Mid-Michigan Guidelines Applied in Practice - Heart Failure (GAP-HF) Project Manuscript and Abstracts

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Improving Quality of Care and Clinical Outcomes for Heart Failure: The Guidelines Applied in Practice for Heart Failure (GAP-HF) Initiative

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Abstract

Objectives: To assess the effect of a quality improvement program for heart failure patients on quality measures and on 30-day risk of readmission and death after hospital discharge.

Background: While treatment guidelines for the care of patients with heart failure are available, strategies to improve guideline application have not been well studied.

Methods: This is a prospective, controlled study using a pre-post intervention design assessing quality of care for hospitalized heart failure patients. Through a collaborative process, representatives from community hospitals designed and implemented standardized tools to facilitate adherence to evidence-based guidelines. The results from the 8 intervention hospitals were compared to the results from 6 control community hospitals with respect to quality of care measures and 30-day and 180-day hospital readmission and death rates.

Results: For intervention hospitals, 1262 baseline and 1255 remeasurement patients were studied, while control hospitals included 544 baseline and 578 remeasurement patients. Neither intervention nor control hospitals demonstrated improvements in documentation of left ventricular function or ACE inhibitor/angiotensin receptor blocker prescription for patients with ejection fraction < 40%, measures previously incented by local pay-for-performance incentives. However, intervention hospitals improved beta blocker and aldosterone inhibitor use and documentation of pneumococcal vaccine, discharge instructions, and smoking counseling. Readmission ≤ 30 days was reduced by 27%, and death ≤ 30 days was reduced by 41% in intervention hospitals.

Conclusions: This quality improvement program resulted in improvement in non-incentivized quality indicators, and reduced the risk of short-term readmission and death in patients hospitalized with heart failure in community hospitals.

Condensed Abstract

While treatment guidelines for the care of patients with heart failure are available, strategies to improve guideline application have not been well studied. We compared the effects of a collaborative quality improvement program for HF patients treated in 8 interventional community hospitals to measures taken from 6 control hospitals. Measures of heart failure quality of care demonstrated more pronounced improvements in GAP-HF hospitals compared to control, but no changes were seen in quality indicators targeted by local-performance incentives. Short-term (30-days), but not long-term (180-days), clinical outcomes were also improved in the GAP-HF intervention hospitals.

Key words: heart failure, quality of care, outcomes, practice guidelines, readmission, death, community hospitals, cooperative behavior

Introduction

Randomized controlled trials have documented the benefits of specific drugs in the treatment of heart failure due to systolic dysfunction, including angiotensin converting enzyme (ACE) inhibitors, [1 2 3 4] beta blockers, [5 6 7] and aldosterone inhibitors. [8] Professional societies concerned with the care of patients with heart failure have focused attention on the creation of treatment guidelines for heart failure. [9 10] Despite the strong scientific evidence supporting these treatments, numerous reports have shown that their use is lower than ideal, although increasing with time. [11 12 13 14 15 16]

These potential gaps in quality of care for heart failure have caused the Centers for Medicare & Medicaid Services (CMS) to target this clinical condition for national quality improvement. The Joint Commission for Accreditation of Hospitals (JCAHO) has also focused attention on the care of heart failure and has defined key core measures in an attempt to measure the quality of care provided in hospitals under evaluation. Additionally, some third party payers (e.g. Blue Cross Blue Shield of Michigan) have selected these heart failure practice domains to measure performance in an effort to promote optimal care. While hospitals have vigorously responded to the outside pressures to address the quality of care provided to heart failure patients, few quality of care interventions have been performed with systematic and controlled measurements before and after to determine the effects of the program. The effect of heart failure quality improvement programs on clinical outcomes such as readmission rates and mortality are not known. Additionally, no quality improvement programs in heart failure have been published that can be applied broadly to hospitals in the community setting. The purpose of this study was to test the effect of a community hospital based heart

failure quality improvement initiative on measures of quality of care as well as clinical outcomes.

Methods

The Guidelines Applied in Practice for Heart Failure (GAP-HF) initiative was performed as a collaborative project between the 8 participating (intervention) hospitals shown in Table 1, the University of Michigan Health System, the Greater Flint Health Coalition (GFHC), the Michigan Peer-Review Organization (MPRO) and the American College of Cardiology. GFHC is a non-profit organization whose mission is to improve the health status of Genesee County (Michigan) residents and to improve the quality and cost effectiveness of the County's healthcare delivery system. Each of the institutional review boards from the participating hospitals approved the study protocol. Representatives from the participating hospitals comprised of general internists, family practitioners, cardiologists, nurses and pharmacists began meeting to plan this project along with the GFHC and MPRO in March, 2003. Over a 6 month period, the participants attended 10 project meetings to create a study design, develop the GAP-HF toolkit and to establish the performance measure targets. Quality care assessment at each hospital was performed at a baseline period before the initiation of the meetings, and at a remeasurement period 15 months after the baseline measurement.

GAP-HF Intervention and Implementation

The GAP-HF project intervention consisted of multiple quality improvement facets. 1) Project leader/champion recruitment – At the initiation of the GAP-HF project, project leaders were recruited from each institution from areas of nursing, pharmacy, family practice, general internal medicine, emergency medicine, and cardiology specialty

groups. These members then participated in a series of meetings to design the project tool kit and overall performance measure goals. 2) Project kick-off – Site visits were performed at the initiation of the project in the form of departmental Grand Rounds or staff meeting presentations regarding the study. Efforts were made to make all hospital staff involved in the care of heart failure patients aware of the performance measures. Each of the hospitals was encouraged to review their own premeasurement quality measures for heart failure. Additionally, chief executive officers from the GAP-HF hospitals endorsed the project and provided encouragement to staff to achieve the project goals. 3) Project learning sessions – Interventional hospitals participated in a series of 6 monthly learning sessions, lead by the GAP-HF quality improvement specialist, Cecelia Montoye, RN, MSN. Project leaders attended these sessions and provided interim results regarding the performance measures and the adoption of the tool kit elements. These leaders were also encouraged to discuss challenges to the success of the project and to share strategies to overcome barriers to success.

Project Tool Kit

The GAP-HF tool kit was based on the published national guidelines. [9] The tool kit consisted of 5 components: 1) Heart failure standard admission orders, 2) Heart failure specific clinical pathway, 3) Heart failure patient discharge contract, 4) Heart failure patient self-management diary, and 5) Hospital heart failure quality performance charts. The GAP-HF tools were designed and approved by the project leaders as templates to be used in the participating hospitals. Each of the hospitals was then allowed to make adjustments in the tool templates to suit the needs of the individual hospital practice style.

Control Hospitals and Michigan Quality Improvement Environment

Control hospitals, serving as comparison hospitals for the GAP-HF intervention hospitals, were recruited in June 2004, coinciding with the final month of the remeasurement period for the project. Candidate hospitals were selected from a list of all hospitals in Mid-Michigan and Southeast Michigan, matching for number of beds. Six of 12 candidate hospitals approached for participation in the GAP-HF study agreed to participate.

All hospitals in the State of Michigan were influenced by a quality improvement program instituted by the State's largest private insurance carrier, Blue Cross Blue Shield of Michigan. This program, initiated in 2002, financially rewarded Michigan hospitals caring for heart failure patients for high performance with two specific quality indicators (documentation of left ventricular function, and prescription of an angiotensin converting enzyme inhibitor (ACEi) for patients with left ventricular ejection fraction (LVEF) < 40%).

Quality Assessment and Outcomes

Selection of the study sample was performed by MPRO. Hospital staff provided a comprehensive listing of patients to MPRO for the baseline period (October 1, 2002 to March 31, 2003) and the remeasurement period (January 1, 2004 to June 30, 2004). For intervention hospitals, all subjects discharged with a primary diagnosis of heart failure were selected. For control hospitals, all subjects with heart failure were included, using a maximum number abstracted of 110, to limit the effect of larger hospitals in the control cohort. After selection of the study sample, the patient's medical record was photocopied and sent for data abstraction to DynKePRO's Clinical Data Abstraction Center (York, PA), an external and internally validated quality improvement assessment agency.

Baseline and remeasurement charts were sampled in a single batch to limit the effect of changes in abstraction techniques or personnel for the two time periods. Data collected during the abstraction included patient demographics, clinical comorbidities, laboratory results, admission and discharge medications, medication allergies and intolerances, diagnostic tests and procedures performed, and process of care information regarding discharge instructions given, smoking cessation advice, and use of heart failure specific admission orders, clinical pathways and discharge contracts.

