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To cite this article: Bruce A. Feldman, Orlando E. Rivera, Christopher J. Greb, Jeanne L. Jacoby, Jennifer Nesfeder, Paul Secheresiu, Mahek Shah & Deborah W. Sundlof (2021): “House Calls” by Mobile Integrated Health Paramedics for Patients with Heart Failure: A Feasibility Study, Prehospital Emergency Care, DOI: [10.1080/10903127.2021.1977439](https://doi.org/10.1080/10903127.2021.1977439)

To link to this article: <https://doi.org/10.1080/10903127.2021.1977439>



Accepted author version posted online: 10 Sep 2021.



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“House Calls” by Mobile Integrated Health Paramedics for Patients with Heart Failure: A Feasibility Study

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Abstract

Background: Early readmissions following hospital discharge for heart failure (HF) remain a major concern. Among the various strategies designed to reduce readmissions, home evaluations have been observed to have a favorable impact. We assessed the feasibility of integrating community paramedics into the outpatient management of HF patients.

Methods: Selected paramedics completed an educational HF curriculum. These Mobile Integrated Health Paramedics (MIHP) performed scheduled home visits 2- and 15-days post-discharge for patients with Stage C HF (Phase I) and patients with Stage D HF (Phase II). Facilitated by a Call Center, a process was created for performing urgent MIHP house calls within 60 minutes of a medical provider’s request. A HF specialist, with an on-call emergency department command physician, could order an intravenous diuretic during home visits. During each phase of the study the incidence of 30-day HF readmissions, 30-day all-cause readmissions, emergency room evaluations, unplanned office encounters, as well as any adverse events were prospectively documented.

Results: Collaborative relationships between our hospital network and local EMS organizations were created. There were 82 MIHP home visits. Eight patients received urgent home evaluations within 60 minutes post-request, 1 requiring transport to an ED. The incidence of all-cause 30-day readmissions in 20 Stage C and 20 Stage D patients was 15% and 40%, respectively. There were no adverse events attributable to the MIHP house calls.

Conclusions: It is feasible to integrate MIHPs into the outpatient management of HF. Signals of effectiveness for reducing early readmissions were observed. Obstacles to creating an effective paramedic “House Calls” program were identified. A randomized trial is required to assess the value of this care process and its impact on early readmissions in patients with Stage C and Stage D HF.

Key Words: House calls, Paramedics, Heart Failure, Readmissions

Introduction

The long-term prognosis of patients hospitalized with heart failure (HF) is poor with a combined readmission and mortality rate of 97% during 5-year follow up(1). A high percentage of patients with HF are readmitted early after an initial hospitalization(2), many occurring within the first 15 days of discharge(3). Multiple factors contribute to early readmissions with only one-third attributable to decompensated HF(4). Various methods to reduce 30-day all-cause and HF-specific readmissions have been evaluated. Patients undergoing an evaluation within 7 days, as opposed to 8 to 30 days after discharge were observed to have reduced 30-day readmissions(5).

A retrospective review of 47 randomized trials compared the effectiveness of other methods to reduce hospital readmissions(6). Only one of these trials, using a high intensity home visiting program with advanced nurse practitioners, reported a reduction in all-cause 30-day readmissions(7). A small randomized pilot study employing in-home care provided by a traveling physician and a nurse observed a trend toward reduced emergency department (ED) visits as well as readmissions(8). These studies suggest in-home patient encounters, performed early post-discharge with the option for home-based medical interventions, may be an effective method for reducing short-term readmissions.

