Outcomes of a 12-month patient-centred medical home model in improving patient activation and self-management behaviours among primary care patients presenting with chronic diseases in Sydney, Australia: A before-and-after study.

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Abstract

Background: Studies report that increased patient activation is associated with increased patient engagement with the health care system, better adherence to treatment protocols, and improved health outcomes. This study aims to evaluate outcomes based on a 12-month Patient-Centred Medical Home (PCMH) model called 'WellNet' on activation levels of patients with one or more chronic diseases in general practices across Sydney, Australia.

Methods: A total of 636 patients aged 40 years and above with one or more chronic conditions consented to participate in the WellNet program delivered across six general practices in Northern Sydney, Australia. The WellNet treatment includes a team-based care with general physicians and trained chronic disease management care coordinators collaborating with patients in designing a patient-tailored care plan with improved self-management support and care navigation according to the level of risk and health care needs. Level of patient activation was measured using the validated PAM 13-item scale at baseline and follow-up. A before and after case-series design was employed to determine adjusted differences between baseline and 12-months using repeated measures analysis of covariance (ANCOVA). Multiple imputation was used to compute missing follow-up scores using Markov Chain Monte Carlo (MCMC) algorithm known as fully conditional specification (FCS). Additionally, backward stepwise multivariate regression models were employed to identify significant predictors of activation at follow-up.

Results: Of the 626 patients, 420 reported their PAM scores at follow-up. The mean (SD) baseline PAM score was 57.9 (13.0). The adjusted model showed significant mean difference in PAM scores of 6.5 (95% CI 5.0-8.1; p-value<0.001) after controlling for baseline covariates. Multivariate regression models showed that older age (B = -0.14; 95% CI -0.28, -0.01), baseline activation score (B = 0.48; 95% CI 0.37, 0.59), and private insurance (uninsured patients) (B = -3.41; 95% CI -6.50, -0.32) were significant predictors of patient activation at follow-up.

Conclusion: The WellNet study is the first of its kind in Australia to report on changes in the patient activation levels among patients with one or more chronic diseases. PCMH has the potential to improve patient activation and engagement which can lead to long-term health benefits and sustained self-management behaviours.

Background

The prevalence of multiple chronic conditions is on the rise which presents significant burden to healthcare systems in Australia and worldwide [1, 2]. Recent advances in medicine and technology have resulted in increased life expectancy which has contributed to the growth of ageing population surviving with increased years of disabilities and accumulation of chronic conditions [3, 4]. The Australian National Health Survey (NHS) 2017-18 data shows that chronic disease prevalence increases with age, with 80% of Australians aged 65 years and above having one or more chronic conditions [5]. There is well-documented evidence of multimorbidity associated with increased risk of mortality [6]; reduced functional status and quality of life [7]; and increased health service utilisation [8, 9]. Furthermore, patients presenting with multimorbidity are often recipients of fragmented care as healthcare systems, including Australia, still remain largely configured to management of single diseases, thereby lacking coordination and continuity of care [10]. Contrarily, there is sound evidence suggesting that collaborative approaches in primary care are associated with effective management of chronic illnesses [11, 12].

Management of multimorbidity requires effective care delivery with emphasis on patient-tailored self-management treatment strategies for better patient outcomes [11]. Patient-centred medical home (PCMH) model

has proven to be one of the effective chronic care models that facilitates continuity of care through comprehensive and coordinated approach whilst aiming to improve patient engagement and self-management behaviours configured to individual needs [13, 14]. This enhanced primary care model is led by general practitioner (GP) as part of a multidisciplinary team (MDT), working with patients to promote coordinated and focussed care that enables continuity of care using a long-term chronic disease approach [13, 18]. There is increasing evidence on the effectiveness of PCMH models of care, primarily in United States, in improving patient activation and self-management of chronic diseases, leading to better quality of health and health utilisation outcomes [15-17]. However, the feasibility and effectiveness of PCMH model remain unclear in Australian primary care practices.

In the past decade, there has been increased advocacy towards patient engagement and self-management of chronic disease/s [18, 19]. Patient activation is defined as a multidimensional construct of one's readiness and ability to manage their own health whilst actively engaging in decision making about healthcare [20, 21]. The level of activation and ability to self-manage conditions play an important role in patient's overall health and wellbeing, especially for those presenting with multimorbidity [20, 22]. There is a growing body of evidence indicating that patients who are actively engaged in health care system have improved self-reported quality of life and clinical outcomes [23-25]. In addition, patients with high activation levels are often empowered through shared decision-making with their GPs and are reported to have better adherence to treatment regimens and lower hospital admissions compared to patients with lower activation scores [26, 27].