Performance measures assessed in the study are shown in Table 2. Primary quality indicators included the core measures of assessment/documentation of left ventricular function, documentation of complete discharge instructions, discharge on ACEi or angiotensin receptor blocker (ARB) or documentation of contraindication in patients with LVEF < 40%, documentation of smoking cessation advice if appropriate, and documentation of pneumococcal vaccination status during the hospitalization. Additional quality indicators were included, as it was felt by the GAP-HF project leaders that effort should be placed on maximizing the use of medications demonstrated in randomized clinical trials to reduce the risk of rehospitalization and/or death.

Clinical outcomes for the study populations were assessed at the 30 day and 180 day time points. Rehospitalization data was provided for the Medicare/Medicaid cohort of patients only by MPRO. Mortality data was collected for all patients in the study using the Social Security Death Index, with the assessment occurring > 6 months after the 180 day follow-up period.

Statistical Analysis

Comparisons of the demographics and clinical characteristics for the study groups were made using a nonparametric 2-tailed binomial *z*-test for proportions, a χ^2 test for categorical variables, and Wilcoxon rank sum tests for continuous variables using SPSS for Windows, Version 14.0 (Chicago, IL). Adherence to each defined quality measure and clinical outcomes are reported for intervention and control hospitals at the baseline and remeasurement time periods. To determine the effect of the GAP-HF intervention on the quality measures and clinical outcomes, and to account for hospital specific characteristics and potential clustering effects, hierarchical non-linear modeling was performed using HLM for Windows, Version 6.02a (Lincolnwood, IL). Using this method, the individual quality indicators and clinical outcomes were treated as binary outcome variables with patient characteristics loaded in the level 1 table, and hospital characteristics in the level 2 table. Hospital level characteristics included number of beds, for-profit status, teaching status, county household income and intervention vs control assignment. Patient level characteristics included age, sex, race, prior PCI, dementia, LVEF < 40%, SBP, DBP, pulse rate, serum sodium, presence of ICD, presence of a biventricular pacemaker, baseline/remeasurement status and the interaction term designating remeasurement*intervention (value =1 for patients discharged from the GAP-HF hospitals during the remeasurement period). Odds ratios (OR) and 95% confidence intervals (CI) were then calculated for the intervention versus control hospital baseline comparison, baseline versus remeasurement time trend comparison, and for the interaction term representing the effect of the GAP-HF intervention. Tool-specific analyses were also performed to determine the effect of the presence or absence of the tools on the performance measures. All *p* values were 2-tailed and were considered significant if < 0.05.

Results

Patients and clinical characteristics

In total, there were 3639 patients studied in the GAP-HF study, 1262 patients from the GAP-HF hospitals and 544 from the control hospitals in the baseline period, and 1255 from the GAP-HF hospitals and 578 from the control hospitals in the remeasurement period. Of the total study population, 2318 patients had either Medicare or Medicaid insurance coverage (GAP-HF baseline - 726 , GAP-HF remeasurement - 857, control baseline - 356, control remeasurement - 379), representing the study population with valid rehospitalization data for analysis. The demographic and clinical characteristics of the patient groups are shown in Table 3. The majority comparisons between the GAP-HF and control subjects demonstrated similarities, as did comparisons between the baseline and remeasurement patient groups.

Comparison of the patients from the GAP-HF hospitals and the control hospitals shows that a higher percentage of the GAP-HF patients were discharged home (rather than to a skilled nursing facility, for example). At baseline and at remeasurement, the control hospital patients had higher serum sodium than the GAP-HF patients. For the remeasurement period, the control hospital patients had higher blood pressures and higher heart rates, and were more likely to have a bi-ventricular pacemaker compared to the GAP-HF patients.

The baseline and remeasurement groups for the GAP-HF hospitals were similar in many respects, except that the remeasurement patients were more likely to have a history of percutaneous coronary intervention, had lower heart rate, lower total cholesterol and were more likely to have been admitted to the hospital within the previous 12 months.

For the control hospitals, the remeasurement period patients were significantly older and consisted of a higher percentage of females than the baseline period. Additionally, the control hospital remeasurement patients had a higher percentage of patients with LVEF < 40%, and had higher diastolic blood pressures and higher heart rates compared to the baseline group.

Heart failure specific tool use

The use of heart failure specific tools is shown in Table 4. There were no significant differences in the use of the tools in GAP-HF and control hospitals at baseline, although there was a trend toward for lower use of the heart failure specific discharge contract in GAP-HF hospitals (adjusted $p = 0.172$). Use of clinical care tools was not restricted to the GAP-HF hospitals, as control hospitals demonstrated increased tool use during the study. The remeasurement period was associated with more frequent use of standard admission orders (OR 2.11, 95% CI 1.59 – 2.80, $p < 0.001$), clinical pathways (1.34, 1.00 – 1.80, 0.049) and discharge contracts (2.73, 1.98 – 3.77, < 0.001). However, the employment of the study tools was significantly higher in the GAP-HF hospitals after the intervention (intervention* remeasurement interaction), with the use of the standing orders increasing by 1.79, (95% CI, 1.28 – 2.50, $p = 0.001$), the use of the clinical pathways increasing by 2.17 (1.54 – 3.06, $p < 0.001$) and the use of the discharge contract increasing by 3.33 (2.24 – 4.96, $p < 0.001$).

Change in performance measures with GAP-HF

Adherence to heart failure performance measures for the GAP-HF and control hospitals is shown in Table 5. No significant changes were observed for the previously incentivized performance measures of documentation of left ventricular function or

appropriate use of and ACEi or ARB for patients with LVEF < 40% for the GAP-HF hospitals after the intervention. As both GAP-HF and control hospitals demonstrated increases in the documentation of left ventricular function, the remeasurement period was demonstrated to be associated with increased adherence to this quality measure (OR 1.62, 95% CI 1.19 – 2.19, p = 0.002).

GAP-HF hospitals after the intervention demonstrated significant increases in the core HF quality indicators of documentation of complete discharge instructions (2.59, 1.76 – 3.82, p < 0.001), appropriate smoking cessation advice (2.21, 1.08 – 4.52, p = 0.031) and documentation of pneumococcal vaccination (1.73, 1.23 – 2.43, p = 0.002). The documentation of complete discharge instructions was significantly lower in the GAP-HF hospitals at baseline (0.329, 0.125 – 0.866, p = 0.028) and was higher in the remeasurement period for both GAP-HF and control hospitals (2.54, 1.88 – 3.44, p < 0.001). The documentation of pneumococcal vaccination was also higher in the remeasurement phase for both hospital groups (1.86, 1.39 – 2.49, p < 0.001). There was no demonstrable difference in the GAP-HF and control hospitals at baseline, the baseline and remeasurement periods or with the GAP-HF hospitals after the intervention with respect to the use of warfarin for patients with atrial fibrillation.

Neither the GAP-HF and control hospitals at baseline, the remeasurement period nor the GAP-HF hospitals after the intervention demonstrated any change in the proportion of patients receiving an ACEi, ARB, or combination of hydralazine and long acting nitrate preparation at discharge. While the GAP-HF hospitals after the intervention did not demonstrate an independent effect on the use of beta blockers at the time of discharge, because both GAP-HF hospitals and control hospitals increased these

rates during the study, the remeasurement phase was associated with significant increases in beta blocker prescription (2.31, 1.22 – 4.38, p = 0.011). Finally, while the GAP-HF hospitals at baseline showed lower rates of aldosterone inhibitor use at discharge compared to controls (0.391, 0.174 – 0.879, p = 0.027), and the remeasurement phase was associated with an overall reduction in the use of these medications (0.464, 0.263 – 0.879, p = 0.009), the GAP-HF hospitals after the intervention demonstrated a strong independent increase in rates of aldosterone inhibitor use at discharge (2.62, 1.34 – 5.12, p = 0.005).

Clinical outcomes

The effects of the GAP-HF intervention on the 30-day and 180-day clinical outcomes are shown in Table 6. Readmission at 30 days was shown to decrease from 26.4% to 21.7% in the GAP-HF hospitals from baseline to remeasurement. Controlling for the differences between the GAP-HF and control hospitals at baseline and differences between the baseline and remeasurement phases, the GAP-HF hospitals after the intervention demonstrate a significant reduction in the risk of 30 day readmission (adjusted OR 0.546, 95 % CI 0.368 – 0.810, p = 0.003). This difference in readmission rate was not found in the GAP-HF hospitals at the 180-day time point.