In contrast, patient education followed by intermittent phone call assessments and nurse home visits performed 1 to 2 weeks post-discharge, although reported to reduce readmissions during extended follow up, did not have a favorable impact on 30-day readmissions(9,10), Telehealth, using technologies to transmit information from the patient's home to a HF team, favorably impacted quality of life variables, but was not consistently associated with reduced early readmissions (11). Six large multicenter, randomized trials of home telemonitoring in >5,200 patients did not reduce short-term readmission rates (12–17). As a consequence of these observations, routine use of remote monitoring is not recommended by the Heart Failure Society of America(18). Although HF management guided by telemonitoring of implanted hemodynamic devices significantly reduced 30-day, as well as long-term readmissions (19,20). cost has restricted utilization of these devices (21). New, safe and cost-effective alternatives to reduce short term readmissions are needed (22).

Emergency medical service (EMS) organizations have formed partnerships with hospitals to provide home care with community paramedics and reported reduced readmissions and cost of care(23–26). These observational studies suggest community paramedics, working within a Mobile Integrated Health Paramedic (MIHP) program, have the capability of providing a timely response to patient concerns and, guided by physicians, the ability to provide acute medical interventions in the home environment. Although a randomized trial has been planned(27), to date there are no published randomized trials designed to assess the impact of a MIHP program on 30-day readmissions or cost of care. In anticipation of performing a randomized trial, we investigated the feasibility of integrating community paramedics into the outpatient management of patients with HF with scheduled and, if needed, urgent "house calls".

Methods

The study was conducted in the Lehigh and Northampton counties of Pennsylvania between August 2017 and December 2019. Only Pennsylvania-certified paramedics employed by one of the participating EMS agencies were eligible to participate. Professional service contracts between our hospitals and private EMS organizations were created. Participating paramedics were required to complete the Collaborative Institutional Training Initiative (CITI) for human subject research and an educational HF curriculum. All paramedics participating in this feasibility trial were required to attend educational sessions (Table 1). In addition, paramedics were required to complete the Collaborative IRB Training Initiative (CITI), an educational program for the protection of human

subjects in research. They were also required to spend time in a dedicated heart failure clinic, seeing patients with a nurse practitioner. Finally, before patient enrollment, paramedics were required to participate in a mock drill, performed in a classroom and a second mock drill in a private residence. These drills were designed to test their knowledge of the signs and symptoms of heart failure as well as to confirm their knowledge of appropriate documentation. The drills also tested the process of communication between a medical provider, the Call Center and the paramedics.

Upon successful completion of the above requirements the paramedic was referred to as a MIHP. Paramedics were required to function within their scope of care defined by the Pennsylvania General Assembly's Title 35, Chapter 81 on the EMS System. In Pennsylvania, paramedics can only accept orders for interventions outside their state protocols from emergency department (ED) command physicians. A MIHP Call Center was created to assist with communications between paramedics, HF specialists and, if needed, an ED command physician. HF specialists included cardiologists and dedicated HF nurse practitioners.

Hospitalized patients were identified utilizing standardized definitions of HF(28–30). These definitions were particularly valuable for identification of patients with HF and preserved ejection fraction (EF), distinguishing them from those with dyspnea due to obesity or lung disease and from patients with edema due to venous insufficiency. Written consent was required for enrollment. The inclusion and exclusion criteria are available in the supplement. The patient's participation in the trial began on the day of discharge and was terminated 30 days after discharge. Enrolled patients received usual care including outpatient clinic evaluations performed 5-7 days after discharge. Patients could receive home health care by a visiting nurse at the discretion of their HF specialist. In addition, each patient received a scheduled MIHP house call 2 and 15 days after hospital discharge. Physicians or nurse practitioners could request an urgent MIHP home evaluation any time during the first 30 days after patient enrollment. Urgent MIHP house calls, facilitated by the MIHP Call Center, were performed within 60 minutes. A HF specialist, in conjunction with the on-call command physician, could order the MIHP to administer an intravenous diuretic or topical nitroglycerin during the home encounter. After administration of any medication, the MIHP provided monitoring for 60 minutes to detect acute beneficial and/or adverse effects. The patient, command physician or the HF specialist could request transport to a local hospital for an emergency evaluation at any time by calling 911. The study investigators encouraged transport to a local ED in response to persistent HR <40 or >130 bpm, RR >25/min, SpO₂ <90% or clinical signs of respiratory failure(31). A HF specialist could request MIHP follow up house calls and additional medical interventions at the patient's home on consecutive days. During each home visit the MIHP documented all information using a standardized electronic template. The documentation of each home encounter was entered into the patient's electronic medical record (EMR).