Understanding an individual's level of activation enables physicians to provide patient-tailored care according to the risk and complexity of healthcare needs [28]. Although chronically ill patients generally report low activation and have increased risk of hospitalisation [26], their levels of activation can be modified through effective education and training [29]. Despite the growing advocacy towards patient activation, there is relatively little information about activation and self-management outcomes among patients presenting with chronic illnesses in Australia. Therefore, the aim of this study is to evaluate the outcomes of a 12-month PCMH model on patient activation among primary care patients presenting with one or more chronic diseases in Sydney, Australia.

Methods

WellNet program and study design

Sonic Clinical Services (SCS) designed a 12-month chronic disease management (CDM) program called 'WellNet' which aims to provide a GP led, MDT based care for patients with one or more chronic conditions. This enhanced primary care program is built upon the principles of PCMH and guided by evidence based, best practice models of clinical care to deliver high quality patient-centric care that is configured to individual risk and complexity levels [30].

Patients were recruited between December 2016 and October 2017 using convenience sampling technique. We used a before-and-after case-series study design to evaluate the outcome of WellNet program in improving self-management outcomes among primary care patients enrolled in six general practices in Northern Sydney, Australia. A written informed consent was obtained from the participants who enrolled in the 12-month study. A detailed description of the program design and evaluation are reported elsewhere [30].

Participants

The Participant, Intervention, Comparator, and Outcome statement (PICO) is briefly summarised in Box 1. Potentially eligible patients (N=1790) were contacted either through letter invites or GP referrals for initial assessment. Eligibility criteria included patients aged 40 years and above; having one or more chronic condition/s; who had consulted a GP three times in the previous two years; and had a Hospital Admission Risk Profile (HARP) score of more than 10. In addition, patients with one or more consistently elevated clinical risk factors were also invited to participate through GP referrals. Patients living in nursing homes and those with severe cognitive impairment or terminal illness (n=10) were excluded. Further details of the patient algorithm, recruitment outcomes, and data collection are reported elsewhere [30]. Out of 688 patients, 52 declined to participate in the program due to unknown reasons resulting in 636 patients. Of the 636 consenting participants, 626 reported their baseline PAM score and were included in this study. The flowchart of patient recruitment outcomes is shown in Figure 1.

WellNet intervention

The 12-month WellNet program is designed to integrate GPs with specially trained chronic disease management (CDM) Care Coordinators (CC) within each of the six participating GP practices [30]. On entry to the program, the team of GPs and CCs coordinate with patients in undertaking a range of validated general and disease-specific risk assessments to determine the patient's baseline health status and wellbeing. The information gathered from these assessments is then used to formulate an individualised CDM plan in consultation with the patient. Included in the care plan are patient driven health goals; modifying and training core skills to self-manage symptoms and medications; improving diet and physical activity; and reducing smoking and alcohol consumption [30]. The care plan includes, and is shared with, all relevant members of the care team. Ongoing support to increase knowledge, understanding and maintenance of positive behaviour change; monitoring of progress towards health goals; and assistance to access health and social care are provided through a combination of in-practice and telephone contacts.

Furthermore, ongoing patient support are also supplemented through user-friendly online platform and a mobile application. "GoShare" is an intuitive online platform that enables digital sharing of evidence-based patient-relevant education materials in a user-friendly manner to achieve maximum impact. Patients' access to the materials and understanding are regularly monitored and assessed through self-reported surveys. The care coordinators focus on low adherence to usage or understanding, so that issues can be resolved. Furthermore, patients are also supported with 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 immunisation status [30]. This is intended to encourage and empower patients to play an active role in their chronic disease care management.

