questions/comments to test knowledge • Understand importance of being compliant with medications
Month 7–9	• Importance of staying well – address risk factors • Continue to build up physical activity • Compliance with dietary advice – salt restriction, alcohol, healthy choices
Month 10–12	• Goal of smoking cessation achieved, if relevant • Repeat CV risk score – understand the drivers of CV risk • Continue to read educational materials, questions/comments to test knowledge

recorded [3]. In addition, WellNet care includes patient-tailored health education, goal setting, motivational interviewing, self-management support, care navigation, reminders, and regular reviews. GPs and CCs collaborate with patients to create tailored self-management CDM plans for managing health and risk factors, which include revising diet plans, physical activity, smoking cessation, and alcohol consumption. A sample patient goal chart for hypertension in the form of a timeline is shown in Fig. 2.

Data collection and outcome measures

The data collected at baseline and the 12-month follow-up in this study were sociodemographic characteristics, smoking status, chronic disease diagnoses, clinical measures (as clinically relevant), and type and number of antihypertensive medications.

The primary outcome of interest for this study was the adjusted difference in mean systolic and diastolic BPs between the treatment patients (WellNet care) and comparison patients (standard GP care) at the 12-month follow-up after controlling for potential confounders. The secondary outcomes of this study were as follows: (1) to determine whether there was a significant difference in the proportion of patients within the recommended BP range (<140/90 or <130/80 if diabetic) between the treatment and comparison groups; (2) to assess compliance with the treatment regimen by evaluating significant changes in the mean number of antihypertensive medications between treatment and comparison group patients at follow-up; and (3) to investigate significant predictors of BP control at the 12-month follow-up.

Statistical analyses

Baseline characteristics are presented as the means and standard deviations (SDs) for continuous data, whereas frequency counts with valid percentages were calculated for categorical variables. To identify any significant differences between the treatment and comparison groups at baseline, independent samples *t*-tests and Pearson's chi-squared tests were performed for continuous and categorical variables, respectively.

Within-group changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP) readings between baseline and the 12-month follow-up were assessed using paired samples *t*-tests to determine any significant changes in each group over time. Adjusted mean changes in SBP, DBP, and number of antihypertensive medications between the treatment and comparison groups at follow-up were assessed using analysis of covariance (ANCOVA) with the Bonferroni post hoc test to correct for baseline differences and other confounders. In addition, a subgroup analysis of patients with BP readings over 140/90 was also performed to highlight treatment effects in patients with Grade 1 hypertension and above. Finally, a multivariate analysis using logistic regression with a backward stepwise approach was used to identify significant predictors of BP control using the binary outcome variable of patients within or not within the recommended BP range at follow-up. All analyses were conducted using R and SPSS version 25 statistical software. The significance level was set as 0.05, and all statistical tests were two sided.

Results

Baseline characteristics

The baseline findings of this study are presented in Table 1. The mean age of the patients was ~72 years, with an almost even sex distribution in both the treatment and comparison groups. In addition, the distribution of the type and number of chronic diseases as well as the mean number of antihypertensive medications at baseline were comparable in

Table 1 Baseline characteristics of WellNet treatment group and comparison group patients

