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CLINICAL RESEARCH
Heart failure and cardiomyopathies

Primary care heart failure service identifies a missed cohort of heart failure patients with reduced ejection fraction

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Aims We explored whether a missed cohort of patients in the community with heart failure (HF) and left ventricular systolic dysfunction (LVSD) could be identified and receive treatment optimization through a primary care heart failure (PCHF) service.

Methods and results PCHF is a partnership between Inspira Health, National Health Service Cardiologists and Medtronic. The PCHF service uses retrospective clinical audit to identify patients requiring a prospective face-to-face consultation with a consultant cardiologist for clinical review of their HF management within primary care. The service is delivered via five phases: (i) system interrogation of general practitioner (GP) systems; (ii) clinical audit of medical records; (iii) patient invitation; (iv) consultant reviews; and (v) follow-up. A total of 78 GP practices (864 194 population) have participated. In total, 19 393 patients' records were audited. HF register was 9668 (prevalence 1.1%) with 6162 patients coded with LVSD (prevalence 0.7%). HF case finder identified 9725 additional patients to be audited of whom 2916 patients required LVSD codes adding to the patient medical record (47% increase in LVSD). Prevalence of HF with LVSD increased from 0.7% to 1.05%. A total of 662 patients were invited for consultant cardiologist review at their local GP practice. The service found that within primary care, 27% of HF patients identified for a cardiologist consultation were eligible for complex device therapy, 45% required medicines optimization, and 47% of patients audited required diagnosis codes adding to their GP record.

Conclusion A PCHF service can identify a missed cohort of patients with HF and LVSD, enabling the optimization of prognostic medication and an increase in device prescription.

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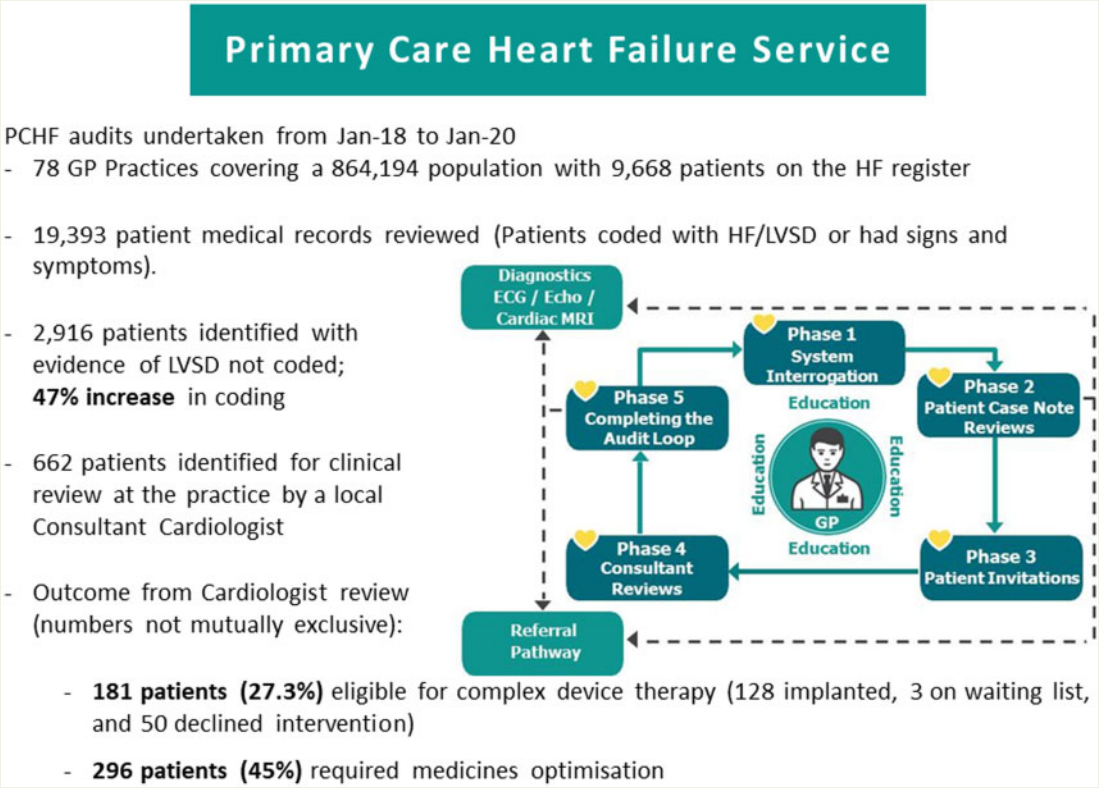
Graphical Abstract