Patient Activation Measure 13 item version

Patient activation was measured with the use of validated PAM-13 item version developed by Hibbard et al [21]. PAM-13 is a self-reported questionnaire composed of 13 items relating to patients' beliefs about healthcare, knowledge about their health condition, and confidence in managing health related tasks. Each item has five response options from 0 to 4 such as: (0) 'not applicable'; (1) 'strongly disagree'; (2) 'disagree'; (3) 'agree'; and (4) 'strongly agree'. The raw responses range from 13-52 which are then transformed through Insignia's proprietary natural logarithm to a standardized metric ranging from 0 to 100 (0 = lower activation; 100 = highest activation). The scores are classified into four levels of activation of Level 1 (≤47.0) – not believing activation is important;

Level 2 (47.1 - 55.1) – Lacking knowledge or confidence in self-management of health; Level 3 (55.2 – 67) – Beginning to take action; and Level 4 (≥67.1) – Taking action but require support in maintaining positive behaviour change. Each of these levels provide insights into a range of health-related characteristics, including behaviours and outcomes [28]. In addition, determining baseline scores allow MDT to determine the best approach to engage and educate patients and thus improve self-management behaviour. Studies report that the minimal clinically important difference (MCID) is at least a 4-point difference in PAM score in addition to transitioning from lower to higher PAM levels [20, 21]. MCID refers to the smallest change in an outcome score that is considered "important" or "worthwhile" by the practitioner and/or resulting in a change in patient management [31]. Changes in outcomes exceeding this minimal threshold are considered clinically relevant [31].

PAM scores were recorded from the patients at the start and completion (12 months) of the WellNet program. Aligned to the outcome of patient activation, key demographic information of age, gender, type and number of chronic conditions, private health insurance status, and total program contacts were analysed in this study.

Self-management impact and readiness to change scale of HARP assessment

The HARP risk assessment tool determines the risk of people with chronic or complex care needs presenting to hospital for treatment in the following 12 months [32]. Question 6 of HARP reports on the self-management and readiness to change behaviours which includes several categories: No capacity for self-management; pre-contemplation; contemplation; preparation; action; maintenance; and relapse. These levels were grouped into levels that closely resemble PAM levels. Level 1: No capacity for self-management Action and maintenance; Level 2: Contemplation/ pre-contemplation; Level 3: Preparation; and Level 4: Action and maintenance. This scale was only used as a supplement to PAM assessment.

Study outcomes

The primary outcome of interest for this study was changes in the mean PAM score between baseline and 12-months after controlling for potential baseline covariates such as age, gender, type and number chronic disease diagnosis, insurance status, median visits, and baseline PAM score. Secondary outcomes include: 1) changes in proportion of patients with respect to different levels of PAM and HARP's self-management impact scale at follow-up; 2) association between PAM levels and self-management impact and readiness to change scale of the HARP risk assessment tool; 3) significant predictors of PAM scores at follow-up.

Data analysis

Descriptive statistics for continuous variables using mean and standard deviation (SD) and percentages for categorical measures are presented in Table 1. One-way analysis of variance (ANOVA) was conducted to test for significant differences in means between one or more groups. Pearson's correlation coefficient test was also used to determine the association within and between PAM scores and HARP's self-management impact scale at baseline and follow-up. Additionally, t-tests and chi-square test were performed to determine any significant difference between completers and non-completers

Primary analysis included completers only model (Model 1) of those who reported both baseline and follow-up scores, and an imputed model (Model 2) which imputed missing follow-up PAM scores using Markov Chain Monte Carlo (MCMC) algorithm known as fully conditional specification (FCS) [33]. For multiple imputation, 25 imputed datasets were created and pooled estimates were reported. The rationale for imputing missing data was

supplemented with primary analysis to test the hypothesis that patients who withdrew prematurely before program completion without reporting their follow-up PAM scores would have similar trends in PAM scores if they had completed the program like patients who completed the program. The multiple imputation model allowed for inclusion of dependent variable of follow-up PAM scores as a covariate to enable unbiased estimates of model coefficients [34].

Adjusted mean difference between baseline and follow-up was measured using repeated measures ANCOVA to control for baseline potential covariates such as age, gender, type and number chronic disease diagnosis, insurance status, and median visits. A sensitivity analysis was also conducted to evaluate adjusted differences in PAM scores between baseline and follow-up among patients with two or more conditions.

Backward stepwise multivariate regression models were conducted to determine the predictors of PAM scores at the 12-month follow-up. Independent baseline covariates tested against follow-up PAM scores in the univariate analysis included: age, gender, type and number chronic disease diagnosis, insurance status, median visits, and baseline PAM score. Any variable with *p*-value of <0.2 was then included in the multivariate model. Backward stepwise regression approach was used to reduce and create the final model while simultaneously assessing the fitness of model in order to avoid dropping of non-significant variables that may affect the model fitness. The final model constitutes variables, which when excluded, cause a prominent deviance change ($p < 0.05$) as compared to the corresponding X^2 test statistic on the relevant degrees of freedom.