Thirty-day mortality for the GAP-HF hospitals decreased from 9.4% at baseline to 7.0% on remeasurement (p = 0.030). While the unadjusted relationship between the GAP-HF hospitals after the intervention and 30 day mortality demonstrates a 41% reduction in this clinical endpoint (0.593, 0.371 – 0.948, p = 0.029), adjustment for population clinical characteristics shows that only a trend toward improvement exists

(0.638, 0.373 – 1.09, p = 0.101). The GAP-HF hospital after the intervention was not significantly associated with the 180-day mortality rate.

Effect of GAP-HF tools on performance measures

The tool-specific rates for selected heart failure quality indicators for the GAP-HF remeasurement group are shown in Table 7. The documentation of left ventricular function was positively associated with both the use of the clinical pathway as well as the discharge contract, while the appropriate prescription of an ACEi or ARB at discharge was associated with the use of standard admission orders and the discharge contract. These associations were accompanied by a significant increase in the documentation of contraindications to an ACEi or ARB. In the case of the standard admission orders, documentation of a reason for not giving an ACEi increased from 8.0% to 16.3%, and for the discharge contract, an increase from 6.8% to 17.8% was seen.

Each of the GAP-HF tools was shown to be associated with the documentation of complete discharge instructions. The discharge contract demonstrated the strongest association by far, with an odds ratio of 168 (without a discharge contract 6.2%, with a discharge contract 91.7%). Similarly, the documentation of appropriate smoking cessation advice was associated with the use of each of the three GAP-HF tools, with the discharge contract demonstrating the strongest association. Both the use of the clinical pathway and the discharge contract were associated with the documentation of pneumonia vaccination administration. None of the tools were associated with appropriate prescription of beta blockade or aldosterone blockade at hospital discharge.

Effect of GAP-HF tools on clinical outcomes

There were significant associations between the use of the GAP-HF tools and the 30-day clinical outcomes. The use of the standard admission orders was associated with lower readmission rate at 30 days (24.6% versus 18.7%). The clinical pathway and the discharge contract use were not associated with 30-day readmission. The discharge contract was strongly associated with a lower risk of death at 30 days (10.6% versus 4.0%).

Discussion

The GAP-HF project demonstrates that a community hospital-based quality improvement program is capable of resulting in tangible benefits in clinical care of patients with heart failure, including significant improvements in quality of care measures and clinical outcomes. While no changes were demonstrated in the core quality measures of documentation of left ventricular function or appropriate prescription of ACEi or ARB for patients with LVEF < 40%, these measures had been under statewide attention in the Blue Cross Blue Shield of Michigan pay-for-performance program. Non-incentivized measures, including the documentation of complete discharge instructions, documentation of appropriate smoking cessation advice, and documentation of pneumococcal vaccination each were shown to be improved by the GAP-HF program. Additionally, the GAP-HF program was shown to increase the appropriate prescription of aldosterone inhibitors for patients with left ventricular systolic dysfunction. While GAP-HF and control hospitals both showed increases in the rate of beta blocker use at discharge, the control hospitals demonstrated a significant decrease in the use of aldosterone inhibitors. Finally, the GAP-HF study demonstrates that quality improvement efforts within a community hospital setting are capable of resulting in a

clear short-term reduction in the risk of readmission and a strong trend toward reducing short-term mortality rate.

Because the GAP-HF project targeted the improvement of heart failure quality in general, rather than one specific quality measure, the precise causative factor leading to improved clinical outcomes cannot be determined. Both GAP-HF and control hospitals increased use of beta blockers to a similar extent, and ACEi/ARB prescription was not improved in the GAP-HF group, arguing against these aspects as the source of the benefit. GAP-HF hospitals increased the rate of aldosterone inhibitor use, while the control hospitals showed a trend toward decrease aldosterone inhibitor use, correlating with the changes in short-term outcomes observed. However, it is also possible that the improved clinical outcomes are caused, in part, by the non-pharmachologic quality indicators, such as the documentation of complete discharge information. Although the GAP-HF hospitals demonstrated more pronounced increases in the documentation of smoking cessation advice and pneumococcal vaccination, it is difficult to understand why these improvements would lead to reduction in short-term outcomes.

Use of the GAP-HF designed discharge contract strongly enhanced the likelihood of documentation of complete discharge instructions. The use of this tool was associated with a 168-fold increase in the discharge instructions core quality measure, and was also significantly associated with lower risk of short-term mortality. Although the documentation of heart failure specific discharge information has been accepted as a core quality measure by national experts, demonstration that this is associated with improved patient outcomes has not been well described. A focused effort to provide heart failure patient education has previously been shown to reduce risk of readmission by 35% and

improve heart failure self-care measures. [18] A discharge document, representing a minimal set of information imparted to the patient, may have a smaller, but still significant, effect on clinical risk.

The GAP-HF program also included aspects other than medical therapy and measured quality indicators that may have resulted in improvements in clinical outcomes. For one, the GAP-HF hospitals developed a patient diary for use by the patient after hospital discharge. This diary was designed for the patient to track daily weights, symptoms, diet and medication usage. Additionally, the GAP-HF hospitals used a discharge document that prompted a clinic visit within one week of hospital discharge. It is plausible that an early post-discharge clinic visit might hold significant benefit, by allowing for adjustment in medications or laboratory monitoring that could reduce the risk of hospital readmission. Finally, the GAP-HF may have improved the clinical outcomes of patients by increasing the community awareness of heart failure quality of care, thereby improving overall post-discharge care. These unmeasured aspects of the GAP-HF may attribute for a significant portion of the observed benefit.

Limitations

Because the GAP-HF study was included a pre-post design, comparisons of the baseline and remeasurement subjects revealed several baseline differences, even though the patients arose from the same community hospitals and represented a consecutive series in each case. Similarly, differences in the patient characteristics in the GAP-HF and control hospitals raise the possibility that the improvements in quality measures and clinical outcomes that were observed are partly due to the bias inherent in these differences. Randomization of the hospitals to intervention or control groups would have

reduced this risk. However, this would have raised other design limitations, as the control hospitals would have been aware of the purpose of the study well in advance of the remeasurement period. To limit the effects of the differences in the patient characteristics, we have reported rates of indicators and outcomes adjusted for all variables found to differ within the patient groups.

The inclusion of a control group of hospitals allows for observation of changes in quality measures and clinical outcomes for heart failure patients treated in hospitals not participating in the GAP-HF intervention. As 5 of the 6 control hospitals in the control group had participated in the GAP acute myocardial infarction study, [19 20 21 22] it is not surprising that these hospitals were independently developing and using heart failure specific tools. Use of GAP naïve hospitals may have given a more realistic, and likely more striking, impression of the value of the GAP-HF intervention. However, since the control hospitals did not demonstrate any improvement in clinical outcomes, the value of the GAP-HF process, rather than the tools alone, is further supported.

Conclusion

The GAP-HF quality improvement program resulted in improvement in the majority of the heart failure quality indicators that were not previously under pressure by the local pay-for-performance incentives, and in addition increase the proportion of patients treated with beta blockers and aldosterone inhibitors at the time of discharge. Moreover, this program also resulted in an improvement in rates of readmission and death at 30-days, but did not alter 180-day clinical outcomes. These improvements, demonstrated in a non-academic hospital setting, illustrate the tangible value of the more comprehensive GAP-HF quality improvement program in heart failure care.

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Table 1. Participating hospitals

Intervention Hospitals	**Location**	**Beds**
Bay Regional Medical Center	Bay City, MI	415
Genesys Regional Medical Center	Grand Blanc, MI	379
Hurley Medical Center	Flint, MI	438
Ingham Regional Medical Center	Lansing, MI	389
Lapeer Regional Medical Center	Lapeer, MI	222
McLaren Regional Medical Center	Flint, MI	459
Mid-Michigan Medical Center	Midland, MI	250
Saint Mary's Medical Center	Saginaw, MI	452

Control Hospitals	**Location**	**Beds**
Central Michigan Community Hospital	Mount Pleasant, MI	137
Oakwood Annapolis Hospital	Wayne, MI	259
Saint Joseph Mercy Hospital	Ann Arbor, MI	529
Saint John Hospital and Medical Center	Detroit, MI	607
Oakwood Southshore Medical Center	Trenton, MI	183
Saint John Macomb Hospital	Warren, MI	376

Table 2. Performance Measures

Core Measures	**Population**
Assessment of left ventricular function *	All subjects
Discharge medications include ACEi or ARB or have documentation of contraindication *	Patients with LVEF < 40%
Discharge medications include warfarin or have documentation of contraindication	Patients with documentation of atrial fibrillation
Documentation of complete discharge instructions (all six components †)	All subjects
Patients have documentation of smoking cessation advice/plan	Patients with documentation of active smoking or history of smoking within last year
Documentation of pneumococcal vaccination up to date or advised/given	All patients
Additional Measures	
Discharge medications include ACEi, ARB or combination of hydralazine and nitrate	Patients with LVEF > 40%
Discharge medications include beta blocker or have documentation of contraindication	Patients with LVEF < 40%
Discharge medications include aldosterone inhibitor or have documentation of contraindication	Patients with LVEF < 35%

* Measure under statewide pressure through the BCBS pay-for-performance program

† Discharge instructions consist of six individual components: 1) Recommendation to weigh themselves daily, 2) Discharge medication list and instructions, 3) Recommended

activity level, 4) Dietary instructions, 5) Follow-up appointment instructions, and 6) Recommendations for what to do if their symptoms worsen.