The assessment of feasibility was performed in 2 phases. During Phase I, patients with Stage C HF were enrolled. During Phase II, patients with Stage D HF were enrolled. During each phase the incidence of 30-day HF readmissions, 30-day all-cause readmissions, emergency room evaluations, unplanned office encounters and any adverse events were prospectively documented. Readmission due to HF was defined as in-hospital care for >24 hours with intravenous diuretics, vasoactive or inotropic agents or the implementation of mechanical cardiac support. Patients on "observation" status meeting these criteria were categorized as a readmission. Written and phone call surveys were performed to assess patient, physician and nurse practitioner perceptions of the MIHP process of care. Any outcome perceived by patients, physicians, nurse practitioners or the MIHPs to be injurious or potentially detrimental to patient well-being was considered an adverse event. Descriptive statistics were used to describe patient attributes and outcomes at 30 days. The study was approved by the Lehigh Valley Health Network Institutional Review Board (Study PRO00004858).

Selection and Description of Participants

Patients 18 years of age or older, admitted the hospital with acute or acute on chronic heart failure (HF), Stage C (phase I) and Stage D (phase II), with New York Heart Association (NYHA) functional class (FC) II-IV who resided within the geographic boundaries of the participating emergency medical services were eligible to participate. Criteria for the diagnosis of HF and Stage of HF were based upon guidelines and consensus statements from the American College of Cardiology Foundation, American Heart Association, American Society of Echo and the European Society of Cardiology(28,29). Criteria for HF with reduced left ventricular (LV) ejection fraction (HFrEF), included signs and symptoms of HF plus an LV EF $\leq 40\%$. Criteria for HF with intermediate or preserved LV ejection fraction (HFpEF), included signs and symptoms of HF, LV EF $>40\%$ plus one of the following: echo Doppler evidence of elevated (LV) filling pressure invasively measured pulmonary capillary wedge pressure >12 mmHg or LV end diastolic pressure >16 mmHg or a biomarker of HF with BNP level ≥ 400 pg/ml or NT-proBNP levels ≥ 450 pg/ml, >900 pg/ml and >1800 pg/ml based on age categories <50 , 50-75 and >75 , respectively (30). Stage C was defined as HF requiring hospitalization and the use of guideline directed medical therapy. Stage D was defined as advanced or refractory HF with persistent signs and symptoms despite guideline directed medical therapy (GDMT). These patients were required to have 2 or more of the following attributes: severe impairment in functional capacity (NYHA FC III-IV); greater than 2 hospitalizations or ED evaluations for HF in past year; progressive rise in BUN/creatinine; intolerance to GDMT due to hypotension or worsening renal function; Persistent systolic BP < 90 mmHg; recent need for escalating doses of loop diuretics equivalent to furosemide >80 mg/day and/or addition of metolazone; progressive decline in serum Na <133 meq/L; frequent ICD shocks; Doppler evidence of elevated LV filling pressure or PCWP > 16 mmHg; weight loss without other cause. Stage D patients could require specialized treatment strategies such as intermittent or continuous inotropic infusions, mechanical circulatory support, or hospice care.

Exclusion criteria included severe valvular disease, pericardial constriction, severe precapillary pulmonary hypertension defined as pulmonary artery systolic pressure >60 mm Hg, mean trans-pulmonary gradient >15 mm Hg or pulmonary vascular resistance >6 Wood units; chronic kidney disease on dialysis, scheduled for re-hospitalization for a procedure within 30 days, receiving skilled nursing care prior to admission, severe cognitive impairment or a very low probability of survival during the next 6-12 months. Patient was unable or unwilling to participate in the study protocol for any reason were also excluded.