A primary care heart failure service can identify a cohort of patients in the community with heart failure and left ventricular systolic dysfunction who are not medically optimized and have not been offered an implantable cardioverter defibrillator or cardiac resynchronization therapy. ECG, electrocardiogram; GP, general practitioner; MRI, magnetic resonance imaging.

Keywords Heart failure • Left ventricular systolic dysfunction • Cardiac resynchronization therapy • Implantable cardioverter defibrillator • Medicine optimization

Introduction

Heart failure (HF) is a major health problem in primary and secondary care in the UK,[1] with a reported prevalence of 1–2%.[2] It is a leading cause of hospital admissions in patients aged over 65,[3,4] whilst 5% of all emergency admissions to hospitals are due to a HF presentation. HF is associated with significant costs to health service budgets and the average cost per admission is ~£4000.[3]

It is estimated that over 900 000 people are currently living with HF in the UK whilst >650 000 people are on their general practitioner (GP) HF register.[5] Anecdotally a high proportion of patients with HF have historically been discharged from HF services once optimized and stable. Importantly many more people are believed to be affected by HF and are left undiagnosed; data suggest a relatively high prevalence of undetected HF exists in the community.[6] This missed cohort of HF patients can be due to a variety of reasons: high levels of misdiagnosis and missed diagnoses,[6,7] health inequalities affecting service provision,[8] patients not presenting to healthcare providers when they become symptomatic[9] (especially relevant during the COVID-19 pandemic), and patients discharged from secondary/tertiary services before appropriate diagnosis and optimization by specialist teams.[10]

There have been important advances in HF care over the last 10 years[11] endorsed both by national and international guidelines for use in carefully selected patients, such as neprilysin inhibitors,[2,12] sodium-glucose cotransporter 2 (SGLT2) inhibitors,[13] intravenous iron,[14] and implantable cardioverter defibrillator or cardiac resynchronization therapy implantation (known as complex cardiac implantable electronic devices [CIED]).[2,15] Patients with HF associated with reduced ejection fraction are at a relatively high risk of sudden cardiac death emphasizing the importance of access to complex CIED.[2,15]

Initiatives to help healthcare professionals identify patients with HF who need changes to their care, based on the latest clinical guidelines, are therefore of great importance. This missed patient cohort under non-specialist care is much less likely to benefit from the latest strategies or other prognostically important therapies and, by inference,

will probably have a higher risk of morbidity and mortality than patients treated in conventional HF services.

Therefore, the primary care heart failure (PCHF) service seeks to screen and identify this high-risk undertreated population of patients with HF and left ventricular systolic dysfunction (LVSD) who require optimization and consideration for complex CIED therapy in the community and provide specialist support to GP practices.

Methods

It was hypothesized by consultant cardiologists in the North West of England and members of Medtronic that there are a significant number of patients with HF that are not under regular HF specialist team follow-up who are eligible for medical optimization and/or complex CIED implantation according to national and international guidelines.

This developed into the PCHF service, a national partnership between Inspira Health, cardiologists who work in the National Health Service (NHS) and Medtronic. Clinical decision-making is exclusively the responsibility of the cardiology team. The PCHF service methodology was developed by Inspira Health, replicating its primary care atrial fibrillation service methodology,[16] and funding for the service was provided by Medtronic.

The service commenced in January 2018 and we collected data for patients assessed by the service up until January 2020. Patients were followed up until November 2020.

The geographical spread and NHS hospitals involved so far with the PCHF service are as follows:

- North West of England: Blackpool Victoria Hospital, Manchester Royal Infirmary, Fairfield General Hospital, Warrington Hospital, and Wythenshawe Hospital.
- North East of England: James Cook University Hospital.
- Midlands: The Shrewsbury and Telford Hospital and Nottingham University Hospital.
- East of England: Royal Papworth Hospital.
- South West of England: Royal Cornwall Hospital and Dorset County Hospital.

