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Improving heart failure care and guideline-directed medical therapy through proactive remote patient monitoring-home telehealth and pharmacy integration

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ABSTRACT

To address ambulatory care sensitive hospitalisations in heart failure (HF), we implemented a quality improvement initiative to reduce admissions and improve guideline-directed medical therapy (GDMT) prescription, through proactive integration of remote patient monitoring-home telehealth (RPM-HT) and pharmacist consultations. Each enrolled patient (n=38) was assigned an RPM-HT registered nurse (RN), cardiology licensed independent provider (provider), and, if referred, a clinical pharmacy specialist (pharmacist). The RN called patients weekly and for changes detected by RPM-HT, while the pharmacist worked to optimise GDMT. The RN and pharmacist communicated clinical status changes to the provider for expedited management. Process measures were the percentage of outbound RN weekly calls missed per enrolled patient; the weekly percentage of provider interventions missed; and the number of initiative-driven diuretic changes. Outcome measures included eligible GDMT medications prescribed, optimisation of those medications, and the pre–post difference in emergency department (ED) visits/hospitalisations. After a 4-week run-in period, RN weekly calls missed per enrolled patient decreased from a mean of 21.4% (weeks 5–15) to 10.2% (weeks 16–23). Weekly missed provider interventions decreased from a mean of 15.1% (weeks 1–15) to 3.4% (weeks 16–23), with special cause variation detected. The initiative resulted in 43 diuretic changes in 21 patients. Among 34 active patients, 65 ED visits (0.16 per person-month) occurred in 12 months pre intervention compared with 8 ED visits (0.04 per person-month) for 6 intervention months (p<0.001). Among 16 patients referred to pharmacist, the per cent of eligible GDMT medications prescribed increased by 17.1% (p<0.001); the number of patients receiving all eligible medications increased from 3 to 11 (p=0.008). Similarly, the per cent optimisation of GDMT doses increased by 25.3% (p<0.001), with the number of patients maximally optimised on GDMT increasing from 1 to 6 (p=0.06). We concluded that a cardiology, RPM-HT RN and pharmacist team improved prescription of GDMT and may have reduced HF admissions.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Optimal adoption of evidence-based approaches for managing heart failure (HF) have not been realised in many clinical settings, limiting their effect on reducing hospitalisations and morbidity.

WHAT THIS STUDY ADDS

⇒ A multicomponent HF programme that integrated remote monitoring-home telehealth, proactive weekly calls from nurses designed to detect early clinical changes and pharmacist consultations resulted in statistically significantly reduced readmissions and emergency department visits for patients enrolled in the programme compared with usual care pre intervention.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This multicomponent intervention reduced hospitalisations and improved guideline-directed medical therapy (GDMT) prescription and optimisation for patients enrolled in the initiative compared with usual care pre intervention. An integrated, interprofessional HF programme offers an effective pathway to increase prescription and optimisation of GDMT and reduce readmissions.

PROBLEM

Heart Failure (HF) is a leading cause of hospitalisations and readmissions among adults, with estimates of US$30.7 billion in 2012 total costs.[1] Hospital admissions for HF and other ambulatory care sensitive conditions have been used in national quality metric tracking.[2] Nationwide, the Veterans' Health Administration (VA) has instituted clinical pharmacy specialists (pharmacists) and remote patient monitoring-home telehealth (RPM-HT) as two modalities for team-based care of patients at high risk of readmissions, including those with HF.[3 4] Pharmacist integration into VA primary care teams has focused on disease and

medication management including medication prescription and titration.[4] RPM-HT provides in-home technology to monitor and wirelessly transmit patient vital sign data and patient transmitted answers to device-generated general health and symptom questions daily. An RPM-HT registered nurse care coordinator (RN) remotely monitors responses and calls patients if responses are outside ranges specified by the referring provider ('a red alert'). Questions asked by the RN in these calls are not standardised nor systematically communicated to the referring clinician and alerts may not always be sensitive to key early changes in patients' clinical status.

This quality improvement (QI) project aimed to implement enhanced team-based care coordination for patients with two or more admissions for HF in the past 365 days at VA Greater Los Angeles Healthcare System (VAGLAHS). We hypothesised that an interprofessional team integrating cardiology licensed independent providers (hereafter, providers), RN care coordinators and a pharmacist would provide improved HF care—including reduced HF admissions and improved HF medication management—compared with usual care. To our knowledge, until now, RPM-HT and pharmacy have not been integrated to provide an HF disease management programme, nor has RPM-HT been used for proactive outreach to high-risk patients prior to a red alert. Each enrolled patient was assigned a dedicated HF provider and RN; pharmacist was available if needed for referrals. Operationally, we aimed to have 20 enrolled patients actively transmitting RPM-HT data at least weekly within 5 months, and for patients with HF with reduced ejection fraction (HFrEF) or mildly reduced ejection fraction, to increase by 50% the number of these patients optimised on guideline-directed medical therapy (GDMT).