Table 3. Clinical characteristics of patients

	GAP-HF hospitals		Control hospitals	
	Baseline	**Remeasurement**	**Baseline**	**Remeasurement**
Number	1262	1255	544	578
Age	73.8 ± 13.1	73.6 ± 13.4	72.3 ± 13.6	74.0 ± 13.6[A]
Female, %	53.9	54.8	50.9	57.4[A]
Black, %	17.1	17.0	19.9	20.1
Hispanic, %	2.2[B]	1.4	0.4	0.9
Discharged home	81.0[B]	81.4[B]	76.5	71.3
History of heart failure, %	80.5	80.8	80.1	80.1
Coronary artery disease	66.4	69.2	66.5	64.7
History of PCI, %	16.3	21.2[AB]	16.7	17.6
History of CABG, %	29.4	29.2	29.6	26.3
Diabetes	49.7	46.9	45.2	47.1
Peripheral vascular disease, %	15.1	15.2	16.0	13.7
Hypertension	79.2	81.8	78.5	82.7
Atrial Fibrillation, %	28.0	28.2	26.8	30.1
Dementia, %	7.9[B]	8.4[B]	11.0	13.0
Weight, lb	186 ± 57	183 ± 57	187 ± 60	182 ± 58
LVEF, %	43.6 ± 17.4	43.7 ± 17.0	42.9 ±17.0	41.9 ± 16.3
LVEF < 40%, %	39.3	39.7	35.7	40.5[A]
Systolic blood pressure, mmHg	149 ± 34	147 ± 32[B]	147 ± 34	150 ± 36
Diastolic blood pressure, mmHg	77 ± 20	76 ± 20[B]	77 ± 21	80 ± 23[A]

Heart rate, bpm	88 ± 22	86 ± 21[AB]	86 ± 21	89 ± 21[A]
Hemoglobin, g/dl	12.0 ± 2.0	12.1 ± 2.0	11.9 ± 2.2	11.9 ± 2.0
White blood cell count, per dl	8.9 ± 3.5	8.8 ± 4.4	9.2 ± 4.4	9.0 ± 3.8
Uric Acid	8.1 ± 3.5	8.7 ± 2.1	7.8 ± 2.9	8.0 ± 3.2
Total cholesterol	157 ± 44	151 ± 40[A]	155 ± 44	154 ± 42
Serum sodium, mg/dl	137 ± 4[B]	137 ± 4[B]	138 ± 5	138 ± 4
Serum creatinine, mg/dl	1.7 ± 1.4	1.8 ± 1.6	1.7 ± 1.4	1.8 ± 2.1
Blood urea nitrogen, mg/dl	30 ± 20	31 ± 20	31 ± 21	31 ± 21
QRS interval, ms	115 ± 40	116 ± 35	113 ± 55	114 ± 34
Implantable cardiac defibrillator, %	8.0	11.6[A]	8.1	9.2
Bi-ventricular pacemaker, %	2.2	2.0[B]	1.7	4.0
Tobacco smoking, current, %	17.5	17.5	18.0	17.5
Prior admit in past 12 months, %	24.5[B]	32.0[A]	37.3	30.3

$P < 0.05$ compared to (A) baseline, or (B) control

Table 4. Heart failure specific tool use

	GAP-HF hospitals			Control hospitals			Comparison between GAP-HF and Control	
							Unadjusted	Adjusted
Tool	BL	RM	p value	BL	RM	p value	OR (95% CI), p value	OR (95% CI), p value
Standing admission orders	21.2	46.6	< 0.001	26.1	42.2	< 0.001	INT: 0.758 (0.120 – 4.79), 0.751 RM: 2.10 (1.60 – 2.77), < 0.001 INT*RM: 1.61 (1.16 – 2.22), 0.005	INT: 0.707 (0.107-4.68), 0.699 RM: 2.11 (1.59-2.80), <0.001 INT*RM: 1.79 (1.28-2.50), 0.001
Clinical pathway	33.8	58.2	< 0.001	35.8	39.1	0.198	INT: 0.955 (0.127 – 7.17), 0.962 RM: 1.20 (0.913 – 1.58), 0.191 INT*RM: 2.42 (1.76 – 3.33), <0.001	INT: 1.85 (0.424-8.09), 0.378 RM: 1.34 (1.00-1.80), 0.049 INT*RM: 2.17 (1.54 – 3.06), <0.001
Discharge contract	8.9	45.2	< 0.001	22.8	40.8	< 0.001	INT: 0.322 (0.059 – 1.75), 0.172 RM: 2.21 (1.62 – 3.01), <0.001 INT*RM: 3.76 (2.56 – 5.52), <0.001	INT: 0.430 (0.113-1.64), 0.192 RM: 2.73 (1.98-3.77), <0.001 INT*RM: 3.33 (2.24-4.96), <0.001

All p values adjusted for age, sex, race, prior PCI, dementia, LVEF < 40%, SBP, DBP, pulse rate, serum sodium, ICD, and Bi-V Pacer, as well as hospital specific variables of number of beds, teaching status, for-profit status, and county household income.

Con = control hospitals, BL = baseline period, RM = remeasurement period, INT*RM = intervention*remeasurement interaction

Table 5. Heart failure quality indicators

	GAP-HF hospitals			Control hospitals			Comparison between GAP-HF and Control	
							Unadjusted	Adjusted
Tool	**BL**	**RM**	**p value**	**BL**	**RM**	**p value**	**OR (95% CI), p value**	**OR (95% CI), p value**
Documentation of left ventricular function *	81.4	83.5	0.217	77.9	81.3	0.287	INT: 1.78 (0.807 – 3.91), 0.14 RM: 1.56 (1..19 – 2.06), 0.002 INT*RM: 0.743 (0.528 – 1.05), 0.088	INT: 1.67 (0.876 – 3.19), 0.108 RM: 1.62 (1.19 – 2.19), 0.002 INT*RM: 0.794 (0.545 – 1.16), 0.230
ACEi or ARB at DC*	72.9	71.8	0.745	73.0	82.6	0.039	INT: 0.987 (0.595 – 1.64), 0.957 RM: 1.60 (0.943 – 2.71), 0.081 INT*RM: 0.588 (0.319 – 1.08), 0.089	INT: 0.847 (0.453 – 1.59), 0.575 RM: 1.71 (0.970 – 3.02), 0.063 INT*RM: 0.585 (0.303 – 1.13), 0.110
Warfarin for AF at DC	55.4	52.3	0.441	54.1	53.4	0.822	INT: 1.20 (0.702 – 2.04), 0.479 RM: 1.09 (0.701 – 1.70), 0.693 INT*RM: 0.810 (0.478 – 1.38), 0.436	INT: 1.38 (0.784 – 2.43), 0.239 RM: 1.12 (0.695 – 1.79), 0.650 INT*RM: 0.738 (0.420 – 1.29), 0.290
Complete discharge instructions	13.0	45.0	< 0.001	30.6	50.5	< 0.001	INT: 0.346 (0.124 – 0.969), 0.044 RM: 2.43 (1.81 – 3.25), <0.001 INT*RM: 2.40 (1.66 – 3.48), <0.001	INT: 0.329 (0.125 – 0.866), 0.028 RM: 2.54 (1.88 – 3.44), <0.001 INT*RM: 2.59 (1.76 – 3.82), <0.001

