

Cohort Profile: Effectiveness of a 12-month patient-centred medical home model of primary care versus standard care for chronic disease management of high risk patients in Sydney, Australia

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Abstract

Background: Patients presenting with multiple chronic conditions have complex healthcare needs that are challenging to manage in primary care. This paper aims to evaluate the effectiveness of a patient-centred medical home (PCMH) model for improving clinical outcomes in high risk patients in Sydney, Australia. **Methods:** A cohort study design with a comparison group and a case-series study design were used to evaluate 'between-group' and 'within-group' effectiveness of a 12-month PCMH treatment called 'WellNet' delivered across several general practices in Sydney, Australia. The intervention group consists of 636 eligible participants who had been diagnosed with one or more chronic diseases and/or one or more elevated clinical risk factors; and had a Hospital Admission Risk Profile (HARP) score of greater than 10 at study enrolment between October 2016 and October 2017. The comparison group consists of 7750 randomly selected and well-matched patients receiving usual general practice (GP) care at four geographically comparable general practices in Sydney. Data collected from the general practices include socio-demographics; clinical measures; and self-completed health surveys. Outcomes include 12-month changes in clinical outcomes and patient reported general and disease-specific health assessments. Paired sample t-test and independent samples t-test will be used to determine significant 'within-group' and 'between-group' differences respectively. In addition, analysis of covariance (ANCOVA) and repeated measures ANCOVA will be used to determine any differences in the clinical measures and assessments after adjusting for covariates such as age, gender and baseline values. **Discussion:** To our knowledge, the WellNet study is the first study in Australia to generate evidence on the feasibility of recruitment, retention, and adherence into, as well as effectiveness of a comprehensive PCMH model using GP-based data. Baseline findings show that mean age of the study participants was 70.05 years with nearly even gender distribution of males and females. The most prevalent chronic diseases in descending order were: circulatory system disorders (69.8%), diabetes (47.4%), musculoskeletal disorders (43.5%), respiratory diseases (28.7%), mental illness (18.8%), and cancer (13.6%). Findings of this study may be beneficial to both patients and providers in terms of improved health outcomes, shared-decision making, and increased satisfaction in delivery of care respectively.

Background

The growing burden of non-communicable diseases including cardiovascular diseases (CVD), diabetes, chronic obstructive pulmonary disease (COPD), mental illnesses, lung cancer, and musculoskeletal disorders is a major cause of disability and death [1, 2]. In Australia, chronic diseases contributed towards 61% of the total disease (fatal and non-fatal) burden and 87% of all deaths in 2015 [3, 4]. Furthermore, the burden of multiple chronic conditions ('multimorbidity') is a major public health issue with recent findings reporting that the prevalence of Australians with two or more and three or more conditions are 26% and 16%, respectively [5]. Studies show that patients with multimorbidity often experience poor health-rated quality of life (HR-QOL) [6], psychological distress [7], and increased mortality [8]. Multimorbidity is also associated with increased hospital admissions [9], health care expenditure [10], and inappropriate polypharmacy [11]. Furthermore, evidence suggests that the health burden of chronic diseases is projected to increase in the future, thereby challenging health systems worldwide to revisit strategies towards effective management and prevention [12, 13].

Over the last few decades, advancements in public health policies and evidence-based medical treatments have contributed to increased life expectancy [14]. Consequently, the higher life span has resulted in a greater number of patients with comorbidities and, subsequently, a greater demand for health services [15, 16]. Health care systems in high-income countries, including Australia, are primarily focused on the 'single-disease framework', where care delivery for the management of multimorbidity is often fragmented, lacking integration, and continuity of care [17]. Conversely, studies show that coordinated and collaborative approaches in primary care, with strong emphasis on self-management of chronic diseases are effective in managing complex multimorbidity [18, 19]. Therefore, the rising demand for effective management of complex multimorbidity requires enhanced models of primary care for better patient and health service delivery outcomes [20].

Primary health care is the cornerstone of Australia's health care system, providing continual, comprehensive and coordinated care that is targeted towards patients' healthcare needs [21, 22]. The country's current primary health care system is built around strong general practice foundation and it is estimated that 85 percent of Australians consulted a GP at least once annually [3]. A number of initiatives have recently been undertaken to integrate primary care for the management chronic diseases, by government and primary care organisations, including the 'Australian Better Health Initiative', 'National Primary Health Care Strategy Framework', and 'Australian Primary Care Collaboratives Program' [23, 24]. Though encouraging, primary care-based data and research on effectiveness and feasibility of these initiatives providing a coordinated, multi-disciplinary team (MDT) care for long term chronic disease management remains limited and not definitive [25, 26].

Patient-centred medical home (PCMH) model has been lauded as providing the best model of primary care for patients with multimorbidity. This is due to provision of continuous, comprehensive, and MDT care for collaborating services to meet patients' health care needs [27]. Although definitions vary [28, 29], PCMH model typically includes a general practitioner (GP), as part of a MDT, working in conjunction with patients to provide coordinated and focussed care that promotes long-term patient engagement using a long-term chronic disease approach. There is a small but growing body of evidence, primarily from the United States, suggesting that various models of PCMH primary care are more effective than standard care in improving clinical outcomes in patients with one or more chronic diseases [30, 31], increasing the quality of care delivered [32, 33], and reducing hospital admissions [34, 35]. However, in Australia, PCMH models have not been evaluated given the country's health care setting and funding models.