BACKGROUND

Reducing readmissions using nurse or pharmacist-based postdischarge interventions has not regularly generated statistically significantly improved results when compared with control groups, although secondary outcomes may improve.[5–7] By contrast, retrospective analyses of RPM-HT have shown declines in emergency department (ED) visits and hospitalisations.[8 9] Additionally, periodic pharmacist telephonic counselling in high-risk non-adherent patients showed a statistically significant reduction in mortality (41% reduced mortality over 2 years, number needed to treat of 16 to prevent one death) and improved medication adherence.[10] RPM-HT pharmacist integration in diabetics failed to demonstrate statistically significant reductions in haemoglobin A1c compared with control but did have higher achievement of A1c guideline goals and more antidiabetic drug changes.[11]

BASELINE MEASUREMENT

Our review of the VAGLAHS electronic medical record (EMR) identified 55 patients meeting our inclusion criteria pre intervention of two or more VA hospital admissions with primary diagnosis of HF in the period from December 2019 to December 2020. Among these, three were already enrolled in RPM-HT. Four had died or moved, six lived in a nursing home, long-term acute care, or assisted living facility, and one had undergone heart transplant; these were excluded from further review. For the remaining 44 patients, we evaluated the cause of repeated admissions. One patient was actively experiencing homelessness and four previously experienced homelessness. Twenty-one patients had no consistent HF provider (eg, no visit in the EMR with a provider in the last 365 days, using the ED for HF care instead of outpatient appointments). Twenty-seven patients' charts demonstrated medication concerns (eg, self-discontinuing HF medications; non-adherence; ED visits for medication refills; discharge summaries recommending resumption of GDMT post discharge without follow-up; discordant diuretic prescriptions from different providers leading to readmission). Fourteen patients' charts noted that a lack of equipment for home blood pressure (BP) or weight monitoring potentially limited optimisation of their home HF regimen. The three categories of no consistent HF provider, medication concerns and lack of home monitoring equipment had considerable overlap in patients: twenty patients had two or more care gaps and nine patients had zero care gaps.

After pharmacist referral, we performed an EMR review to verify appropriateness of the referral process and baseline GDMT prescription. Pre intervention, 18.8% of patients (3 of 16) were found to be prescribed all eligible GDMT medications per evidence-based practice (on average prescribed 65.1% of eligible GDMT) and 6.3% of patients (1 of 16) were maximally optimised on prescribed GDMT (on average 52.5% optimised) (further details in Measurement section).

DESIGN

This QI project was conducted within a large urban VA medical centre and was determined to be non-research by the VAGLAHS Institutional Review Board. Patients were identified by querying the VA online ambulatory care sensitive condition dashboard, which lists all patients who have been admitted to a VA hospital with two or more admissions with a primary diagnosis of HF, with any ejection fraction, in the last 365 days. This dashboard does not identify patients who were admitted to non-VA hospitals, nor those that have been treated in the ED and not hospitalised.

We presented the above care gap analysis to local leadership in pharmacy, cardiology and RPM-HT, in addition to key stakeholders (providers, RNs and pharmacists). Stakeholders discussed logistics of the existing HF programme, including RPM-HT referrals, equipment delivery, coordination of patient remote transmissions and EMR documentation. We used stakeholder input to consider potential initiative workload and designed an integrated initiative to address all three care gaps above.

The consensus design included an assigned, consistent HF provider, an assigned, consistent RN for remote monitoring and care coordination, and a dedicated pharmacist (one half-day per week) for medication management and GDMT optimisation. The pharmacist received proctoring and training from one senior provider regarding workflow, patient medication titration, EMR documentation and evidence-based medication, nutrition and lifestyle counselling. The initiative's conceptual goal was to redesign care to reduce HF admissions and improve GDMT prescribing for patients with two or more hospital admissions with a primary diagnosis of HF in the last 365 days.

We piloted the QI initiative with a subset of patients in order to streamline operational processes before increasing enrolment to all eligible patients. Patients were approached by the team and asked if they were willing to participate. Only patients who agreed to participate were included in the intervention. To refine the intervention during the pilot, we convened a workgroup consisting of two QI leads, the RN manager, three RN champions and the dedicated pharmacist. This workgroup met weekly to discuss operational elements including current workflow for RPM-HT patient responses, methods to standardise RN HF intake and follow-up questions to best assess HF clinical status.

RPM-HT's programme is delivered traditionally as a passive approach, generally calling a patient if vital signs or answers to device-generated general health and symptom questions are outside specified ranges ('red alert'). Red alerts may not always be sensitive to key early changes in patients' clinical status, so the workgroup designed this initiative to instead provide a proactive approach to assessment.