Smoking cessation advice/plan	41.1	62.4	< 0.001	59.2	62.4	0.645	INT: 0.578 (0.233 – 1.44), 0.216 RM: 1.13 (0.641 – 2.00), 0.668 INT*RM: 2.16 (1.08 – 4.31), 0.029	INT: 0.553 (0.201 – 1.52), 0.229 RM: 1.08 (0.597 – 1.96), 0.796 INT*RM: 2.21 (1.08 – 4.52), 0.031
Pneumococcal vaccination	40.1	62.2	< 0.001	72.6	81.0	< 0.001	INT: 0.375 (0.034 – 4.18), 0.396 RM: 1.69 (1.31 – 2.18), <0.001 INT*RM: 1.52 (1.23 – 2.06), 0.007	INT: 0.354 (0.041 – 3.04), 0.311 RM: 1.86 (1.39 – 2.49), <0.001 INT*RM: 1.73 (1.23 – 2.43), 0.002
Additional Measures								
ACEi, ARB or hydralazine and nitrate at DC	77.7	79.1	0.620	82.8	86.3	0.320	INT: 0.671 (0.390 – 1.16), 0.138 RM: 1.14 (0.630 – 2.05), 0.668 INT*RM: 0.874 (0.446 – 1.72), 0.696	INT: 0.601 (0.336 – 1.08), 0.080 RM: 1.19 (0.633 – 2.22), 0.594 INT*RM: 0.886 (0.433 – 1.81), 0.740
Beta blocker at DC	68.4	79.9	< 0.001	77.0	87.8	0.012	INT: 0.602 (0.349 – 1.04), 0.067 RM: 1.94 (1.08 – 3.50), 0.027 INT*RM: 1.05 (0.536 – 2.06), 0.886	INT: 0.601 (0.335 – 1.08), 0.081 RM: 2.31 (1.22 – 4.38), 0.011 INT*RM: 0.861 (0.418 – 1.78), 0.686
Aldosterone inhibitor at DC	26.3	35.1	0.025	48.9	35.1	0.044	INT: 0.403 (0.197 – 0.827), 0.018 RM: 0.443 (0.269 – 0.733), 0.002 INT*RM: 2.82 (1.56 – 5.10), 0.001	INT: 0.391 (0.174 – 0.879), 0.027 RM: 0.464 (0.263 – 0.879), 0.009 INT*RM: 2.62 (1.34 – 5.12), 0.005

All p values adjusted for age, sex, race, prior PCI, dementia, LVEF < 40%, SBP, DBP, pulse rate, serum sodium, ICD, and Bi-V Pacer, as well as hospital specific variables of number of beds, teaching status, for-profit status, and county household income.

Con = control hospitals, BL = baseline period, RM = remeasurement period, INT*RM = intervention*remeasurement interaction

Table 6. Clinical outcomes

	GAP-HF hospitals			Control hospitals			Comparison between GAP-HF and Control	
							Unadjusted	Adjusted
Tool	**BL**	**RM**	**p value**	**BL**	**RM**	**p value**	**OR (95% CI), p value**	**OR (95% CI), p value**
Hospital readmission	26.4	21.7	0.029	26.1	27.7	0.521	INT: 1.03 (0.744 – 1.43), 0.846	INT: 1.26 (0.874 – 1.82), 0.192
30 days							RM: 1.20 (0.883 – 1.62), 0.248	RM: 1.30 (0.941 – 1.79), 0.112
							INT*RM: 0.628 (0.433–0.912), 0.015	INT*RM: 0.546 (0.368 – 0.810), 0.003
	51.9	55.1	0.205	61.0	58.8	0.736	INT: 0.644 (0.476 – 0.873), 0.009	INT: 0.922 (0.607 – 1.40), 0.676
180 days							RM: 1.01 (0.729 – 1.39), 0.971	RM: 1.39 (0.934 – 2.07), 0.104
							INT*RM: 1.14 (0.779 – 1.67), 0.496	INT*RM: 0.780 (0.485 – 1.26), 0.307
Death	9.4	7.0	0.030	8.5	10.7	0.175	INT: 1.10 (0.502 – 2.42), 0.795	INT: 1.04 (0.564 – 1.92), 0.888
30 days							RM: 1.26 (0.861 – 1.836), 0.237	RM: 1.13 (0.732 – 1.75), 0.576
							INT*RM: 0.593 (0.371–0.948), 0.029	INT*RM: 0.638 (0.373 – 1.09), 0.101
	20.5	19.8	0.654	23.9	24.2	0.805	INT: 0.772 (0.457 – 1.32),0.319	INT: 0.777 (0.522 – 1.16), 0.192
180 days							RM: 0.987 (0.754 – 1.29), 0.927	RM: 0.931 (0.689 – 1.26),0.641
							INT*RM: 0.976 (0.700 – 1.36), 0.885	INT*RM: 1.00 (0.693 – 1.45), 0.991

All p values adjusted for age, sex, race, prior PCI, dementia, LVEF < 40%, SBP, DBP, pulse rate, serum sodium, ICD, and Bi-V Pacer, as well as hospital specific variables of number of beds, teaching status, for-profit status, and county household income.

Con = control hospitals, BL = baseline period, RM = remeasurement period, INT*RM = intervention*remeasurement interaction

Table 7. Effect of heart failure specific tool use on quality indicators and clinical outcomes

	Standard admission orders	**Clinical pathway**	**Discharge contract**
Quality indicator	**Tool use, -/+** **OR, 95% CI, p value**	**Tool use, -/+** **OR, 95% CI, p value**	**Tool use, -/+** **OR, 95% CI, p value**
Documentation of left ventricular function	80.0/84.7 1.40, 0.99 – 1.97, 0.056	79.6/84.2 1.58, 1.12 – 2.21, 0.008	79.3/86.7 1.77, 1.24 – 2.52, 0.002
ACEi or ARB at DC	64.9/78.7 2.00, 1.26 – 3.17, 0.003	67.4/74.5 1.41, 0.89 – 2.23, 0.140	66.7/77.5 1.72, 1.09 – 2.73, 0.020
Warfarin for AF at DC	50.0/54.4 1.20, 0.77 – 1.85, 0.427	46.6/55.7 1.44, 0.91 – 2.27, 0.118	50.6/54.1 1.15, 0.74 – 1.78, 0.534
Complete discharge instructions	25.6/66.8 5.86, 4.44 – 7.72, < 0.001	24.1/59.3 4.60, 3.46 – 6.10, < 0.001	6.2/91.7 168, 103 – 273, < 0.001
Smoking cessation advice/plan	57.3/73.6 2.08, 1.12 – 3.84, 0.020	55.6/70.3 1.90, 1.03 – 3.49, 0.040	44.8/80.6 5.12, 3.36 – 7.81, < 0.001
Pneumococcal vaccination	60.0/64.8	56.1/66.6	56.6/66.2

	1.23, 0.98 – 1.54, 0.081	1.56, 1.24 – 1.97, < 0.001	1.50, 1.28 – 1.76, < 0.001
Additional Measures			
ACEi, ARB or hydralazine and nitrate at DC	72.7/85.5 2.21, 1.34 -3.66, 0.002	76.7/80.6 1.26, 0.77 – 2.06, 0.364	74.5/84.0 1.80, 1.10 – 2.96, 0.020
Beta blocker at DC	77.7/82.3 1.33, 0.80 – 2.20, 0.271	81.6/78.9 0.84, 0.50 – 1.42, 0.514	80.8/79.0 0.89, 0.54 – 1.48, 0.662
Aldosterone inhibitor at DC	30.4/39.9 1.52, 0.92 – 2.49, 0.102	29.0/39.1 1.57, 0.93 – 2.64, 0.088	32.0/38.9 1.35, 0.82 – 2.22, 0.233
Clinical outcomes			
Readmission, 30-days	24.6/18.7 0.70, 0.51 – 0.98, 0.035	21.0/22.2 1.08, 0.77 – 1.50, 0.667	23.1/19.7 0.82, 0.58 – 1.14, 0.231
Death, 30-days	8.7/7.2 0.82, 0.50 – 1.34, 0.424	9.4/6.9 0.71, 0.43 – 1.17, 0.179	10.6/4.0 0.36, 0.20 – 0.65, 0.001

Heart Failure Quality Improvement Intervention Reduces 30-day Risk of Death and Readmission in Community Hospitals: The American College of Cardiology Mid-Michigan Guidelines Applied in Practice - Heart Failure Initiative

Authors: Todd M. Koelling, Cecelia K. Montoye, Jianming Fang, Stephen Skorcz, Theresa K. Aldini, Vipin Khetarpal, Daniel Lee, Japhet Joseph, Trissa Torres, Suresh Gupta, Laura Carravallah, Michael James, Jeffery Harris, Frederick VanDuyne, Rodney Diehl, Kim A. Eagle, Anthony C. DeFranco.