Results

Phase I Stage C HF

Collaborative relationships and written agreements between our hospital network and 5 local EMS organizations were created. Nine paramedics completed CITI training and the educational curriculum. Twenty-five eligible patients were identified of which 20 agreed to participate (Table 2). Seven ED command physicians volunteered to be on-call 24/7 for Phase I of the trial. The outcomes at 30 days are summarized in Table 3. A total of 49 MIHP house calls were performed. Urgent in-home visits, requested by a HF specialist, were performed in 6 (30%) participants, one of whom was triaged to a local ED. Command physicians assisted with the order for home intravenous (IV) diuretics for 2 patients, one receiving IV diuretics on two consecutive days. Patient initiated ED evaluations were performed in 4 patients, of which 2 were admitted. Four patients underwent unplanned clinic visits. Four participants, including the 2 patients discharged after an ED evaluation, received follow up MIHP in-home visits. The incidence of 30-day all-cause readmissions was 15%. The incidence of HF readmissions was 5%. There were no adverse events. There were no deaths. Surveys of patients and HF specialists revealed a positive perception of the MIHP process of care.

Phase II Stage D HF

Twenty patients with Stage D HF were identified and agreed to participate (Table 2). One ED command physician volunteered to be on-call 24/7 for Phase II. The outcomes at 30 days are summarized in Table 3. A total of 33 MIHP house calls were performed. Urgent home encounters were performed in 2 (10%) of the participants. One patient withdrew from the study prior to the first scheduled home visit. One patient elected to cancel their second scheduled MIHP house call after they were re-hospitalized for a medical issue unrelated to HF. Four patients declined to have a second scheduled MIHP in-home visit, one of whom expressed concern about duplication of services by a visiting nurse home health care program. Two additional patients did not undergo a second scheduled in-home visit, having been readmitted at the time of their scheduled home encounter. One patient received home intravenous diuretic therapy. Patient initiated ED evaluations were performed in 9 patients (45%), eight of whom were admitted. During Phase II, the incidence of 30-day all-cause readmissions was 40%. The incidence of HF readmissions was 20%. There were no adverse events. There were no deaths.

Discussion

We demonstrated the feasibility of integrating trained paramedics into the outpatient management of patients with HF. They performed scheduled and, when requested by a HF specialist, urgent home encounters for patients with heart failure. The “House Calls” program was designed to be a new option in the outpatient management of patients with heart failure. Urgent home encounters performed within 60 minutes of a request, represented a timely response to non-emergency problems. This response time contrasts with the usual medical response-time of hours to days for non-emergency issues. Signals of effectiveness for reducing early readmissions were observed. For example, in response to patient concerns, HF specialists requested urgent MIHP home assessments in 20% of the enrolled patients. These in-home visits, facilitated by a dedicated Call Center, were performed within 30-60 minutes of a request. Only one of these urgent evaluations resulted in immediate transport to an ED. Urgent MIHP home assessments may provide a cost saving alternative to the usual process of referral to an emergency room and the associated high likelihood of re-hospitalization(32). From the patient’s point of view, assessed by post-enrollment surveys, a timely MIHP in-home evaluation, with a link to their HF specialist, was perceived to be a valuable alternative to an ED visit or urgent office encounter. This process of care may significantly increase a patient’s “home-time”, an important patient-centered variable(33). Surveys of HF specialists and the participating patients revealed a positive perception of the paramedic “House Calls” program.