Patient characteristics	WellNet group ($n = 352$)	Comparison group ($n = 3049$)	p value
Socio-demographics			
Mean (SD) age in years	72.6 (10.4)	72.3 (10.8)	0.672
Age groups (years)			
40–44	3 (0.9)	20 (0.7)	0.564
45–54	17 (4.8)	168 (5.5)	
55–64	52 (14.8)	525 (17.2)	
65–74	121 (34.4)	910 (29.9)	
75–84	115 (32.7)	1022 (33.5)	
≥85	44 (12.5)	404 (13.2)	
Sex			
Males	185 (52.6)	1453 (47.7)	0.081
Females	167 (47.4)	1596 (52.3)	
Smoking status			
Current smokers	21 (6.2)	134 (5.1)	**<0.001**
Ex-smokers	160 (47.3)	936 (35.6)	
Nonsmokers	157 (46.4)	1562 (59.3)	
Missing or unknown	14 (4.0)	417 (13.7)	
Clinical characteristics			
History of co-existing conditions (type and number)			
Cardiovascular disease	275 (78.1)	2396 (78.6)	0.843
Respiratory disease	93 (26.4)	853 (28.0)	0.537
Diabetes	173 (49.1)	1590 (52.1)	0.286
Musculoskeletal disorders	166 (47.2)	1399 (45.9)	0.649
Mental illness	56 (15.9)	432 (14.2)	0.378
Cancer	49 (13.9)	408 (13.4)	0.779
Number of co-existing conditions, mean (SD)	2.3 (0.9)	2.3 (0.9)	0.764
SBP (mmHg), mean (SD)	139.9 (17.7)	137.1 (15.9)	**0.005**
DBP (mmHg), mean (SD)	78.7 (10.6)	75.5 (11.4)	**<0.001**
Medications[a] (type and number)			
Antihypertensives (C02)	50 (14.2)	150 (4.9)	**<0.001**
Diuretics (C03)	45 (12.8)	481 (15.8)	0.136
Beta-blocking agents (C07)	106 (30.1)	958 (31.5)	0.589
Calcium channel blockers (C08)	86 (24.4)	713 (23.5)	0.682
Agents acting on the renin-angiotensin system (C09)	255 (72.4)	2420 (79.6)	**0.002**
Number of anti-HTN medications, mean (SD)	1.6 (0.9)	1.6 (0.9)	0.776
BMI (kg/m^2), mean (SD)	29.8 (6.0)	29.9 (7.5)	0.932
Weight (kg), mean (SD)	82.5 (20.0)	83.3 (19.9)	0.527
HbA1c (%), mean (SD)	6.7 (1.4)	6.7 (1.3)	0.501
HDL-C (mmol/L), mean (SD)	1.4 (0.4)	1.4 (0.4)	0.756
TC (mmol/L), mean (SD)	4.5 (1.2)	4.4 (1.1)	0.153

Data reported as n (%) unless otherwise indicated; Chi-squared test for categorical variables and independent sample t-test for continuous variables

SD standard deviation, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *BMI* body mass index, *HbA1c* glycated hemoglobin, *HDL-C* high density lipoprotein cholesterol, *TC* total cholesterol. Bold values indicate statistical significance with $p < 0.05$

[a]Type of medications follow the Anatomical Therapeutic Chemical Classification System (ATC) codes. Antihypertensives (C02) includes centrally-acting, peripherally-acting, ganglion-blocking, and several other combinations; diuretics (C03) includes diuretics, plain and in combination with potassium or other agents such as vasopressin antagonists; Beta-blocking agents (C07) includes selective/nonselective beta blockers with combinations of alpha blockers, thiazides, and diuretics; calcium channel blockers (C08) include selective/nonselective blockers with mainly vascular or cardiac effects and in several combinations; agents acting on the renin-angiotensin system (C09) include all angiotensin-converting enzyme (ACE) inhibitors plain and in several combinations

both groups. In particular, of the other chronic conditions, the prevalence of CVD was highest in both the treatment (78.1%) and comparison groups (78.6%). Compared with the comparison group, body mass index (BMI), glycated hemoglobin (HbA1c), and cholesterol levels were similar in the treatment group; however, patients in the treatment group had significantly higher systolic and diastolic BP at baseline. To account for these differences, these variables were adjusted for in the primary analyses.

Within-group changes

Within-group analyses conducted using paired samples t-tests showed significant differences in mean SBP and DBP readings between baseline and follow-up in both the treatment and comparison groups. However, the mean differences in SBP (−7.0 mmHg versus −2.0 mmHg) and DBP (−2.9 mmHg versus −1.4 mmHg) observed in the treatment group were much higher than those in the comparison group (Table 2).