Background: While treatment guidelines for the care of patients with heart failure (HF) are available, strategies to improve guideline application have not been well studied. The effects of quality improvement initiatives in heart failure patients on clinical outcomes are not known.
Hypothesis: To assess the effect of a quality improvement program for HF patients on the 30-day risk of readmission and death after hospital discharge.
Methods: Through a collaborative process, 8 intervention hospitals (IH) designed and implemented standardized tools to facilitate adherence to evidence-based guidelines. Identification and independent abstraction of baseline (October – March, 2003) and follow up (January – June, 2004) charts for IH and for 6 control hospitals (CH) was performed. Rehospitalization rates were collected for the Medicare covered patients only and were provided by MPRO. Deaths were recorded for the entire study sample.
Results: For IH at baseline (n = 1262) and at remeasurement (n = 1255), age was 73.8 ± 13.1 and 73.6 ± 13.4, CAD 66.4% and 69.3%, LVEF 44 ± 17 and 44 ± 17, BUN 30 ± 20 and 31 ± 20, QRS 115 ± 35 and 116 ± 36, respectively (p = NS for all). For CH at baseline (n = 544) and at remeasurement (n = 578), age was 72.3 ± 13.6 and 74.0 ± 13.6 (p = 0.03), CAD 66.5% and 64.7% (NS), LVEF 43 ± 18 and 42 ± 16 (NS), BUN 31 ± 21 and 31 ± 21 (NS), and QRS 111 ± 34 and 115 ± 34 (p = 0.03), respectively. Death ≤ 30 days occurred in 118 (9.4%) IH patients and 46 (8.5%) CH patients at baseline and 88 (7.0%) IH patients and 62 (10.7%) CH patients on remeasurement. Readmission ≤ 30 days occurred in 190 (26.2%) IH patients and 93 (26.1%) CH patients at baseline period and 186 (21.7%) IH patients and 105 (27.7%) CH patients in the remeasurement period. The effect of the intervention on the clinical endpoints is shown in the table below.
Conclusions: The ACC Mid-Michigan GAP-HF quality improvement program can reduce the risk of early readmission and death in patients hospitalized with heart failure in community hospitals.

	Control hospitals		Intervention hospitals	
	OR (95%CI)	p - value	OR (95%CI)	p - value
30-day mortality	1.301 (0.871-1.942)	0.198	0.731 (0.548-0.975)	0.032
30-day readmission	1.084 (0.782-1.502)	0.629	0.782 (0.620-0.989)	0.037

Improving Quality of Care in Heart Failure: The American College of Cardiology Mid-Michigan Guidelines Applied in Practice-Heart Failure Initiative (GAP-HF)

Authors Anthony C. DeFranco, Cecelia K. Montoye, Jianming Fang, Stephen Skorcz, Theresa K. Aldini, Vipin Khetarpal, Daniel Lee, Japhet Joseph, Trissa Torres, Suresh Gupta, Laura Carravallah, Michael James, Jeffery Harris, Frederick VanDuyne, Rodney Diehl, Kim A. Eagle, Todd M. Koelling.

Background: While treatment guidelines for the care of patients with heart failure (HF) are available, the use of guidelines to improve HF care has not been well studied.
Hypothesis: To assess the effect of a quality improvement program on adherence to evidence-based guidelines for hospitalized HF patients.
Methods: Through a collaborative change process, 8 interventional hospitals (IH) designed and implemented standardized tools to facilitate adherence to ACC/AHA guidelines. Independent abstraction of 1273 baseline and 1282 follow up charts for IH and 547 baseline and 581 follow up charts for 6 control hospitals (CH) was performed. LVEF documentation and ACE inhibitor use were subjected to pay for performance incentives in the region throughout the study.
Results: Use of standard orders and discharge forms increased in both groups. The IH experienced significant improvement in use of beta blockers and aldosterone inhibitors, and documentation of pneumococcal vaccine, discharge instructions, and smoking counseling. Overall, IH improved performance in 5 of 7 quality indicators while CH improved in 2 of 7 quality indicators. Adherence for the 2 incentive indicators was not influenced by the intervention. In both groups the highest rates were achieved with standardized tools use.
Conclusions: GAP-HF interventions improved adherence to all non-incentivized quality measures in hospitalized HF patients. Use of standardized tools, whether or not part of GAP, significantly enhances quality of care.

Quality measures for patients discharged to home, (* p < 0.05 vs No Tool)

	IH Baseline %n=979	IH Remeasurement %n=983	p value	With Tool %	CH Baseline %n=410	CH Remeasurement %n=408	p value	With Tool %
Standard order use	20.53	44.25	<0.0001	NA	27.32	40.93	<0.0001	NA
Discharge form use	8.17	42.12	<0.0001	NA	21.95	39.46	<0.0001	NA
LVEF documentation	83.45	85.05	0.3327	90.34*	78.05	83.33	0.0556	85.71
ACEI/ARB/HY+N at DC	75.44	75.12	0.9144	80.20*	84.15	87.50	0.3808	88.89
Beta blocker at DC	68.36	80.05	0.0002	80.57	79.08	86.84	0.0717	93.75*
Aldosterone inhibitor at DC	24.74	32.20	0.0192	31.75	40.37	32.10	0.1219	44.29*
Pneumococcal vaccination documentation	39.55	65.20	<0.0001	68.12*	73.55	81.98	0.0031	81.88
Discharge instructions (all six)	12.97	45.57	<0.0001	55.56*	30.00	50.00	<0.0001	65.12*
Smoking cessation advice	42.02	64.40	<0.0001	84.42*	62.35	64.43	0.7596	91.18*

Incremental Value of Quality Improvement Tools on Performance Measures in Heart Failure: The Mid-Michigan Guidelines Applied in Practice - Heart Failure Initiative

Authors: Montoye CK, DeFranco AD, Skorcz S, Aldini T, Fang JM, Eagle KA, Koelling TM.

Background: Through a collaborative process, community hospitals in the Mid-Michigan Guidelines Applied in Practice – Heart Failure (GAP-HF) initiative have demonstrated significant improvement in quality of care performance measures in patients hospitalized with heart failure (HF). It is not understood how individual quality improvement tools impact upon performance measures.
Hypothesis: To assess the individual effect of three separate quality improvement tools on adherence to evidence-based therapies for patients hospitalized with HF.
Methods Project leaders from eight intervention hospitals designed and implemented comprehensive and standardized tools to facilitate adherence to the ACC/AHA HF guidelines and developed strategies to overcome barriers to tool use. Standardized tools included HF specific admission orders (AO), clinical pathway (CP), and discharge contract (DC). After adoption of project tools into clinical practice, charts from 1,282 patients were abstracted for clinical information and performance measure adherence. For each of six separate performance measures, backward stepwise logistic regression analysis was performed to determine the individual impact of tools on guideline adherence.
Results: From the baseline period to the remeasurement period, use of AO increased from 22.4% to 48.0% ($p < 0.0001$), CP increased form 33.8% to 59.9% ($p < 0.0001$), and DC increased from 9.1% to 46.2% ($p < 0.0001$), respectively. Results of logistic regression analysis for each HF performance measure are shown in the table below.
Conclusions: Each of the three GAP-HF quality improvement tools hold significant value with respect to HF performance measures. Use of HF AO is associated with improvements in medication performance measures, while the DC is effective in improving adherence to discharge instructions and smoking counseling measures. The CP is associated with improve adherence to pneumococcal vaccine recommendations.

	Admission orders	Clinical pathway	Discharge contract
	OR (95%CI) p-value	OR (95%CI) p-value	OR (95%CI) p-value
Documentation of LV function	0.99 (0.65 –1.51) 0.958	1.30 (0.89 – 1.89) 0.176	2.17(1.47 – 3.19) <.0001
ACE inhibitor for EF < 40%	2.00 (1.23 – 3.25) 0.005	0.97 (0.58 – 1.63) 0.905	1.98 (1.21 – 3.25) 0.0065
ACE inhibitor or alternative for EF < 40%	1.84 (1.17 – 2.89) 0.008	0.98 (0.59 – 1.63) 0.935	1.43 (0.89 2.31) 0.144
Beta Blocker EF < 40%	1.34 (0.81 – 2.22) 0.254	0.72(0.41 – 1.26) 0.244	1.02 (0.60 – 1.76) 0.930
Aldosterone inhibitor for EF < 40%, NYHA III-IV	1.13 (0.71 – 1.80) 0.620	1.26 (0.78 – 2.04) 0.346	0.86 (0.55 – 1.35) 0.518
Pneumococcal vaccine	0.87 (0.64 – 1.17) 0.353	1.50 (1.15 – 1.96) 0.003	1.14 (0.85 –1.55) 0.384
Discharge instructions	1.01 (0.69 – 1.48) 0.949	1.05 (0.70 – 1.58) 0.802	19.67 (13.22 – 29.26) <0.0001
Smoking counseling	0.92 (0.43 – 1.96) 0.830	1.43 (0.74 – 2.76) 0.286	5.23 (2.55 – 10.71) <0.0001

Improving Quality of Care in Heart Failure: The American College of Cardiology Mid-Michigan Guidelines Applied in Practice-Heart Failure Initiative (GAP-HF)

Authors Anthony C. DeFranco, Cecelia K. Montoye, Jianming Fang, Stephen Skorcz, Theresa K. Aldini, Vipin Khetarpal, Daniel Lee, Japhet Joseph, Trissa Torres, Suresh Gupta, Laura Carravallah, Michael James, Jeffery Harris, Frederick VanDuyne, Rodney Diehl, Kim A. Eagle, Todd M. Koelling.