There is a very high rate of hospitalizations and readmissions during the terminal phase of advanced HF(34,35). Consistent with this expectation we observed a 30-day all-cause readmission rate of 40% in participants with Stage D HF. In contrast, the 30-day all-cause readmission rate among those with Stage C HF was 15%. Similar to previous reports(2,4,36,37), we observed a high incidence of early readmissions unrelated to HF. Factors contributing to these early readmissions have been identified, including medical comorbidities and noncompliance with medications. Efforts to maximize guideline-directed medical therapy during a scheduled MIHP home visit performed very early (2 days), late (15 days) and if needed, urgently, may be valuable. Face-to-face home encounters provide an opportunity to confirm medication compliance, as well as to identify non-cardiac factors which contribute to early readmissions.

In support of the value of home-based care with paramedics, a large program in California reported their multi-community MIHP program reduced ambulance transports, ED visits and hospital admissions without adverse outcomes(38). Among their five MIHP pilot programs, all but one observed a significant reduction in 30-day readmissions. They observed a lower readmission rate when hospital systems provided at least one scheduled MIHP home visit compared to those only relying on a post-discharge phone call. The California MIHP program also reported significant cost savings, in part by avoiding financial penalties for excessive readmissions imposed by Medicare’s Hospital Readmissions Reduction Program.

Although there were no adverse events in our small feasibility trial, a high-volume MIHP program may be associated with unforeseen risks. Inadequate training and suboptimal clinical skills may result in errors of judgement. Verbal and telecommunications between a paramedic and a HF specialist may be suboptimal and result in adverse events. Like observations reported after implementation of the Hospital Readmissions Reduction Program, trends of reduced risk adjusted readmissions maybe offset by an increase in risk adjusted mortality (39,40). Furthermore, in-home visits by MIHPs may be perceived as a duplication of service, conflicting with nurse home care programs. These concerns support the proposal for a randomized trial to confirm a MIHP program will be a safe as well as a cost-effective strategy to reduce early readmissions.

There are multiple challenges to implementing a paramedic “House Calls” program. Successful programs will need to form partnerships with hospital networks and established home care services. Accessing electronic health data at the point of care is required for the success of a community paramedicine program(41). Our MIHP team did not have direct access to the patient’s EMR. This restriction limited their ability to confirm patient compliance with prescribed medications. Uploading home encounter documents into the patient’s EMR in the same location as clinic encounter documents will enhance the value of the information. MIHP programs will require financial support. Health care systems will need to cover the cost of paramedic training, as well as scheduled and urgent home services. Readmission risk scores may help identify HF subgroups with the highest risk of 30-day readmissions(42–45). Incorporating the stage of HF into these readmission risk scores may improve their predictive value and provide a better method to identify those who benefit from paramedic home evaluations. The increased cost of operationalizing a MIHP program may be offset by reducing unnecessary ED visits and their resultant hospitalizations (8,23–26). The Center for Medicare and Medicaid Innovation recently created a new payment model for ambulance services to provide triage and treatment, not just transportation(46). This program, referred to as ET3, aims to lower costs by reducing avoidable transports to the ED and unnecessary hospitalizations resulting from these transports. A MIHP program has the capability of performing triage and, with input from HF specialists, treatment at home. If MIHP programs document their value in multiple clinical scenarios, payors are more likely to be supportive.

Conclusion

A process of care utilizing MIHPs performing scheduled and, if needed, urgent “House Calls” for patients with Stage C and Stage D HF is feasible. Guided by HF specialists, trained paramedics can perform home assessments and, if needed, provide acute medical interventions, possibly avoiding the need for ED evaluations and readmissions. We propose “House Calls” by trained paramedics, working within a MIHP program, may reduce 30-day readmissions and cost of care. A randomized trial is required to confirm this hypothesis. Trial design will need to control for the Stage of HF as well as other variables influencing early readmissions. Collaboration between health care systems and EMS organizations will be required. Cost analysis will need to include the educational as well operational costs of a paramedic program.