Internal consistency of pre and post PAM-13 items in this study were evaluated using Cronbach's alpha. R and SPSS (version 25) statistical software were used to conduct all the analyses. Significance level was set as 0.05 and all statistical tests were two-sided.

Results

Baseline patient characteristics and activation levels

The sociodemographic characteristics and chronic disease prevalence of the study sample by baseline PAM levels are presented in Table 1. The mean age of the patients was 69±13 years with equal gender distribution. The study patients had a mean number of 2±1 co-existing chronic condition with diabetes (49%), musculoskeletal disorder (43%), and circulatory system disorders (34%) as the most prevalent of chronic conditions. In addition, more than two-thirds (69%) of patients had private insurance and almost half (49%) of the patients had more than 11 out of a possible 14 program contacts in the 12-month program.

No significant difference was observed between patients who completed and those who withdrew from the 12-month program. In addition, results of the one-way ANOVA and chi-square tests showed no significant differences by PAM levels with exception for age, private health insurance (PHI) status, glycated haemoglobin (HbA1c), and total cholesterol. Furthermore, the internal consistency of baseline and follow-up PAM in this study was good with Cronbach's alpha coefficients of 0.90 and 0.91 respectively.

Primary outcome

Changes in mean PAM scores

Of the 626 patients who reported their baseline PAM, 420 (67%) reported PAM levels at program completion. The mean (SD) PAM score at baseline was 57.9 (13.0). Within-group analysis between baseline and follow-up showed significant improvement in mean PAM scores with a mean difference (unadjusted) of 6.8 (95% CI 5.39 to 8.25, p-value<0.001). After adjusting for potential confounders, the adjusted model (Model 1) showed a significant mean difference of 6.6 (95% CI 5.03 to 8.06, p-value<0.001). Following the imputation for missing follow-up PAM scores, the adjusted imputed model (Model 2) showed increased mean difference of 8.6 (95% CI 7.52 to 9.71, p-value<0.001) (Table 2).

Additionally, the sensitivity analysis of patients with two or more chronic conditions (N=261) showed higher adjusted mean difference in PAM scores 7.54 (95% CI 5.72 to 9.37, p-value<0.05) for Model 1 and 8.65 (95% CI 7.36 to 9.95, p-value<0.05) for Model 2.

Secondary outcomes

Changes in PAM levels and HARP's self-management impact levels at follow-up

Cross-tabulation between baseline and follow-up showed significant differences in PAM levels with increase for 43% and decrease for 10% of patients (p-value<0.001) (Table 3). More specifically, patients in the WellNet program reported positive change in the PAM levels by significantly increasing from the order of least activated levels (9.2% from Level 1; 24% from Level 2; and 39.2% from Level 3) to the most activated Level 4 at follow-up (p-value<0.001) (Table 3).

In terms of HARP's self-management impact levels, 60% (n=165) of patients in the contemplation/ pre-contemplation level at baseline transitioned to the action and maintenance level at follow-up whereas 64% (n = 73) of patients in the preparation level at baseline transitioned to action and maintenance level at follow-up (Table 4). Furthermore, Pearson's correlation coefficient between PAM and HARP's self-management levels at both baseline and follow-up was less than 0.39 at p<0.01 significance indicating weak positive association (Table 5).

Predictors of change in PAM scores at follow-up

Results of the multivariate regression analyses showing significant predictors of patient activation levels at follow-up are presented in Table 6. Older age, lack of private health insurance (PHI), and higher baseline PAM score were found to be significant predictors in both Models 1 and 2. Increase in patient's age (B = −0.14, p=0.043) and uninsured patients (B = −3.41, p=0.033) were significantly associated with decreased PAM scores at follow-up. Conversely, higher baseline PAM scores (B = 0.48, p<0.001) was significantly associated with higher follow-up PAM scores (Table 6). The significant predictors and trends observed in the imputed model (Model 2) were consistent with Model 1.

Discussion

This study employs GP data in evaluating the outcomes of a 12-month enhanced primary care model in improving the levels of activation and self-management behaviours among patients presenting with one or more chronic conditions in primary care settings across Northern Sydney, Australia. Primary care is well established as the forefront of care delivery in Australia, however research with use of primary care data is relatively low.

Moreover, GP practice activity in Australia shows that the management rate of chronic conditions was 55 per 100 encounters and that 96% of encounters among patients aged 65 years and above had one or more chronic conditions [35].