Design of the WellNet Chronic Disease Management (CDM) Program

Sonic Clinical Services (SCS) developed the 12-month WellNet chronic disease management ("WellNet") program in 2016. This is closely aligned to the principles of PCMH primary care model as it aims to deliver a coordinated and MDT model of care tailored directly to the needs of patients according to the level of risk and complexity of their chronic conditions. This includes health coaching, care navigation, education, self-management and regular review. The

WellNet program combined face to face and telephone consultations with care coordinators and GPs to provide optimal health outcomes through the delivery of patient tailored healthcare interventions. The interventions are based on the key pillars of:

- Patient identification and enrolment;
- Patient centred integrated care;
- Outcomes based program philosophy;
- Data analytics, risk assessment and patient stratification;
- Evidence based interventions;
- Shared electronic health records; and
- Patient education and teaching self-management skills.

The WellNet program structured interventions are based on the best available models of care, applicable to the primary care setting. The program is authored by Australian and international institutes, including the Royal Australian College of General Practitioners (RACGP), Diabetes Australia, Australian Lung Foundation, Therapeutic Guidelines Expert Groups and the National Heart Foundation [36–51]. As patients' clinical presentations and needs are heterogeneous, the structured interventions are adapted to meet an individual patient's needs, within the IT platform, cdmNET, and with the guidance of the patients' usual GP.

A key component of the program is the involvement of specialised Chronic Disease Management (CDM) care coordinators at the medical centres. This was identified as key to successful integration of CDM program by the literature [52, 53]. Supporting the care coordinators were a wide range of services and structured interventions. These included online and print educational materials directed at encouraging behavioural change and a technology platform that facilitates the delivery of interventions, across broad healthcare delivery team.

In addition, patients were provided access to a user-friendly application called "GoShare" which enables sharing of range of health resources including video series, links to credible websites, apps, and tools tailored to patients' information needs. This program is aimed to improve self-efficacy, self-management behaviours, and empower patients to play a more active role in their health care decisions [54].

The WellNet program consisted of 7 in-practice visits and 3 telephone contacts with the care coordinator (2 contacts linked with GP appointments on commencement of the program) and quarterly GP reviews (4 visits) making up to a total of 14 contacts. Flexibility with the number of contacts was also provided according to patient's needs and availability. Therefore, patients' clinical and self-reported outcomes were collected over 12 months plus or minus 3 months.

Methods

Aim, study design, and setting of the study

The aim of the study is to evaluate the effectiveness of a PCMH model of primary care for improving clinical outcomes and risk of hospitalisation in high risk patients. The specific aims of this study are to: (i) evaluate changes in clinical outcomes in study participants compared to patients receiving standard care between baseline and 12 months; (ii) assess changes in participants' self-reported Health-related Quality of Life (HR-QoL) and level of activation; (iii) determine changes in the risk of hospital admissions; (iv) evaluate changes in disease-specific risk assessments; and (v) explore predictors of treatment uptake, response, and compliance.

A cohort study design with a comparison group (aim (i)) and a case-series study design (aims (i) to (v)) was used to evaluate WellNet's 'between group' and 'within group' effectiveness. This was for the WellNet program delivered in six general practices in Northern Sydney, New South Wales, Australia.

Patient characteristics

Treatment group—enrolment methods and outcome

The WellNet study's treatment group constitutes 636 patients from six primary care practices in Northern Sydney who met the eligibility criteria to participate in the 12-month program and provided written consent to have their data shared for evaluation.

The recruitment period for the study was between December 2016 and October 2017. SCS developed and executed a computerised algorithm to identify from electronic medical records those patients who met the diagnosis and risk factor criteria shown in Figure 1. The WellNet risk algorithm categorised patients into four groups of complexity based on the number of chronic conditions and presence of risk factors. Patients in groups C and D (the more complex cases) were the target groups for the intervention, however eligibility was confirmed at initial assessment by Hospital Admission Risk Profile (HARP) score.

Patients were eligible if they satisfied either criteria:

Criteria 1: Patients aged 40 years or above and who had seen a GP at least three times in the last two years; had been diagnosed with one to three chronic diseases and had presented with one or more elevated clinical risk factors; and held a HARP score of greater than 10 (medium risk or greater) OR

Criteria 2: Patients aged 40 years or above and who had seen a GP at least three times in the last two years and had been diagnosed with four or more chronic diseases with or without one or more risk factors; and held a HARP score of greater than 10 (medium risk or greater).

Additionally, patients with low HARP score (<10) but with at least one or more chronic diseases and one or more consistently elevated risk factors were also included in the study through direct GP referrals.

The care coordinators eliminated unsuitable patients, such as those living in nursing homes or with significant cognitive impairment, before presenting a list of potentially eligible patients to GPs for their review and selection. Potentially eligible patients were then contacted either through an invitation letter (n = 1431) or by GP referrals during routine visits (n = 359). A minimum of three follow-up phone calls were made by the care coordinator for each patient invited by letter who did not respond directly to the letter.

Out of the total 1790 patients contacted, 698 (38.9%) attended the initial assessment. From the initial assessment, 688 patients were found to be eligible for the program, based on their HARP score. Of these, 52 declined to participate in the WellNet Program or the cohort study, resulting in 636 (92.4%) consenting eligible participants enrolled into the study. Figure 2 represents the flowchart of patient recruitment outcomes.

Comparison group—matching iterations and outcomes

For matching purposes, four general practices with similar geographical proximity as WellNet practices that did not provide PCMH care were chosen. In order to be concurrent with the enrolment period, patients who visited any one of the four general practices between December 2016 and October 2017 were identified (n = 20,478).

Using “Coarsened Exact Matching” analysis in R, five different matching iterations were conducted. Several variables including age (continuous and categorical), gender, chronic disease type (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer), number of chronic diseases, systolic blood pressure (continuous and categorical), and total cholesterol: HDL-C ratio were considered to determine the best possible matching outcome, and from that, the best model was chosen.