Acknowledgements and project support

The authors would like to acknowledge Jessica Lynn Jacoby, MS, Lauren Crowley, BA and Erin Shigo, BA for their scholarly assistance with editing and formatting this manuscript. **Network of Research and Innovation at LVHN:** Leslie Baga, RN, MSCRA, CCRC; Hope Kincaid, MPH, CPH; Jean Novak, CCRC; Deb Walicki, CCRC.

LVHN legal services: Glenn Guanowsky, Esquire

LVHN medical operations: Eric M. Mueller, MBA

EMS Squads: Centroia, LVHN MedEvac, Macungie, Northampton, Upper Saucon

MIHP team: Kyle Albrecht, Richard Becker, Edwin Boyle, Rachael Diehl, James Frey, Adam Garger, Kathy David-Geisner, Shae Gratz, Ryan Hay, Mark Kleibschedel, Frederick Lavin, Mark Lehman, Matthew Markle, Ricardo Mendenez, Tara Henry-Morrow, Howard Schwartz, Maria Wescoe,

Educational team: Cathy Coyne, PhD; Nael Hawwa, MD; Denise McPherson, CRNP; Alma Ohl, CRNP; Kay Werhun, DNP, MBA; Debbie Salas-Lopez, MD, MPH; David Synnamon, MPH.

LVHN Emergency Medicine Command Physicians: David B. Burmeister, DO; Gavin

C. Barr, MD; Marna Rayl Greenberg, DO; Jeanne L. Jacoby, MD; Michael Nguyen, MD;

Alex Rosenau, DO; Andrew C. Miller, DO.

LVHN Population Health: Debbie Salas-Lopez, MD, MPH; Kay Werhun, DNP, MBA; Cathryn Kelly, RN.

Author Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

This study was funded, in part, by the Dorothy Rider Pool Trust Research and Development Fund, Allentown, PA, USA.

The authors report no conflict of interest to disclose. This work has not been published elsewhere.

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Table 1: Educational curriculum for MIHP

Educational Plan Day 1	
Topic	Objectives
<u>Population Health Overview</u>	The objective of this lecture is to familiarize the learner with the concept of population health. The lecture will focus on the current local and national environments in which hospitals and other entities function in relation to this topic.
Social Needs Assessment and Management	The objective of this lecture is to familiarize the learner's understanding of the importance of social needs assessments, their impact on patient safety, wellbeing, and health outcomes.
Mobile Integrated Health Paramedic Role Overview	The objective of this lecture is to familiarize the learner with the concept of Mobile Integrated Healthcare. The lecture will outline examples of successful MIH programs and will help facilitate the learner's understanding of where the MIH fits in the context of the entire healthcare system as well as this particular feasibility study.
CHF Readmission Challenge and House Calls Feasibility Study Overview	The objective of this lecture is to familiarize the learner with the challenges of CHF readmissions, implications to hospitals, EMS, and the patient. This lecture will also facilitate understanding of the House Calls feasibility study.
Home Safety Assessment	The objective of this lecture is to facilitate the learner's understanding of a professional home risk assessment survey and the steps toward completing one.
Key Clinical Findings in Heart Failure Patients	The objective is to provide information that will guide paramedics and command physicians on appropriate indications for hospital admission for heart failure management.
CHF Clinical Assessments and Management	The objective of this lecture is to improve and expand the learner's understanding of the management, assessment, and treatment of CHF patients. Topics included: CHF focused assessment, medication reconciliation, common lab values, and their significance during a focused CHF assessment and other considerations.