Similarly, in the subgroup analysis of patients with Grade 1 hypertension or above, greater mean differences in SBP and DBP were observed in both groups between baseline and follow-up, particularly in the treatment group (ΔSBP of −15.4 mmHg and ΔDBP of −6.2 mmHg). All the within-group mean differences were highly statistically significant (p value < 0.001) (Table 2).

Table 2 Within-group changes in clinical BP outcomes at baseline and 12-month follow-up (overall and subgroup of at-risk patients)

Outcomes	Overall		At-risk patients[a] (subgroup analysis)	
	WellNet group ($n = 352$)	Comparison group ($n = 3049$)	WellNet group ($n = 194$)	Comparison group ($n = 1458$)
SBP at baseline (mmHg), mean (SD)	139.9 (17.7)	137.1 (15.9)	151.9 (12.2)	149.9 (11.2)
SBP at 12-month follow-up (mmHg), mean (SD)	132.9 (16.9)	135.1 (16.8)	136.6 (16.9)	140.9 (16.9)
ΔSBP (mmHg), mean (SD)	−7.0 (19.4)**	−2.0 (17.8)**	−15.4 (16.7)**	−9.0 (17.9)**
DBP at baseline (mmHg), mean (SD)	78.7 (10.6)	75.5 (11.4)	83.1 (9.8)	80.4 (11.4)
DBP at 12-month follow-up (mmHg), mean (SD)	75.8 (9.3)	74.0 (10.9)	76.9 (9.2)	76.2 (11.2)
ΔDBP (mmHg), mean (SD)	−2.9 (10.7)**	−1.4 (11.2)**	−6.2 (10.8)**	−4.2 (11.9)**

ΔSBP and ΔDBP—within-group changes from baseline to 12 months

HTN hypertension, *SBP* systolic blood pressure, *DBP* diastolic blood pressure, *SD* standard deviation

**p value < 0.001

[a]Patients with elevated BP readings at baseline (SBP > 140 and/or DBP > 90)

Primary outcome

The unadjusted mean differences at follow-up showed significantly greater improvement in SBP (−5.0 mmHg; 95% CI −7.2 to −2.9) and DBP (−1.5 mmHg; 95% CI −2.7 to −0.2) in the treatment group than in the comparison group. After correcting for baseline differences and other potential confounders, the adjusted model showed modest but significant reductions in SBP (−3.4 mmHg; 95% CI −5.1 to −1.7; p value < 0.001) for the treatment group at 12 months. However, there was no significant mean change in DBP at follow-up (Table 3).

Consistent with the overall findings, the at-risk subgroup population exhibited a statistically significant improvement in SBP with an adjusted mean difference of −5.6 mmHg (95% CI −8.1 to −3.1; p value < 0.001) in the treatment group compared with the comparison group, but this difference was not observed in DBP at 12 months (Table 3).

Secondary outcomes

The proportion of patients within the recommended range (<140/90 or <130/80 if diabetic) increased in both groups. However, a larger increase in terms of change in percentage was observed in the treatment group than in the comparison group (13.6% versus 6.4%).

The changes in hypertension grades from baseline to follow-up were classified as follows: no change (− −), low grade to higher grade (− +), higher grade to lower grade (+ −), or no change (+ +). Consistent with the above findings, while patients in both groups transitioned from higher to lower grades of hypertension, the proportion of treatment patients who transitioned to a lower grade was significantly higher (p value < 0.001) than that of the comparison group patients (36.4% versus 26.1%) (Table 4).

In terms of the number of antihypertensive medications, patients in both groups at baseline had a mean (SD) number of medications of 1.6 (0.9). At follow-up, the mean number of medications increased significantly in the treatment group and decreased in the comparison group, resulting in an adjusted mean difference of 0.53 (95% CI 0.44–0.63; p value < 0.001) after controlling for potential confounders (Table 3). The frequency distributions of the type and mean number of antihypertensive medications in each group are presented in Table 4.