Table 1 provides the matching iteration numbers by the variables and their outcomes. Matching iteration number 1 was chosen as the best model as it produced the highest number of patients in both treatment and comparison groups whilst closely matching the two groups based on age, gender, unique type and number of chronic disease groups. Of the WellNet program group of 636 patients, 589 were matched to the comparison group (Figure 3).

Follow-up

There are two phases of follow-up in the WellNet program. Phase 1 involves follow-up at 12 months to evaluate changes in clinical outcomes, HARP, Patient Activation Measure (PAM), self-reported EuroQol 5 Dimensions 5 Levels (EQ-5D-5L), and other disease-specific risk assessments [49, 55–64]. Phase 2 of the evaluation is planned as a two-year post intervention follow up that will study changes in health services utilisation, and medication prescription with the use of hospital-linked administrative datasets.

Data collection

Data collected at various stages of baseline and follow-up from participants include sociodemographic information, private health insurance membership status, lifestyle risk factors, chronic disease diagnoses, clinical measures (as clinically relevant), and several validated health-related surveys that participants were asked to complete upon enrolment (Table 2). These surveys involved information regarding:

- (a) health-related quality of life,
- (b) level of health engagement and activation,
- (c) self-management of their health,
- (d) other disease-specific risk assessments.

Statistical analyses

Data extraction on the WellNet program group and the comparison group were provided by SCS to the researchers. The data were provided in de-identified form and the patient's cdmNET number was used to track patients over time. Descriptive statistics are presented for the initial and final group for WellNet and comparison group. Data are presented as mean and standard deviation (SD) for continuous variables whereas frequency counts and percentages are used for reporting categorical variables.

To assess changes over time between start of the program and program completion, significant within-group mean differences (pre-test/post-test) from baseline to 12 months will be determined by using Paired samples t-test. In addition, between-group analyses (treatment and comparison group) will be conducted to determine significant mean differences using independent samples t-tests and chi-squared tests for continuous and categorical variables respectively. Furthermore, analysis of covariance (ANCOVA) and repeated measures ANCOVA will be used to determine any significant between-group and

within-group differences in the clinical measures and assessments after adjusting for covariates such as age, gender and baseline values. All analyses will be performed using R statistical software. Significance level is set as 0.05 and all statistical tests will be two-sided.

Ethical considerations

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.

Results- Key Findings To Date

Recruitment outcomes

Almost 98% of the patients enrolled in the WellNet program were over 40 years of age, and with 93% having 1 to 3 chronic conditions with one or more risk factors present, and 98% of participants had a HARP score in the >10 range (medium or greater risk). Thereby, it can be observed that the patient identification algorithm used was effective in identifying those patients who potentially met the program's inclusion criteria (Table 3).

As the study is still ongoing, baseline findings are described below.

Sociodemographic characteristics

The key demographic findings are presented in Table 4. The mean (SD) age of the study participants was 70.05 (11.6) years with nearly even gender distribution of males (49.7%) and females (50.3%). A majority of participants (68.7%) in the WellNet treatment group had private health insurance. There is higher than usual patients with private health insurance (PHI) given the higher socioeconomic status of North Sydney region and PHI members targeted for intervention.

Chronic disease diagnosis and clinical indicators

The prevalence of chronic disease among treatment and comparison group was similar. The most prevalent chronic diseases in descending order were: circulatory system disorders (69.8%), diabetes (47.4%), musculoskeletal disorders (43.5%), respiratory diseases (28.7%), mental illness (18.8%), and cancer (13.6%). Consistent with other Australian studies [65, 66], the distribution of chronic diseases significantly differed across age groups as the number of chronic diseases generally increased with age (Figure 4). In terms of gender distribution, diabetes (54.8%) was significantly more prevalent amongst males than females (40.1%), whilst considerably more females had musculoskeletal disorders (54.3% vs 31.3%), respiratory (34.1% vs 23.8%), and mental illness (23.7% vs 16.9%) than males.

Descriptive statistics of clinical measures for treatment and comparison group are present in Table 5. Although treatment and comparison groups were effectively matched based on the type and number of chronic conditions, severity in terms of elevated clinical measures including blood pressure, glycated haemoglobin (HbA1c), Low Density Lipoprotein Cholesterol (LDL-C), total cholesterol, and waist circumference (females only) were not matched. However, there were no statistically significant differences between treatment and comparison group for clinical measures like Body Mass Index (BMI), weight, waist circumference (males only), High Density Lipoprotein Cholesterol (HDL-C), estimated Glomerular Filtration Rate (e-GFR), and Albumin Creatinine Ratio (ACR) at baseline. In order to effectively manage baseline differences, ANCOVA will be used to determine any significant between-group in the clinical measures after adjusting for covariates such as age, gender and baseline values.

Self-reported health assessments

General health and disease-specific risk assessments were recorded only among WellNet treatment group (Table 6). As targeted, around 98% of participants had medium risk or greater HARP scores. The majority of study participants self-rated their health positively with mean EQ-5D-5L index score of 0.79 out of 1. Consistent with other studies [67, 68], the mean EQ-5D-5L score significantly decreased with increased number of chronic diseases ($P<0.001$). In terms of patient activation and self-management, only 21% reported having actively changing their health-related behaviour, with 22% beginning to take actions at baseline. However, 19% believed that action is not important with a majority of participants (38%) reporting that the biggest difficulty in attempting to change behaviour was a lack of confidence or knowledge in managing and improving their condition.

Strengths and weaknesses

Despite general practices being the first point of health-related interactions among predominant percentage of Australians, research based on GP data is disproportionately low [25]. To our knowledge, the WellNet program is the first study in Australia to generate the first real-world evidence on the feasibility and effectiveness of a comprehensive PCMH model with the use of primary care-based data. The study comprises a large, effectively targeted sample with wide range of GP-based data on chronic disease diagnosis and clinical indicators collected by trained health care professionals, as well as self-reported information on general and disease specific risk assessments.