Validation of PAM scores by Hibbard et al and Fowles et al indicate that an increase in PAM score by 4 points is considered clinically meaningful and is associated with improved self-management behaviours [36-38]. The 12-month WellNet intervention resulted in both statistically significant and clinically meaningful improvement in PAM scores with adjusted mean differences in activation score of 6.5 after controlling for potential confounders. There is also evidence showing that each point increase in PAM scores is associated with 2% reduction in hospitalisation and 2% improvement in medication adherence [39].

In the secondary outcome analyses, there was a statistically significant difference observed between baseline and follow-up PAM levels where 43% of study patients experienced transition from a lower PAM level to higher PAM level post-intervention. Similar positive trend was observed in HARP's self-management impact and readiness to change assessment scale. The effect of PCMH care in improving self-management behaviours in patients is consistent across several other studies [37, 38].

In the multivariate regression analyses, older age, PHI, and baseline PAM scores were significant predictors in both main (non-imputed) and imputed models. Increase in years of age as a significant determinant of reduced activation is consistent with findings of studies by Blakemore et al and Overbeek et al [42, 43]. It is reported that older adults have limited self-management skills as a result of having greater number of chronic conditions which are often associated with poor quality of life, reduced functional status and increased disabilities [42, 44]. Consistent with the above study findings, WellNet group observed a slightly higher mean number of co-existing chronic conditions among patients who were over the median age of 70 years compared to those who were less than or equal to 70 years (2.0 vs 1.8, p-value=0.05).

PHI status was a strong predictor of change in activation levels where uninsured patients were associated with significantly lower activation compared to privately insured patients. This may be due the reason that patients with PHI coverage may have better access to healthcare in terms of choice of providers and shorter waiting times for treatment compared to those without PHI [45, 46]. Furthermore, this study is also consistent with findings of studies by Chubak and Rijken et al which have shown that patients who were activated at baseline had improved activation scores over time [47, 48].

This study has several strengths and limitations. To our knowledge, The WellNet program is the first of its kind in Australia to evaluate the outcomes of a PCMH model in improving levels of activation and self-management among patients with multimorbidity using GP data. In addition, the program strengths include large sample size, comprehensive data collection by trained healthcare professionals, and longitudinal measurements rendering determining predictors of change in PAM scores. In terms of study limitations, the WellNet study included a well-matched comparison group based on age, gender, type and number of chronic conditions. However, self-reported health assessments such as PAM assessments were recorded only among the treatment group, therefore, limiting analyses to within-group rather than between-group comparison with standard primary care (comparison group). The lack of control group means that the possibility of potential bias cannot be excluded, and we cannot be sure that improvement in PAM scores may have occurred anyway without the enhanced PCMH intervention. However, that seems unlikely based on trials conducted with use of control groups reporting similar outcomes [20, 49]. In addition, some key socio-demographic and socio-economic variables such as education status and income were

unavailable for assessment reducing the ability to identify other predictors of change in patient activation. Finally, consistent with other originally designed programs, reproducibility of findings is constrained by potential barriers in the form of uniqueness of data and by patient and provider-level determinants [30].

Conclusion

Patient activation is an important precursor not only for effective self-management of chronic conditions but also to empower patients in actively making decisions concerning their health. The integration of GPs and trained CDM coordinators proves critical for provision of individualised care for patients presenting with multiple chronic conditions. This study demonstrates outcomes of an enhanced primary care model in improving patient activation and self-management outcomes over 12-months. Patients who participated in the WellNet program achieved both statistically significant and clinically meaningful improvements in PAM scores. Findings of this study emphasises the need to increase support for older and uninsured patients in managing their health and healthcare needs. Future research should seek to evaluate the long-term effects and cost-benefits of increased activation in this cohort. Furthermore, more research is needed to determine disease-specific interactions on patient activation levels. This will render re-designing the level of care to where it is most needed.

List Of Abbreviations

ANOVA: Analysis of variance

ANCOVA: Analysis of covariance

CC: Clinical coordinator

CDM: Chronic disease management

CI: Confidence interval

CVD: Cardiovascular disease

FCS: Fully conditional specification

GLM: General linear models

GP: General practitioner

HARP: Hospital Admission Risk Profile

MCID: Minimal clinically important difference

MCMC: Markov Chain Monte Carlo

MDT: Multidisciplinary team

NHS: National Health Survey

PAM: Patient Activation Measure

PCMH: Patient Centred Medical Home

PHI: Private health insurance

PICO: Participant, Intervention, Comparator, and Outcome statement

SCS: Sonic Clinical Services

SD: Standard Deviation

SPSS: Statistical Package for the Social Sciences

US: United States

Declarations

Ethics approval and consent to participate

The study was reviewed by the Western Sydney University Human Research Ethics Committee (REDI Reference: H12215). Written informed consent was obtained from the study participants.