The primary care heart failure service

Practice enrolment

GP practices were informed of the availability of the service through direct systematic marketing or by local health service managers and/or medicines management teams. As the service expanded, interest was expressed from GP practices based on recommendations from previously enrolled practices.

Pathway

In each enrolled GP practice, the PCHF service was delivered via five phases, with an additional practice education programme (*Figure 1*).

Education

GPs, practice nurses, community HF nurses, and practice pharmacists were invited to take part in the consultant-led PCHF clinics, allowing opportunities for shared learning and discussion of individual cases. In addition to this, lunch-time or evening education sessions were held at either practice or regional health service level.

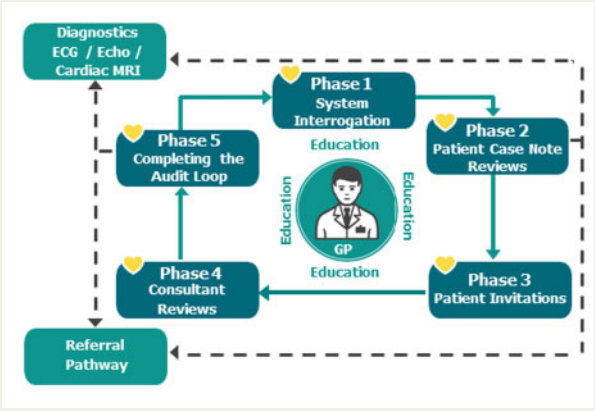


Figure 1 The primary care heart failure service audit cycle.

Phase 1

Bespoke HF queries were run on each GP clinical system producing two lists of patients as follows:

(1) Patients who have been coded as having both HF and LVSD (SNOMED CT codes).
(2) Patients coded with either HF or LVSD or indicative terms, which would suggest that the patient might have HF (case finder). We focused on patients prescribed beta-blockers, angiotensin-converting enzyme inhibitors (ACEi), angiotensin receptor blockers (ARB), mineralocorticoid receptor antagonists (MRA), sacubitril/valsartan, and ivabradine who were not already coded as having HF or LVSD. We also examined the records of patients with SNOMED CT codes for cardiomyopathy, cardiomegaly, hypertrophy, myocardial infarction, or B-type natriuretic peptide (BNP) results who did not have HF or LVSD already coded.

Phase 2

Patients identified on both lists had their medical records comprehensively reviewed by a trained Clinical Auditor to assess current management, compliance with the National Institute for Health and Care Excellence (NICE) guidelines and suitability for consultant cardiologist review. Audit review focused on symptoms that may be compatible with HF, those with a history of myocardial infarction, percutaneous or surgical coronary intervention or atrial fibrillation, the last echocardiogram/ECG, ejection fraction ≤35% or moderate severe LVSD and use of prognostic HF drugs. The case finder element was used to identify patients with HF and/or LVSD that had not been correctly coded in GP records.

Patients were put forward for review if they had severe LVSD (ejection fraction <35%) on their latest investigation or had evidence of symptomatic HF with ejection fraction <50%. Patients were excluded if they already had a complex CIED in situ or were currently under active follow-up with a Cardiology HF Department.

Phase 3

After completion of the clinical audit, the designated consultant cardiologist virtually reviewed the auditor's summary to ensure appropriate patients were invited in for a face-to-face consultation to discuss treatment options for their HF.

Two weeks before the scheduled PCHF clinic, an office administrator sent a letter to the patients eligible for clinical review inviting them to