The WellNet program has some limitations in terms of the evaluation study design and data. The WellNet study was based on the case series study design for the treatment group only that did not include a control group. Therefore, analyses of self-reported assessments were limited to 'within group' comparisons rather than 'between groups'. In terms of data limitations, some important sociodemographic variable such as country of birth, education levels, and employment status were not recorded in both treatment and comparison groups. As aforementioned, although the treatment group was closely matched with comparison group based on age, gender, type and number of chronic disease group, there were statistically significant differences observed across some clinical measures between the two groups at baseline.

Conclusion

The findings of this study may be beneficial to patients, providers and policy makers in terms of improved health outcomes, shared-decision making, increased satisfaction through collaborative work practice, and improved safety and quality of care respectively.

We expect that the findings will inform patients on the benefits of PCMH model in terms of improved clinical outcomes, quality of care as well as reduced risk of hospitalisation. This information could empower patients to partner with their GPs in taking proactive action and making shared decisions to better self-manage their chronic conditions with their GPs [69].

The findings of this study are also anticipated to provide evidence-based information on the efficacy of PCMH care to general practice-based providers, enabling transformational changes in their practices. Providers may greatly benefit from knowledge regarding the effectiveness of PCMH in improving job satisfaction, burnout rates, and patient-provider relationship among transformed practices [70, 71].

Finally, the study findings will also help health administrations and policy makers in understanding the population and organisational level health and economic benefits associated with the integrated PCMH model of primary care [72, 73]. This will render in redirecting resources towards primary prevention and early intervention in management of chronic and complex conditions. Additionally, the findings of this research may also yield sound evidence that will further increase advocacy towards practice and implementation guidelines for PCMH care in Australia [74, 75], which could result in a paradigm shift in the efficiency of primary care in Australia and other health systems worldwide.

List Of Abbreviations

ANCOVA - Analysis of Covariance

BMI—Body Mass Index

BP—Blood Pressure

CDM—Chronic Disease Management

COPD—Chronic Obstructive Pulmonary Disorder

CVD - Cardiovascular disease

eGFR—Estimated Glomerular Filtration Rate

EQ-5D-5L—EuroQol 5 Dimension 5 Levels

GP—General Practitioner

HARP - Hospital Admission Risk Profile

HbA1c—Glycated haemoglobin

HDL—High Density Lipoprotein

HR-QOL—Health-related Quality of Life

IT—Information Technology

LDL—Low Density Lipoprotein

MDT—Multidisciplinary team

NHS—National Health Survey

NSW—New South Wales

PAM—Patient Activation Measure

PCMH—Patient-Centred Medical Home

PHI—Private Health Insurance

RACGP—Royal Australian College of General Practitioners

RCT—Randomised Controlled Trials

SCS—Sonic Clinical Services

SD—Standard deviation

SPSS—Statistical Package for the Social Sciences

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 all participants.

Consent for publication

Not applicable

Availability of data and material

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

Competing interests

JRJ receives a PhD scholarship from the CMCRC for conducting this research work. Total funding: approximately \$150,000 AUD. FG, SG and KT have no competing interests. AMN works for AusTrials, which has received funds from the sponsor for the design and evaluation of the WellNet program. Previously, he was the Chief Medical Officer of SCS. AJ is employed by SCS as the Operational Manager Integrated Care and is responsible for the implementation of WellNet. EA receives approximately \$30,000 AUD in research funding from the CMCRC for conducting this research.

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Author contributions

AMN designed the WellNet program model of care. EA, FG and AMN were involved in the study concept and design. JRJ, SG, AMN, AJ, and KT contributed to data acquisition, data analysis, and reporting of the findings. JRJ, EA, AJ, AMN, SG, FG, and KT were involved in drafting and critical revision of the manuscript. All authors read and approved the final version of the manuscript.

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Tables

Table 1. Matching Iterations and Outcomes

Matching iteration number	Matching variables	Treatment (overall n= 636)	Comparison (overall n =20478)	N (Matched treat: comparison)	N (Unmatched treat: comparison)
1	Age (continuous), gender, type of chronic disease (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer) and number of chronic diseases	617*	20478*	589:7750	28:12728
2	Age (continuous), gender, type of chronic disease (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer), systolic, and total cholesterol: HDL-C ratio.	447**	3899**	228:604	219:3205
3	Agecat (breaks=10 years), gender, (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer), systolic, and total cholesterol: HDL-C ratio.	447**	3899**	260:749	260:749
4	Age (continuous), gender, type of chronic disease (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer), systolic (breaks=2mmHg), and total cholesterol: HDL-C ratio.	447**	3899**	202:517	245:3292
5	Agecat (breaks=10 years), gender, (cardiovascular disease, respiratory disease, diabetes, musculoskeletal disease, mental illness, and cancer), systolic (breaks=2mmHg), and total cholesterol: HDL-C ratio.	447**	3899**	242:735	205:3074

* Of the 636 WellNet participants, 19 did not have a chronic disease and were not included in the matching analysis, resulting in 617 participants.

** Out of 636 WellNet participants, 19 did not have a chronic disease, 15 did not have a systolic reading and 166 did not have a TC: HDL reading, and they were automatically removed during matching.

Similarly, out of 20478 comparison patients, 9176 did not have a chronic disease, 3169 did not have a systolic reading and 4234 did not have a TC: HDL reading, and they were automatically removed during matching.