The workgroup designed an EMR template to assess HF symptoms and related questions based on American Heart Association HF symptom tracker questions and related to published patient-reported outcome measures for HF.[12] The template (online supplemental appendix 1) includes questions about HF symptoms, missed medications, appetite and a 24-hour dietary recall. The workgroup added RN-specific recommended interventions (online supplemental appendix 2) corresponding to template components. RNs called patients proactively weekly and asked the standardised HF template questions, in addition to calling using the template when a red alert occurred. The RN then systematically communicated any clinical status changes to the patient's assigned provider. By detecting clinical changes early, the team aimed to prevent ambulatory care sensitive ED visits.

Similarly, the workgroup developed pharmacist-specific interventions focused on medications and GDMT (eg, medication reconciliation, education on medication indication and side effects, addressing adherence barriers, diet education, guidance surrounding salt and fluid restriction, medication organiser prescription, refill education, diet education counselling, lab ordering, review of laboratory data, medication renewal, mailing of expedited medications, evaluation of patient ability to open and read medication bottles, provision of non-safety caps on medication vials, and provision of tablet cutters).

STRATEGY

Table 1 details the initiative's workflow. For patients with mobility limitations who could not stand up to take weight measurements, the team assessed the patient based on HF template answers. Patients could be disenrolled from the initiative on provider recommendation, if the patient was unreachable by the RN for 30 days, or if the patient was unable to transmit data at least weekly. Patients could be referred to the pharmacist for assistance with medication adherence, administration and dosage adjustments. The pharmacist conducted telephone visits with the patient, completed pharmacist-specific interventions and documented in the EMR with provider oversight.

The pilot began in January 2021; three eligible HF patients were newly referred to RPM-HT by providers. Initial feedback from RN champions was that intake calls and documentation were time-consuming (about 60–90 min). Thereafter, due to improved template familiarity and iterative template improvements, RN champions reported workload improvements (about 30–60 min total for intakes and 20–60 min total for weekly and red alert calls, which is about 5–15 min longer than that of non-HF patients). To accommodate the initiative's workload, the RN manager capped each RN at seven HF initiative patients and allowed continued management of non-HF patients.

Starting in February 2021, the QI leads met with all 14 RPM-HT RNs (champions and non-champions) at VAGLAHS on a two times monthly basis to facilitate project uptake. The first meeting introduced the QI initiative and provided education about HF pathophysiology, symptoms and medication management using patient cases. The second meeting reintroduced the initiative, reviewed HF medication mechanisms of action and featured a 10 min verbal reflection from one RN champion on their pilot initiative experience. To expand the pilot, the RN manager asked for non-champion RN volunteers to participate in this initiative and be assigned patients. All 14 RNs participated in education and learning about the initiative. At each meeting, QI leads reviewed actively enrolled patients, answered questions, provided feedback and readjusted the HF template questions and workflow. Thereafter, eight RNs opted out of the initiative due to workload, leaving six RNs actively enrolling and managing patients. The QI leads also met with four providers every other month to inquire about eligible patients and address any challenges that arose.

Once the RPM-HT HF initiative started enrolling additional patients, the pharmacist component began (March 2021). One provider met with the pharmacist weekly to review the list of initiative patients referred to the pharmacist and discuss pharmacist patient consultations including pertinent RPM-HT notes, vital sign data, laboratory data and current GDMT. They collaborated

Table 1 Quality improvement initiative workflow steps and description

Workflow step	Description
Patient identification	Patients with two or more VA hospital admissions with a primary diagnosis of HF in the last 365 days are eligible for this initiative
Cardiology provider assignment	Eligible patients are assigned to dedicated cardiology provider
Enrolment	Cardiology provider asks patient about their interest in enrolment in initiative
RPM-HT RN assignment	If the patient agrees, an RPM-HT referral is placed and an RPM-HT RN is assigned
Baseline phone call	RPM-HT RN calls the patient, asks HF template questions for baseline and orders the wireless monitoring equipment
Data transmissions	The patient sets up their equipment and starts wirelessly transmitting their vital sign data and answers the device-generated selection of general health and symptom questions daily
Proactive weekly calls	RPM-HT RN calls patient weekly, asks HF template questions and documents in EMR. Calls continue regardless of whether patient is continuously transmitting wireless data (eg, patient goes on vacation, is out of town, or has not received or been able to set up equipment yet)
Calls for red alert	RPM-HT RN calls patient when responses are outside ranges specified by the referring provider (a 'red alert'), asks HF template questions and documents in EMR
Clinical changes communicated to provider	In weekly calls and red alerts, RN reviews and analyses the data and if there is a change in clinical status, formulates a clinical assessment and communicates that assessment to the cardiology via a secure instant message or phone call in addition to an EMR note that includes the answers to the HF template questions
Provider intervention	The cardiology provider reviews the information and triages whether an intervention is needed (eg, medication change to aid symptom resolution, call to send the patient to the ED or clinic, or decision that an intervention is not needed)
Clinical status resolution	The cardiology provider notifies the patient and/or RPM-HT RN and documents their findings in the EMR, follow-up is continued until resolution of the clinical status change
Referral to HF pharmacist	Provider may refer enrolled patients to HF pharmacist for medication reconciliation, management and GDMT optimisation
Pharmacist monitoring	The pharmacist monitors and assesses patient vital sign and weight data to help predict the patient's volume status and determine the need for medication counselling and the candidacy for GDMT titration
Pharmacist phone calls	The calls the patient twice monthly and as needed for follow-up using a pharmacy-specific HF template that includes pharmacy-specific outcomes and interventions to document telephone calls with patients
Collaborative decision-making with cardiology provider	The pharmacist and a designated cardiology provider meet weekly to collaborate and discuss patient care and GDMT optimisation and changes for enrolled patients. All medication changes are collaboratively made with a cardiology provider. The HF pharmacist also has the ability to meet the patient and join discussions during the patient's visits with their cardiology provider.