Consent for publication

Not applicable

Availability of data and materials

Data contained in the WellNet cohort will not be made available to the general public.

Competing interest

JRJ and KT have no competing interests. AJ is employed by SCS as the Operational Manager 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 manuscript for publication.

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Authors' contributions

AJ was responsible for program administration and contributed to data acquisition; JRJ, WKT, and AJ contributed to methodology; Data curation and formal data analysis was performed by JRJ; JRJ was responsible for writing the original draft preparation; All authors have read and agreed to the submitted version of the manuscript.

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Tables

Table 1. Patient characteristics by level of patient activation at baseline

Variable	Total	PAM Level 1	PAM Level 2	PAM Level 3	PAM Level 4	Activation score Mean (SD)
ticipants	626 (100)	121 (19.1)	236 (37.7)	138 (22.0)	131 (20.9)	57.5 (13.1)
years, Mean (SD)*	68.8 (12.9)	70.4 (12.5)	70.5 (12.9)	66.0 (12.9)	67.0 (12.4)	-
n age group						
ears	318 (50.8)	60 (18.9)	107 (33.6)	80 (25.2)	71 (22.3)	58.2 (13.3)
ears	308 (49.2)	61 (19.8)	129 (41.9)	58 (18.8)	60 (19.5)	56.8 (12.8)
r						
	313 (50.0)	62 (19.8)	121 (38.7)	69 (22.0)	61 (19.5)	57.1 (12.9)
es	313 (50.0)	59 (18.8)	115 (36.7)	69 (22.0)	70 (22.4)	58.0 (13.3)
osis of chronic condition (grouped)†						
atory system diseases	214 (34.2)	44 (20.6)	91 (42.5)	41 (19.2)	38 (17.8)	55.7 (11.4)
atory diseases	181 (28.9)	39 (21.5)	64 (35.4)	44 (24.3)	34 (18.8)	57.3 (13.5)
es	307 (49.0)	62 (20.2)	112 (36.5)	71 (23.1)	62 (20.2)	57.1 (12.0)
loskeletal disorders	267 (42.7)	58 (21.7)	98 (36.7)	54 (20.2)	57 (21.3)	57.5 (13.5)
l illness	127 (20.3)	34 (26.8)	48 (37.8)	29 (22.8)	16 (12.6)	54.2 (11.4)
r	92 (14.7)	15 (16.3)	35 (38.0)	21 (22.8)	21 (22.8)	57.3 (13.1)
er of co-existing conditions, Mean (SD)	1.9 (0.9)	2.1 (1.0)	1.9 (0.9)	1.9 (0.9)	1.7 (0.9)	-
nce status**						
e	398 (68.7)	60 (15.1)	152 (38.2)	89 (22.4)	97 (24.4)	59.0 (13.8)
ured	181 (31.3)	50 (27.6)	74 (40.9)	34 (18.8)	23 (12.7)	54.1 (10.4)
rogram contacts						
ontacts	320 (51.1)	64 (20.0)	119 (37.2)	74 (23.1)	63 (19.7)	57.4 (13.4)
ontacts	306 (48.9)	57 (18.6)	117 (38.2)	64 (20.9)	68 (22.2)	57.7 (12.8)
l measures						
c Blood Pressure (mmHg), Mean (SD)	138.8 (19.1)	138.6 (23.1)	138.3 (17.7)	139.4 (19.5)	139.3 (17.3)	-
lic Blood Pressure (mmHg), Mean (SD)	75.9 (18.2)	74.3 (19.5)	76.2 (16.8)	76.2 (18.0)	76.4 (19.6)	-
Mass Index Kg/m2, Mean (SD)	29.9 (7.3)	31.2 (10.1)	29.3 (6.1)	30.1 (6.6)	29.6 (6.5)	-
*ed Haemoglobin (%), Mean (SD)**	6.8 (1.4)	7.1 (1.3)	6.8 (1.3)	6.9 (1.8)	6.4 (1.1)	-
ensity Lipoprotein Cholesterol	1.3 (0.4)	1.3 (0.4)	1.3 (0.4)	1.3 (0.4)	1.4 (0.4)	-