Table 2. Summary of data collected in the WellNet Study

Type of data	Time of data collection	Variables measured
Socio-demographic data	Baseline	Age and gender
Private health insurance membership	Baseline	Private insurance status and name of the insurance provider
Diagnosis of chronic condition	Baseline	Diagnosis of arthritis, asthma, back pain, cancer, cardiovascular diseases (CVD), chronic obstructive pulmonary disease (COPD), diabetes, mental illness and kidney diseases.
Clinical assessments	Baseline 6-month 12-month	Height, weight, waist circumference, Body Mass Index (BMI), blood pressure (BP), blood sample - cholesterol [serum total cholesterol, high density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C)], triglycerides, glycated haemoglobin (HbA1c), estimated glomerular filtration rate (eGFR), and urine albumin-creatinine ratio (UACR).
Risk of hospital admission	Baseline 12-month	Hospital Admission Risk Profile (HARP) score
Health utility data	Baseline 12-month	Medication – drug name, dosage and frequency of use and number of prescriptions.
Patient activation, engagement and readiness to change	Baseline 12-month	Patient Activation Measure (PAM) scores
Patient self-reported health-related quality of life	Baseline 12-month	EuroQol 5 Dimensions 5 Levels (EQ-5D-5L)
Disease-specific risk assessments	Baseline 12-month	Absolute Cardiovascular Disease Risk (CVDR), Australian Type 2 Diabetes Risk Tool (AusDrisk) scores, UK Prospective Diabetes Risk Engine (UKPDS), Chronic Obstructive Pulmonary Disease Assessment Test (CAT) scores, Kessler Psychological Distress scale (K10) scale, Depression Anxiety Stress Scale (DASS21), short versions of Knee Injury and Osteoarthritis Outcome Score (KOOS), Hip Disability and Osteoarthritis Outcome Score (HOOS).
Patient experience survey	12-month	Patient satisfaction survey.
Feasibility outcomes	12-month	Recruitment: number of patients' who potentially met the program's inclusion criteria; Retention rates: number of completed and dropouts; Treatment compliance: rates of adherence to overall protocol.

Table 3. Feasibility outcomes

Recruitment outcomes	
Criteria	Success rate
Age	
40 years and above	97.5%
Number of chronic diseases	
Number of patients with 1 to 3 chronic diseases	93.4%
Number of patients with 4 or more chronic diseases	6.6%
Risk factors	
Patients with 1 chronic disease (n=227)	
<i>1 risk factor</i>	47.6%
<i>>1 risk factor</i>	31.7%
Patients with 2 chronic diseases (n=237)	
<i>1 risk factor</i>	42.6%
<i>>1 risk factor</i>	27.4%
Patients with 3 chronic diseases (n=115)	
<i>1 risk factor</i>	40%
<i>>1 risk factor</i>	35.7%
Patients with 4 or more chronic diseases (n=38)	
<i>1 risk factor</i>	44.7%
<i>>1 risk factor</i>	26.3%
HARP score >10	97.7%

Table 4. Sociodemographic characteristics and prevalence of chronic conditions in the treatment and comparison group.

Determinants	WellNet treatment group (N=589)	WellNet comparison group (N=7750)	P-value
	N (%)	N (%)	
Age groups			0.798
<i>40-44 years</i>	7 (1.2)	141 (1.8)	
<i>45 - 54 years</i>	57 (9.7)	722 (9.3)	
<i>55 - 64 years</i>	118 (20.0)	1580 (20.4)	
<i>65 - 74 years</i>	188 (31.9)	2360 (30.4)	
<i>75 - 84 years</i>	156 (26.5)	2029 (26.2)	
<i>≥85 years</i>	63 (10.7)	918 (11.8)	
<i>Mean (SD)</i>	70.05 (11.59)	69.95 (11.86)	
Sex			0.936
<i>Male</i>	293 (49.7)	3842 (49.6)	
<i>Female</i>	296 (50.3)	3908 (50.4)	
Smoking status			<0.001
<i>Ex-smoker</i>	237 (42.1)	2274 (36.4)	
<i>Non-smoker</i>	280 (49.7)	3655 (58.6)	
<i>Smoker</i>	46 (8.2)	309 (5.0)	
<i>Unknown</i>	26 (4.4)	1512 (19.5)	
Drinking status			<0.001
<i>Drinker</i>	256 (43.5)	1465 (18.9)	
<i>Non-drinker</i>	176 (29.9)	147 (1.9)	
<i>Unknown</i>	156 (26.5)	6138 (79.2)	
Private insurance status			-
<i>Yes</i>	404 (68.7)	NA	
<i>No</i>	184 (31.3)		
<i>Missing</i>	1 (0.2)		
Prevalence of chronic conditions			1.000
<i>Diseases of the circulatory system</i>	411 (69.8)	5408 (69.8)	
<i>Respiratory diseases</i>	169 (28.7)	2224 (28.7)	
<i>Musculoskeletal disorders</i>	256 (43.5)	3368 (43.5)	
<i>Diabetes</i>	279 (47.4)	3671 (47.4)	
<i>Mental illness</i>	111 (18.8)	1461 (18.8)	
<i>Cancer</i>	80 (13.6)	1053 (13.6)	
Number of chronic conditions			1.000
<i>1 disease</i>	133 (22.6)	1750 (22.6)	
<i>2 diseases</i>	249 (42.3)	3276 (42.3)	
<i>3 diseases</i>	159 (27.0)	2092 (27.0)	
<i>4 diseases</i>	42 (7.1)	553 (7.1)	
<i>≥5 diseases</i>	6 (1.0)	79 (1.0)	

p-value by Chi-square test

NA - Not available

SD - Standard deviation

Table 5. Clinical measures among treatment and comparison group collected at baseline.