ED, emergency department; EMR, electronic medical record; GDMT, guideline-directed medical therapy; HF, heart failure; Pharmacist, clinical pharmacy specialist; Provider, licensed independent provider; RN, registered nurse; RPM-HT, remote patient monitoring—home telehealth; VA, veterans health administration.

to prescribe and titrate GDMT; pharmacist notes were cosigned by the provider due to the pharmacist's clinical level.

MEASUREMENT

We assessed three process measures using chart review. The first was the weekly percentage of outbound proactive RN calls per enrolled HF patient that were missed over time. If outbound calls failed to occur, we hypothesised we were not proactively identifying potential clinical status changes. The second process measure was the weekly percentage of clinically necessary provider interventions that were missed over time. EMR documentation served as the basis for determining whether intervention completion occurred. Reducing missed interventions was important because chart review revealed two pilot patient cases where timely provider interventions likely would have prevented an HF admission. KAL, QI lead/primary care internist who did not directly interact with initiative patients, identified missed provider interventions as those where a call to a patient was clinically warranted to address a change in vital sign or device/template question but either no intervention occurred, or no documentation of any intervention was made.

Recorded missed provider interventions were corroborated by QI lead/provider (SSdP). To inform our root cause analysis, we followed up with individual providers to ask about reasons for missed interventions. The third process measure was the number of diuretic changes for enrolled HF patients attributed to RN and pharmacist calls.

Plan–Do–Study–Act (PDSA) cycles were used to evaluate weekly RN outbound call completion as well as completion of clinically necessary provider interventions. The first and second RN PDSA cycles aimed to decrease missed outbound RN calls. After RN training was complete, RN PDSA 1 (week 4) made weekly outbound calls mandatory. During intervention week 15, RNs instituted RN PDSA 2, a reminder in their electronic RPM-HT system to call patients proactively weekly. Additionally, if the assigned RN was not working, the system would flag a covering RN to call the patient and use the HF template. Separately, one provider PDSA cycle (week 15) focused on missed provider interventions. QI leads reviewed the missed interventions and data up to week 15 with the providers that were part of the initiative to conduct a root cause analysis and verbally reminded providers to document their findings in the EMR.

There were six outcome measures. The first was a self-assessment by providers of the number of potential ED visits that might have been prevented because of provider, pharmacist or RN intervention. Several times over the course of the project, providers were asked the following question about patients currently under their management, 'without your intervention was there more than a 50% chance that the patient would have ended up in the ED or been admitted to the hospital?' The second outcome measure, evaluated via chart review, was the difference in ED visits or hospitalisations per person-month pre intervention versus post intervention for HF initiative patients currently using RPM-HT, using negative binomial regression in STATA. For patients referred to the pharmacist with HFrEF or mildly reduced ejection fraction, we calculated four outcome measures all via chart review using a pre–post comparison: the overall average percentage of eligible GDMT medications prescribed; the percentage of patients prescribed all eligible GDMT medications; the overall average percentage of GDMT optimisation; and the percentage of patients maximally optimised on GDMT. Percentage of patients prescribed all eligible GDMT was calculated as the number of GDMT medications each patient was prescribed divided by the total number of GDMT medications each patient was eligible for. For example, a patient with HFrEF prescribed carvedilol, sacubitril/valsartan and spironolactone but not empagliflozin is prescribed three out of four GDMT medications or 75% of their eligible GDMT. Percentage of patients maximally optimised on GDMT was calculated by assigning medications a percentage optimisation for each dose (online supplemental appendix 3). Under the ACE inhibitor/angiotensin II receptor blocker (ARB)/angiotensin receptor–neprilysin inhibitor (ARNI) category, patients on ACE/ARB were considered optimised only if the patient had failed ARNI or had a documented contraindication. For example, a patient with HFrEF prescribed carvedilol 3.125 mg two times per day, sacubitril/valsartan 97/103 mg two times per day and spironolactone 25 mg daily, but not empagliflozin has a 56.3% GDMT optimisation (25%+100%+100%+0% divided by four eligible medications).