Background: While treatment guidelines for the care of patients with heart failure (HF) are available, the use of guidelines to improve HF care has not been well studied.
Hypothesis: To assess the effect of a quality improvement program on adherence to evidence-based guidelines for hospitalized HF patients.
Methods: Through a collaborative change process, 8 interventional hospitals (IH) designed and implemented standardized tools to facilitate adherence to ACC/AHA guidelines. Independent abstraction of 1273 baseline and 1282 follow up charts for IH and 547 baseline and 581 follow up charts for 6 control hospitals (CH) was performed. LVEF documentation and ACE inhibitor use were subjected to pay for performance incentives in the region throughout the study.
Results: Use of standard orders and discharge forms increased in both groups. The IH experienced significant improvement in use of beta blockers and aldosterone inhibitors, and documentation of pneumococcal vaccine, discharge instructions, and smoking counseling. Overall, IH improved performance in 5 of 7 quality indicators while CH improved in 2 of 7 quality indicators. Adherence for the 2 incentive indicators was not influenced by the intervention. In both groups the highest rates were achieved with standardized tools use.
Conclusions: GAP-HF interventions improved adherence to all non-incentivized quality measures in hospitalized HF patients. Use of standardized tools, whether or not part of GAP, significantly enhances quality of care.

Quality measures for patients discharged to home, (* p < 0.05 vs No Tool)

	IH Baseline %n=979	IH Remeasurement %n=983	p value	With Tool %	CH Baseline %n=410	CH Remeasurement %n=408	p value	With Tool %
Standard order use	20.53	44.25	<0.0001	NA	27.32	40.93	<0.0001	NA
Discharge form use	8.17	42.12	<0.0001	NA	21.95	39.46	<0.0001	NA
LVEF documentation	83.45	85.05	0.3327	90.34*	78.05	83.33	0.0556	85.71
ACEI/ARB/HY+N at DC	75.44	75.12	0.9144	80.20*	84.15	87.50	0.3808	88.89
Beta blocker at DC	68.36	80.05	0.0002	80.57	79.08	86.84	0.0717	93.75*
Aldosterone inhibitor at DC	24.74	32.20	0.0192	31.75	40.37	32.10	0.1219	44.29*
Pneumococcal vaccination documentation	39.55	65.20	<0.0001	68.12*	73.55	81.98	0.0031	81.88
Discharge instructions (all six)	12.97	45.57	<0.0001	55.56*	30.00	50.00	<0.0001	65.12*
Smoking cessation advice	42.02	64.40	<0.0001	84.42*	62.35	64.43	0.7596	91.18*

Lack of Gender Disparity in Quality of Care in The Mid-Michigan Guidelines Applied in Practice-HF Initiative

Authors, Cecelia K. Montoye, MSN, Anthony C. DeFranco, MD, Jianming Fang, MD, Stephen Skorcz, FACHE, Theresa K. Aldini, MS, Kim A. Eagle, MD and Todd M. Koelling, MD

Body: Objective: Previous studies have suggested that women hospitalized with heart failure receive lower quality of care compared to men**.**

Methods: Data from the ACC Mid-Michigan HF GAP study, a quality improvement initiative in 2003-2004, were used to assess disparity in care based on gender. Analysis was completed to determine rates of LVEF assessment, medication prescription, documentation of discharge instructions and smoking counseling for women compared to men. Comparisons based on gender were made for subjects discharged to home.

Results: Females were older than males (72.3 vs 70.0 years, $p < 0.0001$), were less likely to have CAD (61.3% vs 74.3%, $p < 0.0001$), but more likely to have HTN (82.7% vs 79.2%, $p = 0.0166$) and diabetes (50.3% vs 46.2%, $p = 0.0327$). Females were 36% less likely to have low LVEF compared to males (32.4% vs 50.6%, $p < 0.0001$) and were more than twice as likely to be discharged to a skilled nursing facility rather than to home compared to males (14.8% vs 6.1%, $p < 0.0001$). Despite these baseline differences, guideline-based medical care was similar for females and males (see table). Females were less likely to have LVEF documented compared to males (81.6% vs 84.9%, $p = 0.0211$), but were more likely to receive appropriate smoking cessation advice than males (62.4% vs 52.3%, $p = 0.0191$). Additionally, there were no differences in the use of study tools (heart failure standard admission orders, clinical pathways or discharge contracts) based on gender.

Conclusions: While females with heart failure differ in many ways compared to male heart failure patients, there is little gender disparity in the quality of care demonstrated in the ACC Mid-Michigan HF GAP initiative.

[table 1]

Heart Failure Quality Measures and Gender			
	Male n=1367 (%)	Female n=1412 (%)	p value
LVEF documented	84.9	81.6	0.0211
ACE-I or alternative	77.3	79.9	0.3033
Beta Blocker	77.2	76.2	0.6963
Aldosterone inhibitor	31.3	30.0	0.6436
D/C instructions	20.6	21.9	0.3935
Smoking counseling	52.3	62.4	0.0191

Overcoming barriers to implementation of standardized tools in the ACC Mid Michigan Heart Failure Guidelines Applied in Practice Initiative

Cecelia K. Montoye, Theresa K. Aldini, Anthony C. DeFranco, Dan Keehner, Willa Rousseau, Cathy Fenwick, Carol Wank, Connie Allen, Tracie Hopkins, Mary Latarte, Lori Belger, Cameron Shultz, Jianming Fang, Kim A. Eagle, Todd M. Koelling.

Background: The ACC AMI Guidelines Applied in Practice (GAP) Projects demonstrated that the use of standardized tools to guide care lead to a significant improvement in rates for the evidenced-based quality indicators for that particular patient population. The ACC GAP Collaborative Model was used as the improvement methodology to increase the use of standardized tools in the ACC Mid Michigan Heart Failure GAP.

Hypothesis: Use of the ACC GAP Collaborative Model will help overcome barriers in the implementation of standardized tools for care of patients with heart failure.

Methods: Using the ACC GAP Collaborative Model, leaders from eight interventional (INT) hospitals attended a series of learning sessions with a goal of implementing standardized tools for care of patients with heart failure. The learning sessions focused on identifying barriers in each phase of the project implementation: planning, process changes, monitoring tool use, remeasurement, and results. Strategies were developed and applied to overcome barriers and practice was monitored to determine an increase in tool use. This presentation will share the unique barriers identified and strategies developed to increase tool use.

Results: At an aggregate level there was significant improvement in the use of standardized orders, discharge documents, and critical pathways with variable improvement at the hospital level. There was significant improvement in six of the hospitals in the use of standardized orders, in all eight hospitals in the use of the discharge document, and in seven hospitals in the use of a critical pathway.

Conclusions: Using the ACC GAP Collaborative Model, hospital teams identified barriers to tool use and developed successful strategies to increase the use of standardized orders sets, discharge documents, and critical pathways for care of patients with heart failure.