Clinical Measures	WellNet treatment group (N=589)	WellNet comparison group (N=7750)	P-value
	N (%)	N (%)	
Grades of hypertension			
<i>Normal (SBP <140 and/or DBP <90)</i>	268 (46.0)	3411 (54.4)	<0.001
<i>Grade 1 (SBP 140-159 and/or DBP 90-99)</i>	241 (41.4)	2198 (35.0)	
<i>Grade 2 (SBP 160-179 and/or DBP 100-109)</i>	58 (10.0)	606 (9.7)	
<i>Grade 3 (SBP ≥180 and/or DBP ≥110)</i>	15 (2.6)	57 (0.9)	
<i>Missing</i>	7 (1.2)	1479 (19.1)	
<i>Blood pressure - systolic (mmHg) - Mean (SD)</i>	139.37 (19.30)	135.96 (16.51)	<0.001
<i>Blood pressure - diastolic (mmHg) - Mean (SD)</i>	79.27 (10.32)	76.02 (11.31)	<0.001
Body Mass Index			
<i>Underweight (<18.50 kg/m²)</i>	4 (0.7)	15 (0.9)	0.002
<i>Normal (18.50 - 24.99 kg/m²)</i>	155 (26.6)	378 (23.0)	
<i>Overweight (25.00 - 29.99 kg/m²)</i>	188 (32.3)	657 (39.9)	
<i>Obese (30.00 - 39.99 kg/m²)</i>	193 (33.2)	524 (31.8)	
<i>Morbidly obese (≥40 kg/m²)</i>	42 (7.2)	71 (4.3)	
<i>Missing</i>	7 (1.2)	6105 (78.8)	
<i>Mean (SD)</i>	29.54 (6.36)	29.12 (5.63)	0.151
<i>Weight (kg) - Mean (SD)</i>	81.81 (20.72)	81.73 (19.70)	0.930
Waist Circumference* (Males)			
<i>Normal (<93.99 cm)</i>	55 (19.5)	82 (19.9)	0.972
<i>Moderate risk (≥94 cm)</i>	70 (24.8)	99 (24.1)	
<i>High risk (≥102 cm)</i>	157 (55.7)	230 (56.0)	
<i>Missing</i>	11 (3.8)	3430 (89.3)	
<i>Mean (SD)</i>	106.09 (15.63)	104.30 (14.30)	0.120
Waist Circumference* (Females)			
<i>Normal (<79.99 cm)</i>	30 (11.0)	70 (13.8)	0.018
<i>Moderate risk (≥80 cm)</i>	31 (11.4)	90 (17.8)	
<i>High risk (≥88 cm)</i>	212 (77.7)	345 (68.4)	
<i>Missing</i>	23 (7.8)	3403 (87.1)	
<i>Mean (SD)</i>	98.82 (14.62)	93.15 (12.47)	<0.001
HbA1c (%) (Restricted to Diabetic patients)			
<i><7%</i>	128 (55.9)	1857 (70.7)	<0.001
<i>7-8 %</i>	53 (23.1)	418 (15.9)	
<i>>8%</i>	48 (21.0)	353 (13.4)	
<i>Missing</i>	50 (17.9)	1042 (28.4)	
<i>Mean (SD)</i>	7.16 (1.41)	6.71 (1.24)	<0.001
High Density Lipoprotein cholesterol (mmol/L)			
<i>≥1.0 mmol/L</i>	377 (87.3)	3941 (88.6)	0.422
<i><1.0 mmol/L</i>	55 (12.7)	509 (11.4)	
<i>Missing</i>	157 (26.7)	3300 (42.6)	
<i>Mean (SD)</i>	1.37 (0.40)	1.40 (0.42)	0.147
Low Density Lipoprotein cholesterol (mmol/L)			
<i>≤2mmol/L</i>	140 (32.9)	1633 (37.0)	0.096
<i>>2.0 mmol/L</i>	285 (67.1)	2778 (63.0)	
<i>Missing</i>	164 (27.8)	3339 (43.1)	
<i>Mean (SD)</i>	2.71 (1.08)	2.52 (0.98)	<0.001
Serum total cholesterol (mmol/L)			
<i><4 mmol/L</i>	157 (33.3)	1827 (34.2)	<0.001
<i>4.0 - 6.9 mmol/L</i>	292 (62.0)	3451 (64.5)	
<i>≥7 mmol/L</i>	22 (4.7)	70 (1.3)	
<i>Missing</i>	118 (20.0)	2402 (31.0)	

<i>Mean (SD)</i>	4.81 (1.38)	4.60 (1.13)	0.001
Triglycerides (mmol/L)			
<i>≤2mmol/L</i>	371 (78.9)	NA	-
<i>>2mmol/L</i>	99 (21.1)		
<i>Missing</i>	119 (20.2)		
<i>Mean (SD)</i>	1.63 (1.16)		
Estimated Glomerular Filtration Rate (mL/min/1.73m²)			
<i>>90 mL/min/1.73 m²</i>	109 (24.9)	1467 (24.8)	0.868
<i>60-89 mL/min/1.73 m²</i>	247 (56.5)	3436 (58.2)	
<i>45-59 mL/min/1.73 m²</i>	46 (10.5)	622 (10.5)	
<i>30-44 mL/min/1.73 m²</i>	26 (5.9)	274 (4.6)	
<i><30 mL/min/1.73 m²</i>	9 (2.0)	106 (1.8)	
<i>Missing</i>	152 (25.8)	1845 (23.8)	
Albumin-Creatinine Ratio* (mg/mmol) (Males)			
<i>Normal (<2.5 mg/mmol)</i>	70 (58.8)	550 (68.3)	0.100
<i>Microalbuminuria (2.5-25 mg/mmol)</i>	36 (30.3)	177 (21.9)	
<i>Macroalbuminuria (>25 mg/mmol)</i>	13 (10.9)	79 (9.8)	
<i>Missing</i>	174 (59.4)	3036 (79.0)	
<i>Mean (SD)</i>	15.52 (67.54)	13.08 (53.18)	0.653
Albumin-Creatinine Ratio* (mg/mmol) (Females)			
<i>Normal (<3.5 mg/mmol)</i>	66 (73.3)	401 (73.4)	0.508
<i>Microalbuminuria (3.5-35 mg/mmol)</i>	20 (22.2)	132 (24.2)	
<i>Macroalbuminuria (>35 mg/mmol)</i>	4 (4.4)	13 (2.4)	
<i>Missing</i>	206 (69.6)	3361 (86.0)	
<i>Mean (SD)</i>	7.53 (22.31)	8.07 (32.12)	0.878

p-value by Chi-square test (categorical) or independent samples t-test (continuous) between treatment and control group