We used descriptive statistics to evaluate our measures. Using a p-type control chart in Microsoft Excel, we plotted the weekly percentage of outbound RN calls (using the new HF template) missed per enrolled patient. Weeks 1–4 were a run-in period, so we calculated a mean for weeks 5–15 (RN PDSA 1) and split this from the mean for weeks 16–23 (RN PDSA 2).[13–15] A separate p-type control chart plotted the percentage of clinically necessary provider interventions missed over time with data split into two periods; a mean calculated for weeks 1–15 (baseline) and a mean for weeks 16–23 (provider PDSA 1). Special cause variation was assessed.[16] We split the mean in both charts to examine changes from PDSA cycles. Upper and lower control limits were based on three SD above or below the mean incorporating the sample size for each period.[13 14] For our four pharmacy measures, McNemar's exact significance test was used for dichotomous variables and a paired t-test was used for continuous variables.

RESULTS

From February to July 2021 of 58 patients with two or more HF admissions, 41 RPM-HT referrals were placed successfully, and patients were assigned a dedicated provider; the remaining 17 patients declined participation in this initiative. Three patients received their devices but were unable to set them up due to life stressors, leaving 38 patients who transmitted their vital signs and device questions successfully for at least 1 week. As of July 2021, 30 patients were actively transmitting weekly. RNs used the new HF template to document symptoms in more than 385 different notes. The initiative resulted in 43 provider-initiated diuretic changes in 21 patients and 9 pharmacist-initiated diuretic changes in 6 patients. The initiative resulted in 43 provider-initiated diuretic changes in 21 patients and 9 pharmacist-initiated diuretic changes in 6 patients. Of the pharmacist-initiated diuretic changes, five increased dosage, one decreased dosage, one restarted a patient-discontinued medication, one changed medication type and one held a medication. The pharmacist made 13 total non-diuretic medication changes, of which 5 increased dosages, 2 corrected dosages, 3 restarted a patient-discontinued medication, 1 changed medication type, 1 added a medication (empagliflozin) and 1 held a medication. Providers made 23 total non-diuretic medication changes. There were 23 total non-diuretic medication changes by providers. In four cases (four patients), providers referred patients to the ED.

As seen in figure 1A,B, there was a decrease in missed outbound RN calls per enrolled patient over time, with