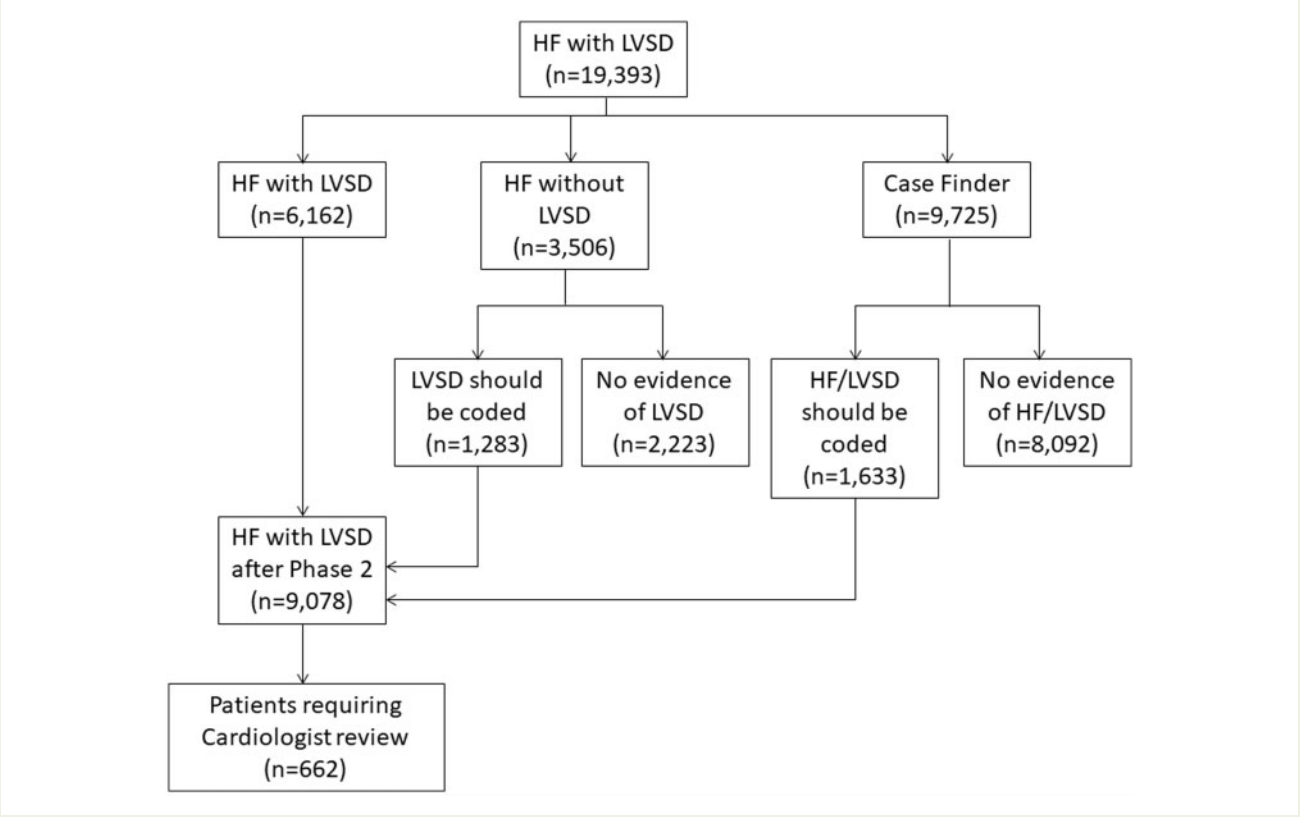


Figure 2 Number of medical records audited and patients with heart failure and left ventricular systolic dysfunction.

attend a PCHF appointment at their local GP practice. Patients were then contacted by telephone 1 week prior to their appointment to explain the service and answer any queries and again 1 day prior to minimize non-attendance ('call and recall' approach).

Phase 4

Consultant cardiologists delivered PCHF clinics at the patients' local GP practices. Prior to the clinic, patients had an up to date ECG. During the clinical consultation, the patients' current HF signs and symptoms were assessed and treatment amended accordingly. Medication was prescribed in accordance with NICE guidelines, and either uptitrated at the patients' local GP practice or overseen subsequently by community HF nurses as per local protocols to ensure the safe management of blood pressure, renal function, and other important blood results (such as management of sacubitril/valsartan). Patients requiring complex CIED implantation or further diagnostic investigation, e.g. repeat echocardiogram or cardiac magnetic resonance imaging or advanced HF management, were referred to their local Hospital Cardiology Department for ongoing care. The requirement for complex CIED implantation was assessed in accordance with NICE guidelines.[15]

Phase 5

Three months after PCHF clinics, a member of the PCHF service staff reviewed the medical records to assess recommendations made from each consultation that included: changes in medication and/or referral for further diagnostics or complex CIED implantation. This review was repeated at 6, 9, 12, 18, 24, and 30 months to ensure that all necessary clinical actions had been either completed or were being actively managed. Any outstanding actions were flagged to the appropriate GP practice and designated consultant cardiologist.