Comparison of baseline to remeasurement standardized tool use in individual hospitals									
	Standardized order			Discharge document			Critical pathway		
	Baseline	Remeasure	p value	Baseline	Remeasure	p value	Baseline	Remeasure	p value
Hospital 1	1.03%	68.18%	<0.0001	0.00%	58.52%	<0.0001	54.12%	72.16%	0.0003
Hospital 2	47.50%	50.44%	0.6534	0.00%	60.18%	<0.0001	55.00%	55.75%	0.9081
Hospital 3	1.89%	22.31%	<0.0001	0.00%	22.31%	<0.0001	17.61%	60.00%	<0.0001
Hospital 4	20.99%	35.32%	0.0018	4.32%	36.90%	<0.0001	20.37%	48.02%	<0.0001
Hospital 5	1.32%	32.24%	<0.0001	0.00%	29.61%	<0.0001	0.00%	54.61%	<0.0001
Hospital 6	14.29%	49.06%	<0.0001	0.00%	11.32%	0.0096	3.57%	58.49%	<0.0001
Hospital 7	52.74%	60.18%	0.1088	35.44%	47.51%	0.0088	50.63%	62.90%	0.0082
Hospital 8	29.51%	76.67%	<0.0001	1.64%	65.00%	<0.0001	57.38%	83.33%	0.0018
Aggregate	21.82%	47.45%	<0.0001	8.06%	42.18%	<0.0001	34.09%	59.81%	<0.0001

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Assessment of Predictive Accuracy of Centers for Medicare and Medicaid Services' Method to Risk Adjust Patients for Interhospital Comparison of 30-day Mortality Rates

Author Block: Todd M Koelling, Sara Saberi, Univ of Michigan, Ann Arbor, MI; Anthony C DeFranco, Stephen Skorcz, Greater Flint Health Coalition, Flint, MI; Cecelia K Montoye, St. Joseph's Mercy Hosp, Ann Arbor, MI; Cameron Shultz, Kirk D Smith, Andrew Fotenakes, Pete A Levine, Greater Flint Health Coalition, Flint, MI; Keith D Aaronson, Univ of Michigan, Ann Arbor, MI

Abstract:
Introduction: The Centers for Medicare and Medicaid Services (CMS) will initiate public reporting of 30 day death rates for hospitals caring for patients with heart failure (HF). While hospital specific rates will be adjusted for medical comorbidities, it is not known if this method is adequate to allow direct hospital comparisons.
Hypothesis: More accurate risk adjustment of patients can be accomplished by including variables that have previously been described to be predictors of mortality in HF.
Methods: We assessed the CMS HF risk adjustment model in a population of 3639 patients studied in the Guidelines Applied in Practice (GAP) - HF study. Probabilties for 30 day mortality were calculated for the CMS model. Multivariable logistic regression analysis was then performed with other models including variables (no mVO_2) from the Heart Failure Survival Score (HFSS), ADHERE Registry model (ARM), body mass index categories (BMI), pre-admission origin of patient (PAO), and admission in the previous 6 months (AP6). Probabilities of mortality were tabulated. Backward selection was then used to derive the best model from all candidate variables from a derivation data subset, followed by testing of the model on a validation data subset. Area under the curve (AUC) was then compared for each model.
Results: The AUCs and 95% CI are shown in the table below. Calculated AUCs for the CMS model and separate models were similar. The best model was defined by the following variables: admission in the previous 6 months, BUN > 43, systolic blood pressure > 115, 35 ≤ BMI < 40, BMI ≥ 40, mean arterial pressure, serum sodium, and PAO as well as the CMS model variables. The AUCs for the derivation and validation sets were both significantly greater than that provided by the CMS model alone.
Conclusions: Risk adjustment for the purpose of interhospital comparison of 30-day mortality rates is best performed with models that include clinical admission variables in addition to the medical comorbidites.

Comparison of AUCs for 30 day mortality prediction

			Categorization (% correct)[a]	
	AUC	95% CI	Alive	Dead
CMS Model	0.631	0.597 - 0.664	97.9	8.3
ARM Model	0.626	0.591 - 0.662	96.1	13.4
HFSS Model	0.639	0.605 - 0.673	98.7	4.4

BMI Model	0.594	0.560 - 0.628	97.8	6.7
PAO Model	0.610	0.573 - 0.647	100.0	0.0
AP6 Model	0.613	0.579 - 0.647	99.6	1.3
Best Model (derivation)	0.756	0.713 - 0.798	95.9	26.2
Best Model (validation)	0.701	0.657 - 0.745	96.8	14.1
a. Cutoff value is 0.20				

:

Author Disclosure Block: **T.M. Koelling**, None; **S. Saberi**, None; **A.C. DeFranco**, None; **S. Skorcz**, None; **C.K. Montoye**, None; **C. Shultz**, None; **K.D. Smith**, None; **A. Fotenakes**, None; **P.A. Levine**, None; **K.D. Aaronson**, None.

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Cardiology Specialty Care is Associated with Higher Quality Performance for Patients Admitted with Heart Failure

Author Block: Robert D. Grande, Cecelia K. Montoye, Anthony C. DeFranco, Jianming Fang, Todd M. Koelling, University of Michigan, Ann Arbor, MI

Background: Community hospitals participating in the ACC Mid-Michigan Guidelines Applied in Practice - Heart Failure (GAP-HF) initiative have demonstrated significant improvement in quality of care measures in patients hospitalized with heart failure (HF). It is not understood what individual patient care characteristics influence the quality of care delivered to HF patients.
Methods For the 3639 patients studied in GAP-HF, a HF quality score (HFQS) was calculated as the proportional adherence to each of 13 separate HF quality measures (LV function assessment, appropriate use of ACE inhibitor or alternative, beta blocker, aldosterone inhibitors, and warfarin, pneumococcal vaccine, smoking cessation advice, and instruction for diet, daily weight monitoring, activity level, medications, symptom changes, and follow-up plan). Patient demographics, clinical characteristics, and hospitalization variables were entered into a multivariable logistic regression model using stepwise selection to determine independent predictors of high HFQS (≥ median).
Results: The median HFQS for the population (age 74 ± 13 years, 54% female, 49% with EF < 40%) was 0.64 (IQR 0.36 - 0.80). HFQS was higher for patients treated by a cardiology specialist than patients treated by a primary care physician alone (0.61 vs 0.42, $p<0.0001$). Logistic regression analysis revealed that age, female gender, LVEF ≥ 40%, lower blood pressure, arrival to hospital between 12pm and 4pm, discharge on a weekday, ICU requirement, dialysis requirement, presence of pneumonia, and presence of dementia were all independent predictors of lower HFQS, while care that included a cardiology specialist predicted higher HFQS (OR 2.27, 95%CI 1.21 - 4.25, $p= 0.01$). AUC for the final multivariable model = 0.708.
Conclusions: Derivation of a predictive model for HF quality of care suggests that attention be paid to specific populations of patients with HF, including females, patients with preserved EF and patients arriving in the middle of the day or discharged during a weekday. Involvement of cardiology specialty care may help to improve the overall quality of care of HF in community hospitals.

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Lower Rate of Dietary Advice Given to Heart Failure Patients with Preserved Systolic Function is Associated with Adverse Short-Term Clinical Outcomes After Hospital Discharge

Authors: Scott Hummel, Cecelia K. Montoye, Anthony C. DeFranco, Stephen Skorcz, Theresa K. Aldini, Vipin Khetarpal, Daniel Lee, Japhet Joseph, Trissa Torres, Suresh Gupta, Laura Carravallah, Michael James, Jeffery Harris, Frederick VanDuyne, Rodney Diehl, Kim A. Eagle, Todd M. Koelling.

Background:
It is not known whether application of ACC/AHA disease specific performance measures primarily designed for systolic heart failure (SHF) benefits patients with heart failure and preserved systolic function (HFPSF), although many of these measures are recommended regardless of ejection fraction (EF).
Methods:
The ACC Guidelines Applied in Practice - Heart Failure (GAP-HF) study tracked guideline-based quality improvement metrics and clinical outcomes in HF patients admitted to 15 community hospitals. We performed Chi-square analysis to compare guideline adherence in patients with systolic heart failure (SHF, EF < 40%, n=1420) and HFPSF (EF ≥ 50%, n=1079). We then performed binary logistic regression to assess the relationship between the HF quality indicators and 30-day clinical outcomes in patients with HFPSF.
Results:
At discharge, patients with HFPSF were less likely to receive written instructions for daily weights (35.2% vs 42.0%), activity level (83.1% vs 88.4%), and low sodium diet (48.3% vs 56.3%) than patients with SHF ($p < 0.05$ for all). No difference was found in the rates of patients receiving appropriate information regarding discharge medications (65.2% vs 68.7%), follow-up appointments (97.0% vs 97.2%), or a plan for what to do if their symptoms worsen (48.5% vs 50.6%). Patients with HFPSF were less likely to receive complete (all six elements) discharge instructions than patients with SHF (24.5% vs 30.9%, $p = 0.002$). Multivariable regression analysis reveals that documentation of advice given to follow a low sodium diet was strongly associated with a lower risk of adverse outcomes at 30-days post discharge (death at 30 days - (OR, 95% CI, p value) 0.246, 0.098 - 0.620, 0.003; readmission at 30 days - 0.578, 0.362 - 0.925, 0.022; death or readmission at 30 days - 0.404, 0.256 - 0.636, <0.001)
Conclusions:
Appropriate HF discharge instructions are documented less frequently in the management of HFPSF compared to SHF. The prescription of a low-sodium diet is independently associated with decreased event rates in the 30 days following admission for HFPSF. Further study is needed to determine if this relationship is causal or simply a marker of better overall care.