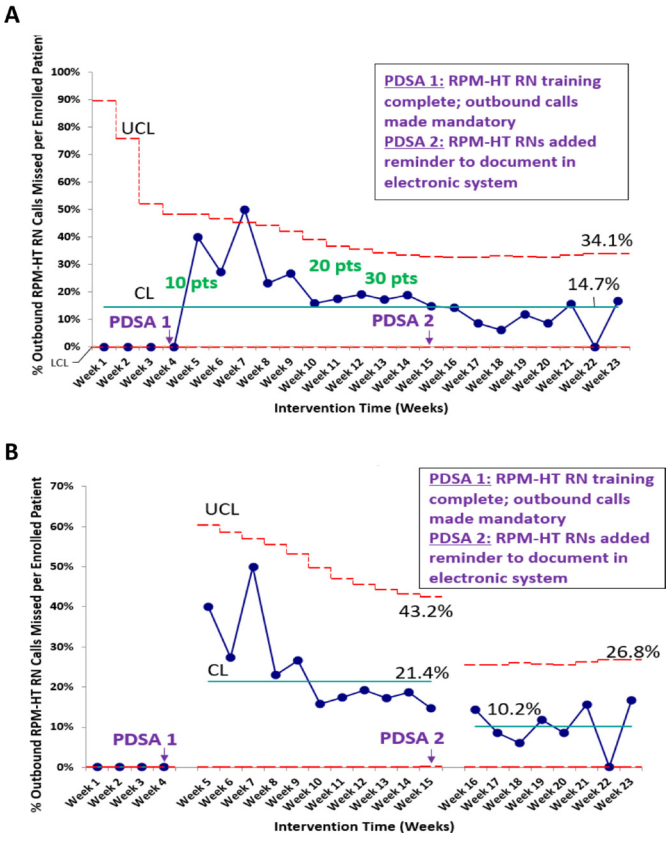

Figure 1 (A) Weekly percentage of outbond RPM-HT RN calls with HF template missed per enrolled patient over time—P chart. Averaged across all intervention weeks, the mean weekly percentage of outbound RPM-HT RN calls with HF template that were missed per enrolled patient was 14.7%. (B) Weekly percentage of outbond RPM-HT RN calls with HF template missed per enrolled patient over time—P chart split mean. We split the mean to examine changes from PDSA Cycles implemented to decrease RPM-HT RN calls missed. Weeks 1 through 4 were a run-in period, so we calculated a mean for weeks 5 through 15 (RN PDSA 1) and split this from the mean for weeks 16-23 (RN PDSA 2). Total enrolment of patients in the initiative increased over time. PDSA Cycles to decrease RPM-HT RN calls missed are annotated in the figure (RN PDSA 1 at week 4; RN PDSA 2 at week 15). Upper and lower control limits were based on three standard deviations above or below the mean incorporating the sample size for each time period. CL, control limit; HF, heart failure; PDSA, Plan–Do–Study–Act Cycle; pts, patients; RN, registered nurse; RPM-HT, remote patient monitoring-home telehealth; UCL, upper control limit.

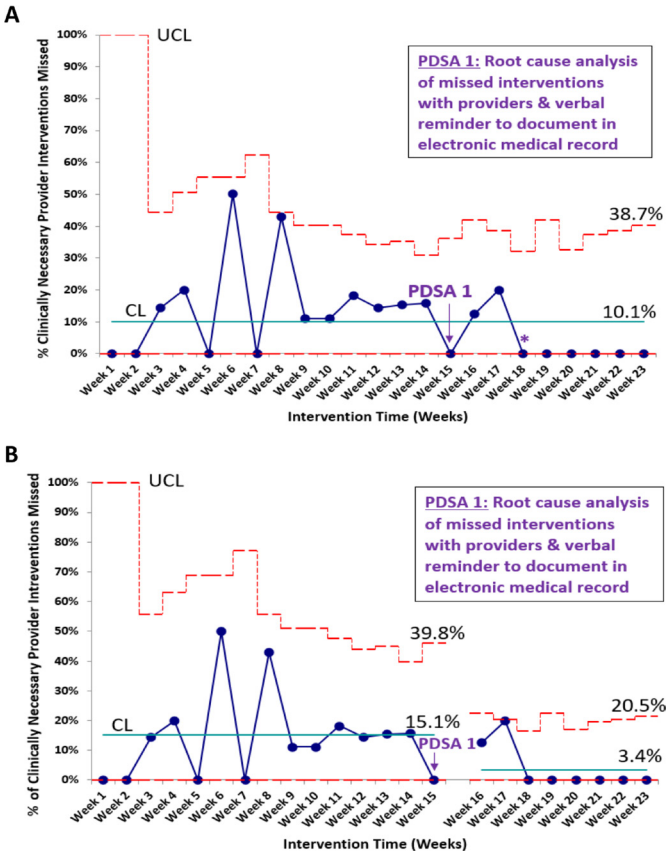

Figure 2 (A) Weekly percentage of clinically necessary provider interventions missed over time—P chart. Across all intervention weeks, mean weekly percentage of clinically necessary provider interventions missed was 10.1%. Special cause variation was detected (noted with *) starting at week 18 with six data points all more than 1 sigma below the mean, at the lower control limit. (B) Weekly percentage of clinically necessary provider interventions missed over time—P chart split mean. We split the mean to examine changes from provider PDSA cycle 1 to decrease clinically necessary provider interventions missed. Data was split into two periods, a mean calculated for weeks 1 through 15 (baseline) and a mean for weeks 16 through 23 (Provider PDSA 1). Clinically necessary cardiology provider interventions missed were defined as where, by project lead chart review, a call to a patient was clinically warranted to address a change in vital sign of device/template question but either no intervention occurred, or no documentation of any intervention was made in the electronic medical record. Missed provider interventions were corroborated by one provider who was also a quality improvement lead. Provider PDSA cycle 1 to decrease clinically necessary provider interventions missed is shown in figure. Upper and lower control limits were based on three standard deviations above or below the mean incorporating the sample size for each time period. CL, control limit; PDSA, Plan–Do–Study–Act Cycle; UCL, upper control limit.

a decrease in the mean from 21.4% (RN PDSA 1: weeks 5–15) to 10.2% (RN PDSA 2: weeks 16–23). Special cause variation was not found.

As seen in figure 2A,B, there was a decrease in missed provider interventions per total clinically necessary provider interventions, with a decrease in the mean from 15.1% before provider PDSA 1 (week 1–15) to 3.4% after (week 16–23). From week 18 to 23 there were no missed interventions recorded, with special cause variation detected with six points more than one sigma below the mean.

Patients maximally optimised on GDMT

Over 5 months of intervention, providers' self-assessment was that 26 ED visits might have been prevented because of their interventions. Examples included diuretic titration

after non-VAGLAHS hospital admissions, diuretic titration after dietary indiscretion, provider counselling to resume diuretics after patient self-discontinuation, discontinuation of BP medication in the setting of side effects from empagliflozin and other medications, and a provider finding that an assisted living facility administered the wrong dose of diuretic daily after hospital discharge. In all these cases, providers and RNs collaborated to follow-up with patients to ensure resolution of clinical status changes.