Clinical audit

This work was classified as clinical audit as it did not involve anything being done to patients beyond their normal clinical management and therefore did not require formal ethical approval. We did not involve patients or the public in the design, conduct or reporting of our work. Results/findings have been disseminated back to relevant GP practices and individual patients as part of their ongoing clinical care.

Data collection

During delivery of the PCHF service, data were collected on patient characteristics [age, sex, aetiology, hypertension, atrial fibrillation, diabetes, renal dysfunction (defined as estimated glomerular filtration rate <60 mL/min/1.73 m^2), chronic obstructive pulmonary disease, ejection fraction, and QRS duration], diagnosis (HF and LVSD coded or requiring coding), medication prior to and prescribed following cardiologist review (beta-blockers, ACEi, ARB, MRA, sacubitril/valsartan, and ivabradine), clinic attendance status and clinic date, initial outcome from clinic (potential complex CIED candidates requiring repeat assessment of left ventricular function with or without medicines optimization, medicines optimization only, and not requiring any changes in their management), follow-up status (device implanted, device waiting list, device declined by patient, potential device candidate still being investigated, potential device candidate under active follow-up, medicine management, and patient inactive: i.e. moved GP practice or deceased), and device type including implant date. We did not collect data on the number of patients taking

Table 1 Patient characteristics and medications prior to cardiologist review ($n = 662$)

Age (years)	75 (33–89)
Male sex	471 (71.1%)
Ischaemic aetiology	338 (51.1%)
Hypertension	329 (49.7%)
Atrial fibrillation	140 (21.1%)
Diabetes	162 (24.5%)
Renal dysfunction	243 (36.7%)
Chronic obstructive pulmonary disease	120 (18.1%)
Ejection fraction <35%	489 (73.9%)
QRS >120 ms	251 (37.9%)
Medications	
Beta-blocker only	122 (18.4%)
ACEi/ARB only	87 (13.1%)
Dual therapy (beta-blocker and ACEi/ARB)	262 (39.6%)
Triple therapy (beta-blocker, ACEi/ARB, and MRA)	174 (26.3%)
Other combination	17 (2.6%)

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; MRA, mineralocorticoid receptor antagonist.

Table 2 Medicines initiated or optimized during cardiologist reviews at local general practitioner practices ($n = 662$)

ACEi/ARB	283 (42.7%)
Beta-blocker	207 (31.3%)
MRA	132 (19.9%)
Sacubitril/valsartan[a]	44 (6.6%)
Ivabradine	5 (0.8%)

ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; MRA, mineralocorticoid receptor antagonist.
[a]All patients who had sacubitril/valsartan prescribed/optimized were initiated on this agent following the primary care heart failure review.

Table 3 Follow-up outcomes following cardiologist reviews at local general practitioner practices ($n = 662$)

Device implanted	128 (19.3%)
Device waiting list	3 (0.5%)
Device declined by the patient	50 (7.6%)
Potential device candidate still being investigated	21 (3.2%)
Potential device candidate under active follow-up	187 (28.2%)
Medicine management	226 (34.1%)
Patient inactive (moved GP practice or deceased)	47 (7.1%)

GP, general practitioner.

Table 4 Type of device either implanted or on a waiting list to be implanted following cardiologist reviews at local general practitioner practices ($n = 131$)

Cardiac resynchronization therapy pacemaker	60 (45.8%)
Implantable cardioverter defibrillator	35 (26.7%)
Cardiac resynchronization therapy defibrillator	36 (27.5%)

SGLT2 inhibitors as this was not a NICE-recommended treatment for patients with HF and LVSD during the time period reported here.

The UK index of multiple deprivation was used by Clinical Commissioning Group to measure socioeconomic deprivation, using the 2018/19 data available from Public Health England[17] as a proxy for each GP practice participating in PCHF audits.