/L), Mean (SD)						
*ensity Lipoprotein Cholesterol /L), Mean (SD)**	2.7 (1.1)	2.6 (1.2)	2.6 (1.0)	2.8 (1.1)	2.9 (1.1)	-
*Cholesterol (mmol/L), Mean (SD)**	4.8 (1.4)	4.8 (1.6)	4.6 (1.2)	5.0 (1.3)	5.2 (1.4)	-
ceride (mmol/L), Mean (SD)	1.6 (1.1)	1.6 (0.9)	1.7 (1.2)	1.7 (1.1)	1.6 (1.3)	-

esented as N (%) unless specified otherwise

es reported as percentages were tested with chi-square analyses and variables reported as means and standard deviations were with ANOVA.

c chronic diseases were grouped as per the International Statistical Classification of Diseases and Related Health Problems (ICD-sification.

e<0.05

ıe<0.001

. Per-protocol and imputed models of repeated measures ANCOVA (main and sensitivity analyses)

lel	Main analysis		Sensitivity analysis (patients with ≥2 chronic conditions)	
	Unadjusted mean difference (95% CI)	Adjusted mean difference (95% CI)	Unadjusted mean difference (95% CI)	Adjusted mean difference (95% CI)
col	6.82 (5.39, 8.25)**	6.55 (5.03, 8.06)**	7.71 (5.99, 9.43)**	7.54 (5.72, 9.37)*
nodel	8.11 (5.40, 10.82)**	7.95 (6.85, 9.04)**	8.70 (7.46, 9.93)**	8.65 (7.36, 9.95)*

e<0.05

ıe<0.001

Table 3. A cross-tabulation table of PAM levels pre- and post-intervention

	Follow-up PAM			
Baseline PAM	Level 1 (least activated)	Level 2	Level 3	Level 4 (most activated)
Level 1	14 (18.4)	31 (40.8)	24 (31.6)	7 (9.2)
Level 2	12 (7.8)	63 (40.9)	42 (27.3)	37 (24.0)
Level 3	1 (1.0)	10 (10.3)	48 (49.5)	38 (39.2)
Level 4	0 (0.0)	13 (14.0)	9 (9.7)	71 (76.3)

Data represented as N (%)

Table 4. A cross-tabulation table of HARP's self-management impact levels pre- and post-intervention

	Follow-up levels		
line levels	Contemplation/ pre-contemplation	Preparation	Action and maintenance
emplation/ pre-contemplation	46 (16.8)	62 (22.7)	165 (60.4)
aration	18 (15.8)	23 (20.2)	73 (64.0)
n and maintenance	2 (9.5)	3 (14.3)	16 (76.2)

Data represented as N (%)

Table 5. Correlation test between PAM levels and HARP's self-management levels at baseline and follow-up

	Baseline PAM levels	Follow-up PAM levels	Baseline HARP levels	Follow-up HARP levels
Baseline PAM levels	1	.493**	.190**	.205**
Follow-up PAM levels	.493**	1	.186**	.252**
Baseline HARP levels	.190**	.186**	1	.062
Follow-up HARP levels	.205**	.252**	.062	1

Pearson's bivariate correlation coefficients

**p-value<0.01 (two-tailed test)

. Predictors of patient activation scores at 12-month follow-up (main and imputed model)

Predictors	Main model (N=420)		Imputed model (N=626)	
	B	p-value	B	p-value
Age	-0.14 (-0.28, -0.01)	0.043	-0.13 (-0.23, -0.04)	0.006
Insurance status: Uninsured	-3.41 (-6.50, -0.32)	0.033	-3.27 (-5.40, -1.15)	0.003
Baseline PAM score	0.48 (0.37, 0.59)	<0.001	0.43 (0.36, 0.51)	<0.001

B – unstandardized beta coefficient (slope)

Box 1

Box 1. PICO statement

- **Participants** – Patients aged 40 years and above; one or more chronic conditions/ one or more elevated clinical risk factors; at least 3 or more GP visits in the last 2 years; HARP* score > 10.
- **Intervention** – 12-month enhanced primary care program called 'WellNet' based on patient-centred medical home model which involves team-based care, patient-tailored chronic disease self-management support, health coaching and education, care coordination, shared decision making, and regular review.
- **Comparator** – PAM scores were not recorded for the comparison group.
- **Outcomes** – **Primary:** Changes in PAM scores and PAM levels of activation; **Secondary**: 1) Changes in proportion of patients with respect to different levels of PAM and HARP's self-management impact scale at follow-up; 2) association between PAM levels and self-management impact and readiness to change scale of the HARP risk assessment tool; and 3) significant predictors of PAM scores at follow-up.