To evaluate whether there was a statistically significant difference in ED visits pre intervention vs post intervention, for the 34 HF initiative patients actively using RPM-HT, 65 ED visits (0.16 ED visits per person-month) occurred in the 12 months pre intervention, compared with 8 ED visits (0.04 ED visits per person-month) for the 6 months of intervention. Pre intervention, 61 ED visits (93.8%) resulted in admission; post intervention, all 8 ED visits (100%) resulted in admission. There was a 75% decrease in ED visits or hospitalisations post intervention compared with pre intervention (p<0.001).

Sixteen patients with HFrEF or mildly reduced ejection fraction were referred to the pharmacist. Pre intervention, 18.8% of patients (3 of 16) were prescribed all eligible GDMT medications. At 20 weeks of intervention, this had increased to 68.8% (11 of 16) (p=0.005 for pre–post comparison, using McNemar's test). Pre intervention, patients were prescribed an average of 65.1% of eligible GDMT medications. At 20 weeks of intervention, this increased to 85.9% (p<0.001 for pre–post comparison, using paired t-test). Pre intervention, 6.3% of patients (1 of 16) were maximally optimised on prescribed GDMT. At 20 weeks of intervention, this had increased to 37.5% (6 of 16) (p=0.03 for pre–post comparison, using McNemar's test). Pre intervention, patients were on average 52.5% optimised on GDMT. At 20 weeks of intervention, this had increased to 77.8% (p<0.001 for pre–post comparison, using paired t-test).

Lessons and limitations

Integrating RPM-HT and pharmacist consultations into an HF-specific disease management programme is a unique feature of this initiative, in addition to the proactive weekly calls designed to detect early clinical status changes; both of these innovations contributed to our success. We achieved our aims by enrolling over 30 patients who actively transmitted RPM-HT data weekly within 5 months, and by increasing more than 50% the number of HFrEF patients maximally optimised on GDMT. Statistically significantly reduced HF admissions and ED visits for patients enrolled in the initiative compared with usual care pre-intervention demonstrates the potential financial savings for this project. Optimal adoption of GDMT has not been realised in many clinical settings limiting its potential benefits on morbidity and mortality; this study offers a pathway to increase prescription and optimisation of GDMT.[17]

Involving all RNs in training was essential to keep missed weekly outbound calls low, so that covering RNs understood the workflow and could call patients proactively using the template weekly (when flagged by the electronic system after RN PDSA 2). Stressing the importance of missed interventions to providers and going through root cause analyses of missed interventions together helped emphasise that intervening on RPM-HT clinical status changes (eg, sending a patient to the ED, making a medication change, or reassuring the patient/RN that the clinical status change did not warrant an intervention) could help improve patient care. As a result, this relatively low-reliability reminder actually decreased missed provider interventions.

Early stakeholder engagement allowed us to develop an HF-specific template that targeted provider needs and to redesign RN workflow to facilitate weekly phone calls accompanied by rapid, proactive, systematic communication of any clinical status changes to the patient's provider. RNs asked if they could use the HF template for all their patients with HF, not just those enrolled in the initiative, reflecting template utility. RN and pharmacist-specific interventions helped team members share responsibility for medication titration and HF counselling. An RN said, 'This [initiative] has really helped us excel as nurses and be more confident in ourselves. I think we are actually helping them [patients], and they are getting to trust us and be more honest with us'. The proactive weekly phone calls may have increased the quality of the patient–RN relationship, allowing the RN to more effectively collaborate with the provider to intervene when a clinical status change occurred. Providers reported improved workload as a result of the initiative, 'This is helping me a lot. I am now spacing out my patient appointments from once a week to once every twoweeks and I'm more comfortable doing phone appointments because I have the blood pressure, heart rate and the template and I can trust the information is reliable'. The initiative's focus on engaging RN champions and pharmacist proctoring resulted in a number of staff promotions. The team consistently reported enthusiasm about the initiative and feeling aligned in the mission to improve HF care for patients. Patients overall reported positive experiences with the initiative. One provider reported improved collaboration with her patient's adult children around changes in symptoms, 'My patient's son is really happy because [RPM-HT] is bridging the gap. Overall things are going really well'. One patient requested more frequent phone calls from the pharmacist as he felt the follow-up kept him on track with his medications.

Limitations include the non-randomised nature of this pilot study and the lack of a concurrent control group; a true decrease in HF readmissions cannot be attributed solely to this initiative and may be a result of regression to the mean. The RNs and pharmacist focused on both medication and lifestyle factors of HF management; however, a dietitian was not involved, which could improve dietary education. Future counselling protocols could include physical activity. This initiative brings up ethical considerations of resource allocation due to its focus on devoting higher care intensity to a small number of patients.