Statistical analysis

Continuous data are expressed as median average with minimum to maximum range as appropriate. Categorical data are shown as absolute numbers and percentages. Linear regression analysis was used to examine the relationship between the number of device candidates identified and patients with medicines optimized at each practice against the level of deprivation.

Results

General practitioner practices and heart failure/left ventricular systolic dysfunction prevalence

From January 2018 to January 2020, 78 GP practices covering a patient population of 864 194 participated in the service. In total, 19 393 patients' medical records were audited (*Figure 2*). The number of patients audited from the HF register was 9668 (prevalence 1.1%) and 6162 patients were coded as having LVSD (prevalence 0.7%). The HF case finder data extraction identified 9725 additional patients to be audited. From these, 2916 patients required LVSD codes to be added to the patient medical record (47% increase in patients coded with LVSD). The prevalence of HF with LVSD before and after the PCHF service was 0.7% and 1.05%, respectively.

Patient characteristics

Six hundred and sixty-two patients were invited for a consultant cardiologist review at their local GP practice, with an attendance rate of 74.2% ($n = 491$). Patient characteristics and medications prior to PCHF review are shown in *Table 1*.

Cardiologist review outcomes

During cardiologist review, 413 (62.4%) were classified as a potential complex CIED candidate requiring repeat assessment of LV function with or without medicines optimization, 112 (16.9%) required medicines optimization only, and 137 (20.7%) did not require any change in their management.

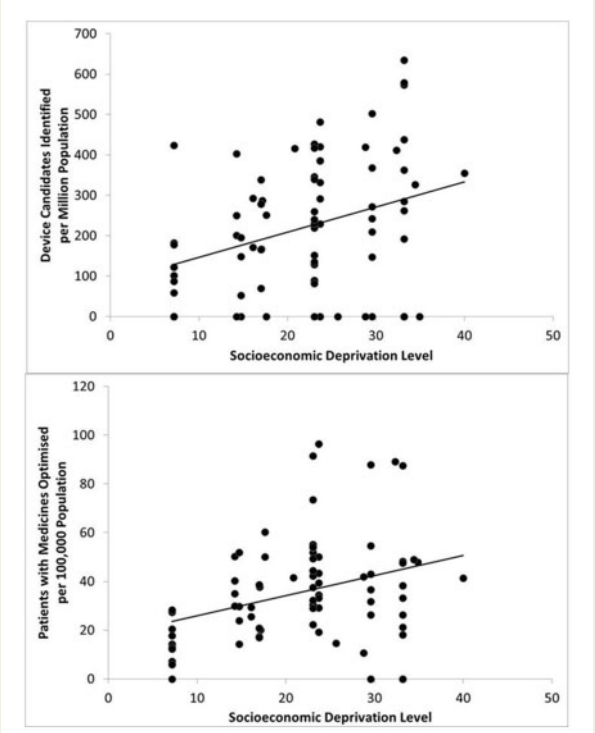


Figure 3 Linear regression of device candidates identified vs. socioeconomic deprivation (top) and patients with medicines optimized vs. socioeconomic deprivation (bottom). Each dot represents a general practitioner practice.

Of the patients reviewed, 49% ($n = 325$) were already deemed to be on optimal medication. Forty-five percentage of patients ($n = 296$) had medication altered during cardiologist review. The breakdown of medicines initiated or optimized is shown in *Table 2*.

Follow-up

The median follow-up for all patients was 20 months (minimum 10 months, maximum 30 months). At the time of follow-up, 85% of patients were deemed to be on optimal medication. After follow-up appointments at hospital, 181 (27.3%) patients were deemed appropriate for complex CIED implantation (with 128 implanted, 3 on a waiting list, and 50 who declined intervention). All outcomes for the 662 patients reviewed by cardiologists are shown in *Table 3*.

Twenty percent ($n = 131$) of all patients reviewed either received a complex CIED implant or were on a waiting list for device therapy. *Table 4* shows the type of device either implanted or on a waiting list to be implanted. The median duration from PCHF clinic cardiologist review to device implantation was 6 months (minimum 1 month, maximum 20 months).