Finally, in the multivariate analysis, a number of factors were found to be significantly associated with BP control at 12 months. Older age and a positive history of CVD were associated with better BP control. An increase in age was associated with 2% higher odds (OR 1.02, 95% CI 1.01–1.03), and a positive history of CVD was associated with 28% higher odds (OR 1.28, 95% CI 1.06–1.55) of better BP control at follow-up. However, an increase in the

Table 3 Unadjusted and adjusted mean change in BP outcomes and number of antihypertensive medications at 12 months

Outcomes	Unadjusted mean difference (95%CI)	Adjusted mean difference (95%CI)
Primary outcome of change in BP readings		
Overall		
ΔSBP between groups at 12 months (mmHg)	−5.0 (−7.2, −2.9)**	−3.4 (−5.1, −1.7)**
ΔDBP between groups at 12 months (mmHg)	−1.5 (−2.7, −0.2)**	0.6 (−0.4, 1.6)
At-risk patients		
ΔSBP between groups at 12 months (mmHg)	−6.4 (−9.0, −3.7)**	−5.6 (−8.1, −3.1)**
ΔDBP between groups at 12 months (mmHg)	−2.1 (−3.8, −0.3)**	0.4 (−1.0, 1.9)
Secondary outcome of change in number of anti-HTN medications		
Number of anti-HTN medications	0.6 (0.5, 0.7)**	0.53 (0.44, 0.63)**

Adjusted for age, sex, baseline BP readings, and history of CVD

CI confidence interval

***p* value < 0.001

number of comorbidities and SBP at baseline was associated with poor BP control. Every increase in the number of comorbidities was associated with 3% lower odds (OR 0.97, 95% CI 0.96–0.97), and every unit increase in SBP (mm/Hg) was associated with 15% lower odds (OR 0.85, 95% CI 0.78–0.93) of BP control at follow-up (Table 5).

Discussion

This study adds to the growing body of evidence demonstrating the effective management of hypertension through a coordinated and collaborative approach promoting continuity of care. This was demonstrated by the finding that patients who received comprehensive PCMH care had significantly greater improvements in BP readings than patients receiving standard care. Furthermore, the treatment group also exhibited a higher proportion of patients within the recommended BP range at 12 months compared with the group receiving standard care. The WellNet treatment was particularly effective for patients who had elevated BP readings (≥140/90) at baseline. These patients are often more challenging to treat due to increased cardiovascular risk and therefore require comprehensive patient-tailored management as opposed to treatment based only on antihypertensive medication [31, 32].

The management of hypertension through the combination of comprehensive lifestyle modifications with appropriate antihypertensive medication is well established [33, 34]. In accordance with the NHF Australia guidelines, the care team developed comprehensive patient-tailored CDM plans with lifestyle modifications relevant to the individual. These typically included (1) limiting salt content in diet, alcohol intake, and smoking; (2) promoting a healthier lifestyle by starting a physical activity plan for weight loss; and (3) revising medication type and dose as needed. Studies show that even a modest 1 g/day reduction in dietary salt or mild to moderate physical activity was associated with a substantial decrease in CVD events and was more cost-effective than treatment with antihypertensive medications [35, 36].

The magnitude of BP reduction was modest compared with the outcomes of similar studies; [15, 17] however, the reductions observed may be of value, given that even small reductions in BP of 3–5 mmHg have been shown to reduce the risk of adverse cardiac events, stroke, and mortality [37, 38]. In the secondary outcome analysis, the proportion of patients achieving the target BP levels (<140/90 or <130/80 if diabetic) was double in the treatment group compared with proportion in the usual care group at follow-up (13.6% versus 6.4%). The effect of team-based care on increasing the proportion of patients within the recommended range is consistent across several studies [15, 39].

The WellNet program had additional aims of improving patient knowledge, activation and self-management of chronic condition/s through effective counseling and health education. Studies have shown that increasing patients' knowledge is associated with improved adherence to the program and medication regimen and that patients with good compliance to treatment were three times more likely to achieve BP targets and have reduced CVD events than less-adherent patients [40, 41]. GPs and CCs provided ongoing monitoring and support to patients consistent with the scope of the care plan, which included patient-relevant self-management advice, medication adherence, and regular assessments of clinical progress.