Organization Structure	The objective of this lecture is to facilitate the learner's understanding of where they fit in the House Calls feasibility study organizational and reporting structure.
Patient Visits	The objective of this lecture is to facilitate the learner's understanding of the following House Calls feasibility study processes: <ul style="list-style-type: none"> • General operational processes • Exams/assessments • Protocols • Referrals/Follow Up • Urgent "house call" process
Communications	The objective of this lecture and workshop is to facilitate the learner's understand of crucial communications that will take place during their participation on the House calls feasibility study. The overview will focus on the following communication processes: <ul style="list-style-type: none"> • Communication with referring party • Communication with "MIHP Command Physician" • Communication with "EMS Medical Command Physician" • Communication with the Community Care Team (CCT)
Documentation	The objective of this lecture and workshop is to facilitate the learner's understanding of the House Calls feasibility study's documentation platform (REDCap). The session will include an overview of the system and hands-on practice.
Educational Plan Day 2: Scenarios	
Scenario	Objectives
2 day post discharge visit, no patient complaints	Test entire process

<p>Urgent house call, unexpected weight gain, referring provider advises patient to increase frequency of Lasix and/or other actions not requiring command physician.</p>	<p>Test entire process. Test MIHP call out procedure.</p>
<p>15 day post discharge visit, patient complaining of mild dyspnea on exertion. Referring provider requests MIHP administration of Lasix.</p>	<p>Test entire process. Test MIHP to referring provider to EMS command physician communication process.</p>
<p>Urgent house call. Visiting nurse on scene with patient experiencing unexpected weight gain and nocturnal dyspnea. (Would like to have actual visiting nurse representative.) Referring provider requests MIHP administration of Lasix.</p>	<p>Test entire process. Test MIHP call out procedure. Test MIHP to referring provider to EMS command physician communication process.</p>
<p>Urgent house call. Mild dyspnea on exertion. MIHP arrives to find patient complaining of mild dyspnea at rest. Referring provider requests MIHP administration of Lasix. Communication via video conferencing.</p>	<p>Test entire process. Test MIHP call out procedure. Test MIHP to referring provider to EMS command physician communication process via video conferencing.</p>

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Table 2: Patient Characteristics

	Stage C HF (n = 20)	Stage D HF (n = 20)
Age, median years (range)	70 (51-88)	67 (37-90)
Female (%)	25	25
Race		
White (%)	90	85
Black (%)	0	10
Other (%)	10	5
HFr EF \leq 40 (%)	65	75
HFpEF > 40 (%)	35	25
Diabetes mellitus (%)	75	50
Chronic kidney disease		
Stage 1-2 (%)	31	12
Stage 3-4 (%)	69	88
Atrial fibrillation (%)	50	60
ICD (%)	20	35
Medications at discharge		
Beta blocker (%)	95	85
ACEI/ARB (%)	70	35
Mineralocorticoid antagonist (%)	40	50
Hydralazine/nitrate (%)	15	20
Sacubitril /valsartan (%)	10	25
Furosemide or equivalent		
0-19 mg (%)	10	0
20-39 mg (%)	20	26
40-79 mg (%)	55	53
\geq 80 mg (%)	15	21

ACEI/ARB = angiotensin converting enzyme inhibitors/angiotensin-receptor blockers

EF = ejection fraction

HFp EF = heart failure with preserved ejection fraction

HFr EF = heart failure with reduced ejection fraction

ICD = implantable cardioverter-defibrillator

Table 3. Outcomes at 30 Days Post-Discharge

	Stage C HF N-20	Stage D HF N-20	Total N-40
House Calls by MIHP			
Scheduled	39	31	70
Urgent	6	2	8
Follow up	4	0	4
Total	49	33	82
HF readmissions	1 (5)	4 (20)	5 (13)
All-cause readmissions	3 (15)	8 (40)	11 (28)
Unplanned clinic visits	4 (20)	4 (20)	8 (20)
ED evaluations			
MIHP initiated	1	0	
Patient initiated	3 (15)	9 (45)	
Total	4 (20)	9 (45)	13 (33)
Admissions from ED	2 (10)	8 (40)	10 (25)
Command Physician orders	3 (15)	1 (5)	4 (10)
Adverse events	0	0	0
Values are N (%)			

ED= emergency department

HF = heart failure

IV = intravenous

MIHP = Mobile Integrated Health Paramedic

Order = IV furosemide