The initiative has been sustained beyond the collection of data for this manuscript due to leadership support for re-engineering teams to work at the top of their license and work together to decrease ambulatory care sensitive ED

visits and improve care. This initiative has been expanded to accept HF patients being discharged from the ED and from the hospital. Prior research has indicated possible reductions in readmissions as a result of postdischarge telemonitoring.[18] Our ED and inpatient teams have indicated an ability to discharge patients sooner due to the close outpatient follow-up and reliable team structure provided by this programme. An HF hub was created for this programme expansion where RNs are only assigned HF patients and have fewer patients assigned to them because of the increased workload. The RN workload is an important consideration and should be seen as a balancing measure to ensure sustainment of this programme. Replication of these results will likely most easily be facilitated in an integrated delivery system that can incorporate some version of RPM-HT and pharmacist consultations.

CONCLUSIONS

We hypothesised that an interprofessional cardiology, RPM-HT RN and pharmacist team would provide improved HF care—this hypothesis was verified through statistically significantly reduced HF admissions and improved GDMT prescription and optimisation for patients enrolled in the initiative compared with usual care pre intervention.

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REFERENCES

1 Heidenreich PA, Albert NM, Allen LA, *et al*. Forecasting the impact of heart failure in the United States: a policy statement from the American heart association. *Circ Heart Fail* 2013;6:606–19.
2 Centers for Medicare & Medicaid Services. Ambulatory care sensitive condition (ACSC) and care coordination outcome measures included in the 2013 quality and resource use reports. Available: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/PhysicianFeedbackProgram/Downloads/QRUR-ACSC-Outcome-Measures.pdf [Accessed 16 Feb 2022].
3 Buck C, Kobb R, Sandreth R, *et al*. Maximizing VA remote patient monitoring during the COVID-19 response. *Telehealth and Medicine Today* 2021;6.
4 Zogas A, Gillespie C, Kleinberg F, *et al*. Clinical pharmacist integration into veterans' primary care: team members perspectives. *J Am Board Fam Med* 2021;34:320–7.
5 Finkelstein A, Zhou A, Taubman S, *et al*. Health Care Hotspotting - A Randomized, Controlled Trial. *N Engl J Med* 2020;382:152–62.
6 Ong MK, Romano PS, Edgington S, *et al*. Effectiveness of remote patient monitoring after discharge of hospitalized patients with heart failure: the better effectiveness after transition -- heart failure (BEAT-HF) randomized clinical trial. *JAMA Intern Med* 2016;176:310–8.
7 Topinková E, Baeyens JP, Michel J-P, *et al*. Evidence-Based strategies for the optimization of pharmacotherapy in older people. *Drugs Aging* 2012;29:477–94.
8 Darkins A, Kendall S, Edmonson E, *et al*. Reduced cost and mortality using home telehealth to promote self-management of complex chronic conditions: a retrospective matched cohort study of 4,999 veteran patients. *Telemed J E Health* 2015;21:70–6.
9 Alrajab S, Smith TR, Owens M, *et al*. A home telemonitoring program reduced exacerbation and healthcare utilization rates in COPD patients with frequent exacerbations. *Telemed J E Health* 2012;18:772–6.
10 Wu JYF, Leung WYS, Chang S, *et al*. Effectiveness of telephone counselling by a pharmacist in reducing mortality in patients receiving polypharmacy: randomised controlled trial. *BMJ* 2006;333:522.
11 McFarland M, Davis K, Wallace J, *et al*. Use of home telehealth monitoring with active medication therapy management by clinical pharmacists in veterans with poorly controlled type 2 diabetes mellitus. *Pharmacotherapy* 2012;32:420–6.
12 American Heart Association. Rise above heart failure Self-Check plan for heart failure management, 2019. Available: https://www.heart.org/-/media/Files/Health-Topics/Heart-Failure/HF-Symptom-Tracker.pdf
13 Shewhart WA. *Economic control of quality of manufactured product*. Mansfield Centre, CT: Martino Publishing, 2015.
14 Benneyan JC. The design, selection, and performance of statistical control charts for healthcare process improvement. *IJSSCA* 2008;4:209–39.
15 Perla RJ, Provost LP, Murray SK. The run chart: a simple analytical tool for learning from variation in healthcare processes. *BMJ Qual Saf* 2011;20:46–51.
16 Montgomery D. *Introduction to statistical quality control*. 4th ed. New York: John Wiley, 2001.
17 Bhatt AS, Solomon SD, Vaduganathan M. Prioritizing dissemination and implementation science in cardiometabolic medicine: connecting the dots. *JAMA* 2021;326:311–3.
18 Dawson NL, Hull BP, Vijapura P, *et al*. Home Telemonitoring to reduce readmission of high-risk patients: a modified intention-to-treat randomized clinical trial. *J Gen Intern Med* 2021;36:3395–401.