NA - Not available

SD - Standard deviation

*Variables with gender-specific cut-off points

Table 6. General and disease-specific assessments among WellNet treatment group only at baseline

Patient survey questionnaires	WellNet treatment group (N=635)
	n (%)
HARP risk profile (N=628)	
<i>Low risk (1-10)</i>	14 (2.2)
<i>Medium risk (11-23)</i>	581 (92.5)
<i>High risk (24-38)</i>	33 (5.3)
<i>Missing</i>	7 (1.1)
Patient Activation Measure scores (N=626)	
<i>Not believing that activation is important (<47)</i>	121 (19.3)
<i>A lack of knowledge and confidence to take action (47.1-55.1)</i>	236 (37.7)
<i>Beginning to take action (55.2-67)</i>	138 (22.0)
<i>Taking action (>67.1)</i>	131 (20.9)
<i>Missing</i>	9 (1.4)
Mean EQ-5D-5L score (overall) - Mean (SD)	0.79 (0.19)
EQ-5D-5L score percentage	
EQ-5D-5L mobility (N=626)	
<i>No problem</i>	298 (47.6)
<i>Slight problem</i>	171 (27.3)
<i>Moderate problem</i>	108 (17.3)
<i>Severe problem</i>	47 (7.5)
<i>Unable to walk</i>	2 (0.3)
<i>Missing</i>	9 (1.4)
EQ-5D-5L self-care (N=623)	
<i>No problem</i>	521 (83.6)
<i>Slight problem</i>	79 (12.7)
<i>Moderate problem</i>	19 (3.0)
<i>Severe problem</i>	4 (0.6)
<i>Unable</i>	0 (0.0)
<i>Missing</i>	12 (1.9)
EQ-5D-5L usual activities (N=626)	
<i>No problem</i>	312 (49.8)
<i>Slight problem</i>	187 (29.9)
<i>Moderate problem</i>	98 (15.7)
<i>Severe problem</i>	26 (4.2)
<i>Unable</i>	3 (0.5)
<i>Missing</i>	9 (1.4)
EQ-5D-5L pain/discomfort (N=627)	
<i>No problem</i>	156 (24.9)
<i>Slight problem</i>	246 (39.2)
<i>Moderate problem</i>	165 (26.3)
<i>Severe problem</i>	55 (8.8)
<i>Extreme</i>	5 (0.8)
<i>Missing</i>	8 (1.3)
EQ-5D-5L anxiety/depression (N=629)	
<i>No problem</i>	321 (51.0)
<i>Slight problem</i>	190 (30.2)
<i>Moderate problem</i>	94 (14.9)
<i>Severe problem</i>	16 (2.5)
<i>Extreme</i>	8 (1.3)
<i>Missing</i>	6 (0.9)
DASS21 Scores (N=331)	
DASS21 - Depression scale	
<i>Normal</i>	230 (69.5)
<i>Mild</i>	26 (7.9)
<i>Moderate</i>	40 (12.1)
<i>Severe</i>	12 (3.6)
<i>Extremely severe</i>	23 (6.9)
DASS21 - Anxiety scale	
<i>Normal</i>	211 (63.7)
<i>Mild</i>	32 (9.7)
<i>Moderate</i>	53 (16.0)

<i>Severe</i>	14 (4.2)
<i>Extremely severe</i>	21 (6.3)
DASS21 - Stress scale	
<i>Normal</i>	260 (78.5)
<i>Mild</i>	29 (8.8)
<i>Moderate</i>	20 (6.0)
<i>Severe</i>	15 (4.5)
<i>Extremely severe</i>	7 (2.1)
K10 scores (N=302)	
<i>Low level of psychological distress</i>	137 (45.4)
<i>Moderate level of psychological distress</i>	88 (29.1)
<i>High level of psychological distress</i>	49 (16.2)
<i>Very high level of psychological distress</i>	28 (9.3)
UKPDS risk profile (N=140)	
<i>Coronary Heart Disease risk - mean percentage (SD)</i>	18.98 (14.11)
<i>Fatal Coronary Heart Disease risk - mean percentage (SD)</i>	14.94 (16.14)
<i>Stroke risk - mean percentage (SD)</i>	14.37 (15.10)
<i>Fatal stroke risk - mean percentage (SD)</i>	2.33 (2.60)
<i>Missing</i>	53 (27.5)
AusDRisk scores (N=220)	
<i>Low risk</i>	5 (2.3)
<i>Intermediate risk</i>	34 (15.5)
<i>High risk</i>	181 (82.3)
<i>Missing</i>	137 (38.4)
Absolute cardiovascular risk (N=370)	
<i>Low risk</i>	167 (45.1)
<i>Moderate risk</i>	84 (22.7)
<i>High risk</i>	119 (32.2)
<i>Missing</i>	48 (11.5)
COPD impact scores (N=26)	
<i>Normal</i>	2 (7.7)
<i>Low</i>	4 (15.4)
<i>Medium</i>	12 (46.2)
<i>High</i>	3 (11.5)
<i>Very high</i>	5 (19.2)
<i>Missing</i>	38 (59.4)
HOOS score (N=31)	
<i>HOOS pain score - Mean (SD)</i>	64.92 (23.37)
<i>HOOS function score - Mean (SD)</i>	68.95 (19.80)
<i>HOOS symptoms score - Mean (SD)</i>	66.15 (17.23)
<i>Missing</i>	168 (84.4)
KOOS score (N=59)	
<i>KOOS stiffness score - Mean (SD)</i>	61.86 (28.37)
<i>KOOS pain score - Mean (SD)</i>	64.72 (22.01)
<i>KOOS function score - Mean (SD)</i>	63.13 (25.58)
<i>KOOS symptoms score - Mean (SD)</i>	63.09 (18.14)
<i>Missing</i>	140 (70.3)