In relation to better management of antihypertensive medications, patients in the WellNet group exhibited a slight increase in the number of antihypertensive medications, whereas standard care patients exhibited a significant

Table 4 Difference in proportion of patients within recommended range and type and number of anti-HTN medications at follow-up

Outcome	WellNet group ($n = 352$)	Comparison group ($n = 3049$)
Within recommended range		
Baseline (%)	115 (32.7)	1131 (37.1)
Follow-up (%)	163 (46.3)	1325 (43.5)
Change in %**	13.6	6.4
Change in HTN grades at follow-up**		
− −	114 (32.4)	1150 (37.7)
− +	53 (15.1)	573 (18.8)
+ −	128 (36.4)	796 (26.1)
+ +	57 (16.2)	530 (17.4)
Medications (type and number) at follow-up[a]		
Antihypertensives (C02)	50 (14.2)	118 (4.3)
Diuretics (C03)	51 (14.5)	292 (10.7)
Beta-blocking agents (C07)	113 (32.2)	644 (23.5)
Calcium channel blockers (C08)	85 (24.2)	430 (15.7)
Agents acting on the renin-angiotensin system (C09)	250 (71.2)	1479 (54.1)
Number of anti-HTN medications, mean (SD)	1.7 (1.0)	1.1 (1.0)

Data reported as *n* (%) unless otherwise indicated; Within recommended range (<140/90 or <130/80 if diabetic); anti-HTN antihypertensive medication; − − no change low risk to low grade; − + low risk to high grade; + − high risk to low grade; + + no change high risk to high grade

**p value < 0.001 using Chi-squared test

[a]Type of medications follow the Anatomical Therapeutic Chemical Classification System (ATC) codes. Antihypertensives (C02) includes centrally-acting, peripherally-acting, ganglion-blocking, and several other combinations; diuretics (C03) includes diuretics, plain and in combination with potassium or other agents such as vasopressin antagonists; Beta-blocking agents (C07) includes selective/nonselective beta blockers with combinations of alpha blockers, thiazides, and diuretics; calcium channel blockers (C08) include selective/nonselective blockers with mainly vascular or cardiac effects and in several combinations; agents acting on the renin-angiotensin system (C09) include all angiotensin-converting enzyme (ACE) inhibitors plain and in several combinations

Table 5 Multivariate regression model showing significant predictors of BP control at 12 months

Predictors	AOR (95%CI)	*p* value
Diagnosis of CVD: yes	1.28 (1.06, 1.55)	0.011
Age	1.02 (1.01, 1.03)	<0.001
Number of chronic conditions	0.97 (0.96, 0.97)	<0.001
SBP at baseline	0.85 (0.78, 0.93)	<0.001

AOR adjusted odds ratio (interpreted as % of higher or lower odds), *CI* confidence interval

reduction in the mean number of antihypertensive medications at follow-up. Previous studies have revealed that one of the barriers to adequate BP control is physicians' failure to adequately alter the number or dose of antihypertensive medications as needed [42, 43]. On the other hand, there is evidence from other studies showing that large improvements in BP control over time coincide with adequate modifications in the number of antihypertensive medications [44, 45].

The multivariate regression model showed that patients diagnosed with one or more CVD conditions were more likely to have BP measures within the target range. This is consistent with the results of previous studies that have indicated that a history of CVD is a significant predictor of better BP control [46, 47]. This may be because patients with CVD condition/s may have been treated not only for a longer period of time but also with a more aggressive treatment regimen than those without a history of CVD. In addition to the above reasons, drugs other than antihypertensive medications prescribed mainly for CVD, for instance, renin-angiotensin-aldosterone system (RAAS) inhibitors for managing chronic heart failure, could have indirectly contributed to lower BP levels among patients with a history of CVD [48]. In addition, the more intensive CDM plan for the higher risk elderly patients might explain better BP control in this study. Elevated SBP at baseline and an increase in the number of chronic conditions were also associated with poor BP control, which is consistent with other study findings [46, 49]. This may be explained by patients who present with multimorbidity having complex treatment regimens, with any treatment benefits taking longer than the treatment period of 12 months of the WellNet program to manifest.