Correlation with socioeconomic deprivation

There was a correlation between device candidates identified, shown as per million population, and socioeconomic deprivation level, with an increasing number of patients requiring complex CIED found in more deprived areas (R^2 0.1062, $P = 0.004$; *Figure 3*). There was also a correlation between patients who required medical optimization, shown as per 100 000 population, and socioeconomic deprivation level, with an increasing number of patients requiring medical optimization found in more deprived areas (R^2 0.1109, $P = 0.003$; *Figure 3*). There was no correlation between deprivation and missing LVSD coding (R^2 0.0003, $P = 0.89$).

Discussion

We report on our results from the first 2 years of the PCHF service. To date, the service has included GP practices with a catchment area accounting for 1.3% of the UK population.

We have demonstrated that (i) missed patients with HF and/or LVSD in the community who are not under the care of conventional HF services are undertreated with guideline-based therapies, often requiring medical optimization and/or consideration of complex CIED implantation, and (ii) such patients can be readily identified using a simple approach. The novel approach of the PCHF service model is that it specifically targets missed patients in primary care who were not otherwise being seen by secondary care specialized services. Left untreated, it would be expected this group of HF patients would be at a higher risk of adverse outcomes compared with HF patients treated in conventional services. We believe that the model can be easily replicated and used alongside different HF service models. This service has particular relevance in light of the COVID-19 pandemic when HF services have been under particular pressure.[9]

Our experience has found that within primary care, 27% of missed HF patients identified for a cardiologist consultation are eligible for complex CIED therapy, 45% require medicines optimization, and 47% of patients audited require diagnosis codes adding to their GP system medical record (*Graphical abstract*).

Despite international guidelines and NICE guidance, undertreatment of high-risk populations remains a significant problem. The UK National Cardiac Rhythm Management Audit shows a significant regional variation in complex CIED prescription across England.[18] However, few data exist on strategies to improve guideline-directed device implantation rates in high-risk populations and, therefore, reduce inequalities. A PCHF service model could be targeted towards those geographical areas known to have lower complex CIED implantation rates and effectively 'level up' access to HF specialized treatments in undertreated areas.

Of the patients who were suitable for complex CIED therapy, 50 declined such intervention, which equates to 27.6% of the 181 eligible patients, similar to reported rates.[19] The reasons for declining this treatment were not collected in detail as part of this work, but anecdotally, most patients who declined complex CIED implantation within the PCHF service were asymptomatic, a phenomenon that has also been noted previously.[20]

HF is a multi-factorial syndrome and dynamic bidirectional changes in symptoms or functional markers (such as ejection fraction) may occur. If not identified, these changes over time may result in misclassification of patients or failure to institute the correct treatment.[21] Poor adherence to guideline-recommended medical therapy in HF

patients is associated with a doubling of risk of overall, cardiovascular and HF deaths and impacts on hospitalization.[22] The proportion of patients prescribed ACEi/ARB, beta-blocker and MRA therapy prior to PCHF review were higher than those reported in the CHAMP-HF registry with 81%, 84.9%, and 28.9% in our experience, respectively, compared to 73%, 67%, and 33%.[23] Half of the missed patient cohort identified by the PCHF service required optimization of their medical therapy at their first PCHF review and 1 in 20 patients were also initiated on sacubitril/valsartan. This demonstrates how the model enabled patients to easily be established on the most recent evidence-based therapies, some of which need specialist initiation such as sacubitril/valsartan,[12] and could help establish newly approved therapies such as SGLT2 inhibitors.[13,24]

The barriers to optimal management of HF patients in primary care have been described, including uncertainties around diagnosis, concerns about prescribing appropriate medications in frail and elderly patients, gaps in knowledge and lack of access to specialist care and the influence of individual preference/local organizational factors.[25–27] Another cause of suboptimal treatment within primary care could also be due to the finding that 1 in 5 newly diagnosed HF patients are not reviewed or assessed by a specialist HF team when admitted to secondary care.[28] The PCHF service model has the capacity to overcome all of these barriers by inviting appropriate patients to be seen directly by a consultant cardiologist within the primary care environment.

Cardiologists delivering the PCHF service anecdotally described some other barriers to effective HF treatment they observed. These include individual patient reluctance to present to their GP or to be referred into a HF service and patients having been discharged historically from secondary care or community HF services (so do not readily have access to evolving evidence-based treatment strategies).