*HARP risk assessment tool determines the risk of people with chronic or complex care needs presenting to hospital for treatment in the following 12 months.

Figures

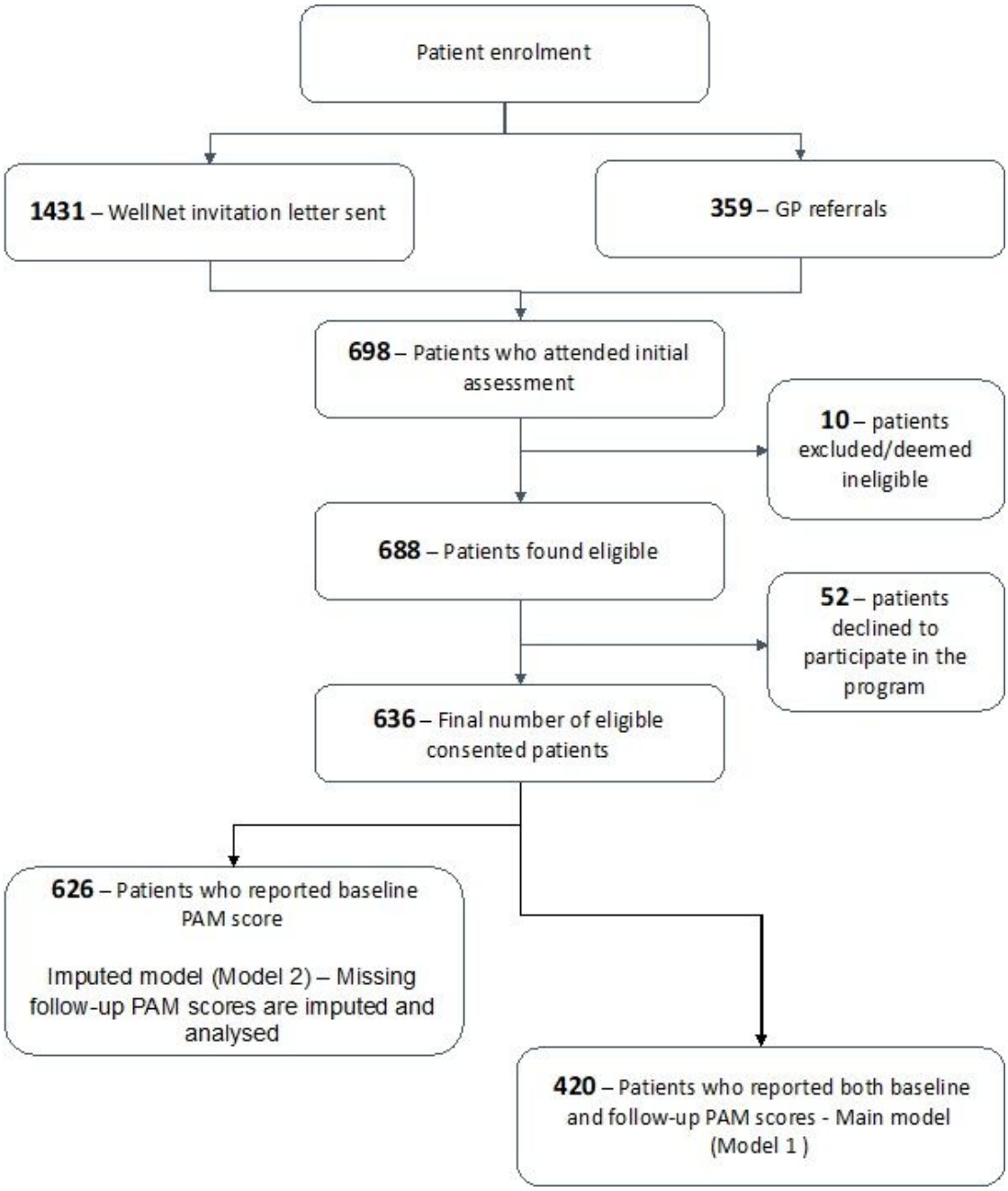

Figure 1

Flowchart of patient enrolment

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Strobechecklist.pdf