N - Total number of valid observations

SD - Standard Deviation

Figures

Patients aged ≥ 40 years and had seen a GP at least 3 times in the last two years

Chronic disease diagnosis

- 1) Cardiovascular disease – *Angina, atrial fibrillation, chronic heart failure, congestive heart failure, coronary artery disease, heart attack, rheumatoid, stroke, transient ischaemic attack, and venous thromboembolism.*
- 2) Respiratory disease – *asthma and chronic obstructive pulmonary disease*
- 3) Diabetes – *Type 1 or Type 2*
- 4) Musculoskeletal disorders – *osteoarthritis, osteoporosis, and chronic low back pain*
- 5) Mental illness – *anxiety, depression, bipolar disorder, schizophrenia, and psychosis*
- 6) Cancer

1-3 Dx

4 or more Dx
(with or without one or
more risk factors)

AND

Any one or more risk factors

- 1) Severe obesity (BMI ≥ 40)
- 2) High total cholesterol (≥ 5.5 mmol/L)
- 3) High blood pressure ($\geq 140/90$)
- 4) HbA1c levels ($>7.5\%$)
- 5) eGFR < 60 ml/min
- 6) UACR > 2.5 (males) >3.5 (females)
- 7) Hb < 11 g/dL
- 8) Elevated LFTs
- 9) Platelets $> 480 \times 10^9/L$
- 10) Current treatment with oral steroids

HARP** > 10

Figure 1

Figure 1. Eligibility criteria for the WellNet study ** Additionally, patients with low HARP score (< 10) but with at least one or more chronic diseases and one or more consistently elevated risk factors were also included in the Study through GP referrals. Dx – Diagnosis of a chronic disease



Figure 2

Figure 2. Flowchart detailing the WellNet Study enrolment process

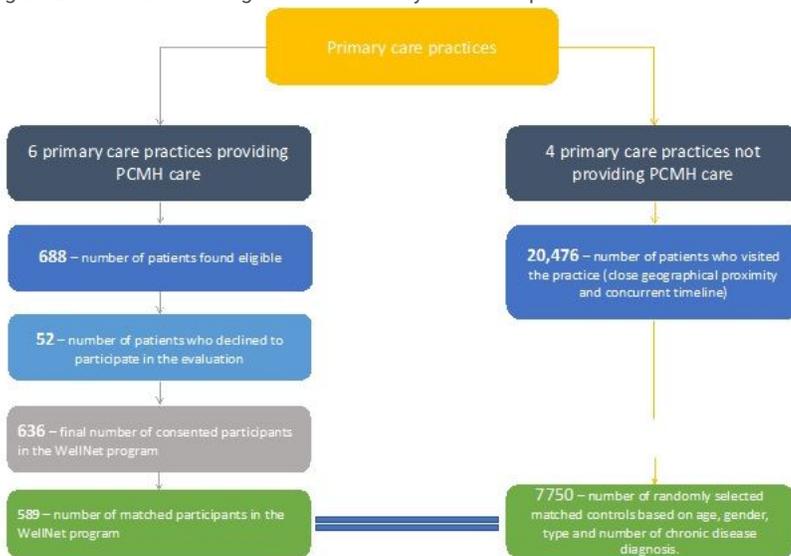


Figure 3

Figure 3. Patient enrolment

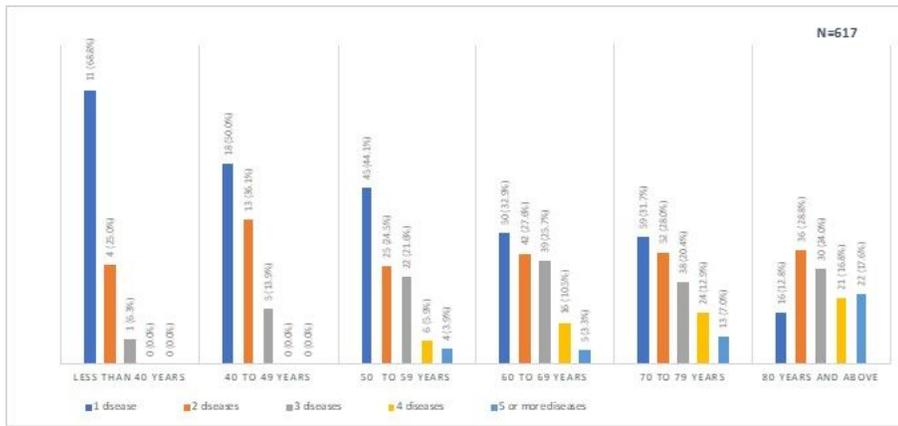


Figure 4

Figure 4. Chronic disease prevalence among WellNet treatment group Chi-squared test returned a $P < 0.001$.

Supplementary Files

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

- [Tables.docx](#)