This study had a number of limitations. The treatment and comparison groups were closely matched for age, sex, type and number of chronic conditions, and geographical proximity with a concurrent timeline. However, statistically significant baseline differences in some clinical measures between the two groups may have impacted the outcomes. To minimize this, ANCOVA techniques were used to control for baseline differences. Furthermore, although GP medical record systems in GP settings are well structured, providers may have poor compliance with populating the information in accordance with the systems, resulting in incomplete data. In terms of data limitations, the CDM plans for each patient recording short-term goals and any adverse events were overwritten at subsequent scheduled visits, and therefore, it was not possible to assess the longitudinal changes between the visits. Another limitation was that sociodemographic variables such as country of birth, education level, and employment status were not available, reducing the ability to identify key outcomes and analyze endpoints.

Similar to other studies based on an originally developed program, the reproducibility of study findings is constrained

by the uniqueness of the data and by several patient- and provider-level determinants. Patients' levels of education, social class and health behavior and practices would have different levels of impact on health coaching and self-management practices, leading to varying levels of management. For instance, patients with a higher level of education will better perceive the importance of self-management and would be more likely to adhere to health coaching provided by the GPs and CC in the WellNet program. In terms of provider-level determinants, varying levels of experience and training among GPs and CC will impact quality of care in terms of effectively delivering PCMH care.

Our study also has several strengths. Although primary care practices are patients' first point of contact with the health care system, research based on GP data is limited [50]. PCMH models in the form of 'health care homes' are currently being trialed in several primary health networks throughout the country. However, to our knowledge, the WellNet program is the first study in Australia to provide real-world evidence on the effectiveness of the PCMH model in primary care patients presenting with multimorbidity with the use of GP data (John et al., 2019, unpublished article). This study also constitutes a large targeted sample of patients whose chronic disease diagnosis and pathology were collected by trained health care professionals, eliminating the possibility of self-reported bias.

Conclusion

This study demonstrates the effectiveness of the PCMH model versus standard GP care in improving BP outcomes in hypertensive patients after 12 months. This shows that patients in the WellNet program achieved both statistically significant and clinically meaningful changes in their BP. The findings of this study may be beneficial to both patients and providers in terms of improved health outcomes, shared decision making, and improved delivery of care. Future research should evaluate the long-term sustainability of BP improvements and the cost effectiveness of the WellNet program given the improved clinical outcomes in the treatment group compared with those in the comparison group of patients.

Acknowledgements This paper uses unit record data from the WellNet Program in the North Sydney region. The WellNet Program was initiated and funded by the WellNet partners, SCS, North Sydney PHN, Bupa, HCF, NIB and Teacher's Health. We would especially like to thank Sonic Clinical Services for collecting and sharing the patient data and providing insights into the development and delivery of WellNet. The WellNet partners had no control or influence over the decision to submit the final paper for publication. We are particularly grateful to the health care teams of the participating primary care practices for their high-quality work in data collection. We wish to thank Munro Neville, Shima Ghassempour, Federico Girosi and Evan Atlantis for input and feedback provided for this study.

Funding JRJ's PhD scholarship was provided by the Capital Markets Cooperative Research Centre (Now Rozetta Institute). The funders did not have any role in the design, methods, analysis, or preparation of this paper.

Compliance with ethical standards

Conflict of interest JRJ and KT have no competing interests. AJ is employed by SCS as the Operational Manager of Integrated Care and is responsible for the implementation of WellNet. However, SCS and WellNet partners had no control or influence over the decision to submit the final paper for publication.

Ethical approval The study was reviewed by the Western Sydney University Human Research Ethics Committee (REDI Reference: H12215).

Informed consent Written informed consent was obtained from the study participants.

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