Under-coding of HF and LVSD is one barrier to ensuring that patients are on optimized treatment and appropriate specialist follow-up. Previous work performed in 8 GP practices in Belgium has reported that identified cases of HF with reduced ejection fraction increased by 74% after an extended audit.[7] Other UK work has shown that the true prevalence of HF in older people in long-term care may be as high as 24% with most undiagnosed.[6]

Socioeconomic deprivation is an important cause of healthcare related inequalities and is a powerful predictor of HF development and adverse outcomes.[8,29] Measures of socioeconomic deprivation are also associated with all-cause mortality and all-cause hospitalization in patients with HF.[30] We found that the need for a new complex CIED implant in our missed patient cohort was greatest in GP practice catchment areas with higher levels of deprivation, which has also been observed in a previous hospital cohort.[30] We also identified that the need for guideline-directed medical therapy was higher in patients from areas with higher deprivation which has also been described in historical community cohorts.[31,32] The PCHF service model could be targeted at areas with higher levels of social deprivation with the aim of reducing inequalities in HF care.

Other benefits of this type of service model are the legacy of education provided. The model is designed to bring the expert knowledge of HF management to the GP practices and with GP, pharmacist, or nurse involvement in patient consultations, specialist training is provided with the intention of leaving each GP practice with the knowledge to improve HF management at the local healthcare setting. Consultant cardiologists also provided educational sessions to GP practices on the latest management techniques for the treatment of HF including medicines optimization and steps for identifying patients who are suitable for complex CIED therapy.

Limitations

We did not collect complete data on reasons for declining complex CIED therapy and this would be useful for a better understanding of decision-making by patients and to help devise strategies for increasing implant rates further. The publicly available proxy area data we used for deprivation compared GP practices with each other but may not have necessarily reflected the socioeconomic level of individual patients. Another limitation of our work is that <10% of patients audited had either BNP or NT-proBNP tests performed across primary care. Patients with these results were audited as part of the case finder exercise but levels were not retained so is not available for reporting.

Conclusion

A PCHF service model enables the identification of a high-risk missed HF cohort in primary care and facilitates medical optimization and/or complex CIED implantation. Services that enable closer/joined up working between primary and secondary care should be supported and implemented for the benefit of this undertreated group.

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Author's Contributions

NGC and AS developed the initial concept of the PCHF service. This was further developed by CH and ADG who designed the methodology for the service, with additional support from AS. NGC and ADG agreed the outline for the manuscript, whilst MK and ADG wrote the first draft. All the authors made an important contribution to subsequent versions of the manuscript, which significantly helped with its development. NGC and ADG made significant revisions to the manuscript and NC is the guarantor.

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Medtronic Limited provided funding for the Clinical Audit. This funding was paid directly to Inspira Health and used for set-up costs of the service, staff salaries and reimbursement of physicians. None of the industry funding was paid directly to the physicians involved in the service, and support was explicitly not contingent on the use of Medtronic implantable devices in patients reviewed by the service.

Ethical approval

This work was classified as Clinical Audit as it did not involve anything being done to patients beyond their normal clinical management and therefore did not require formal ethical approval.

Conflict of interest: C.H. and A.D.G. are members of Inspira Health and received funding from Medtronic Limited for set-up costs and staff salaries. M.K., P.S.C., M.J.N.K.C., and N.G.C. received reimbursement from Inspira Health for delivering PCHF clinics. A.S. is a member of Medtronic. M.K. has received research grants or honoraria from Medtronic, Biotronik, Novartis, and Astra Zeneca. P.S.C. has received educational grants, research grants or honoraria from Medtronic, Boston Scientific, Biotronik, Novartis Pharmaceuticals, and Astra Zeneca. M.J.N.K.C. has received honoraria and educational grants from Medtronic, Boston Scientific, Novartis, and Biotronik. N.G.C. has received educational grants, research grants or honoraria from Medtronic, Boston Scientific, Biotronik, Abbott, and Pfizer/BMS.

Data availability

Summarized datasets for each GP practice stratified by geographical area will be made available on request at www.inspirahealth.co.uk. No patient identifiable data will be made available and GP practice names will be anonymized.

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