Clinical Implications of an Accurate Problem List on Heart Failure Treatment

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CONTEXT: The premise of the problem-oriented medical record is that an accurately defined problem list will directly result in more thorough and efficient patient care. However, little empirical evidence exists demonstrating improved patient outcomes as a result of an adequately structured problem list.

OBJECTIVE: To determine the impact of problem list documentation of heart failure on the likelihood that evidence-based pharmacotherapy has been prescribed.

DESIGN: Cross-sectional study.

SETTING: Community-based primary care clinics in Portland, Oregon.

SUBJECTS: Active patients in the network with a left ventricular ejection fraction of 40% or less, with and without heart failure, in their structured problem list.

MAIN OUTCOME MEASURES: The proportion of patients prescribed medications with known benefits for systolic dysfunction.

RESULTS: In this group of patients with known systolic dysfunction, the likelihood of therapy with either an angiotensin converting enzyme inhibitor or angiotensin II receptor blocker was higher in patients who had heart failure listed on their problem list compared to patients who did not (92.2% vs 76.7%; $P < .05$). This association remained after statistical adjustment for age, gender, and ejection fraction. Patients with accurate problem list entries were also more likely to receive digoxin (61.1% vs 36.7%; $P = .001$) and spironolactone (26.7% vs 13.3%; $P = .025$). There were no differences in the use of beta-blockers between the 2 groups.

CONCLUSION: Accurate documentation of heart failure on the problem list of patients with known systolic dysfunction is associated with a significant increase in the likelihood of being prescribed medications with known clinical benefit.

KEY WORDS: problem-oriented medical records; heart failure; quality indicators; drug therapy.

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In the late 1960s, Lawrence Weed successfully advocated for a fundamental change in the approach to medical record organization and documentation.¹ In his landmark publication, Dr. Weed identified the challenge physicians face in providing single-minded attention to complex patients with multiple existing and developing problems. His proposed solution would orient data around each patient problem, creating a complete "problem list" displayed prominently in each chart. This Problem-oriented Medical Record (POMR) would be updated at each subsequent care episode. While problem lists have become commonplace in ambulatory practice, there is substan-

tial variation in physician adherence to the use and completeness of information entry. As stated in Dr. Weed's original publication, "Among physicians there is a remarkable spectrum of behavior from the compulsively elaborate to the sketchy and haphazard."¹ Today, practice variation is still considered a significant contributor to inadequacies in health care quality.²⁻⁵

The premise of the POMR is that an accurately defined problem list will directly result in more thorough and efficient patient care. Despite this assertion, there has been little validation that this approach translates into improved patient outcomes. Simborg et al. evaluated 2 consecutive visits in 6 ambulatory clinics to determine the problems identified in the first visit and the follow-up care for these problems provided in the second visit.⁶ It was found that problems listed in the front of the chart were more likely to be addressed at the subsequent visit, particularly if there was a longer interval between visits. Recognizing that practice variation continues to exist decades after Dr. Weed's original publication and that expensive physician resources are required to maintain an accurate problem list, we sought to further quantify the impact of this process on patient outcomes.

Heart failure (HF) is a prevalent condition that requires intensive medical management, and it is conceivable that construction and maintenance of an accurate POMR would likely contribute toward enhanced patient outcomes. Several medication classes are known to prolong survival and improve health status in patients with HF and, as such, represent valid process-related quality indicators that are strongly associated with favorable outcomes.⁷ Accordingly, the aim of this study was to evaluate the impact of accurate problem list entry for HF on the likelihood that evidenced-based pharmacotherapy has been prescribed.

METHODS

Setting and Participants

This was a retrospective, cross-sectional study involving participating practices from the Providence Primary Care Practice-based Research Network. Participating network practices included 80 practitioners providing care to approximately 200,000 patients in 9 clinic locations in Oregon. All network practices share a common electronic medical record (EMR), Logician. Problem lists were generated and maintained through physician entry of patient diagnosis. Problem list entries were stored in a dedicated searchable data field, based on the International Classification of Disease, ninth revision, system. There were no limits on number of problems that could be entered per patient. Notes from all patient visits were documented completely in the EMR. Issuing a prescription to a patient simultaneously records that prescription in the patient's active medication list. Paper prescription pads were not used within the network. Patient data including demographics, insurance status, medications, and laboratory values were also

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available through this clinical database. During the study period, the use of complimentary paper charts was limited to external documents such as specialty consult letters and test results.

The study population consisted of 180 patients within the network who had a confirmed diagnosis of HF due to systolic dysfunction. Patients with HF were identified by query of left ventricular ejection fraction (LVEF) results stored in local echocardiography laboratory databases. Patient charts with any reference to low ejection fraction, congestive heart failure, HF, or systolic dysfunction in the patient chart were included in the analysis. Systolic dysfunction was defined by an LVEF of 40% or less. Patients were excluded if chart evidence of physician awareness of HF diagnosis was not present or if they were deceased, had transferred care outside the network, or their active status could not be confirmed. The definition of active status included documentation of patient encounters (i.e., telephone contact, office visit, or medication refill) before and after the cross-section date of June 11, 2001. Patients identified with systolic dysfunction with or without a problem list entry of HF were selected for analysis.

Outcomes and Data Collection

The primary objective of this study was to determine the association between the presence of HF on the problem list and treatment with medications demonstrated to benefit patients with systolic dysfunction. Angiotensin-converting enzyme (ACE) inhibitors and beta-blockers have been well documented to improve survival in patients with HF.^{7,8} According to guidelines, angiotensin II receptor blockers (ARB) or the combination of hydralazine and a long-acting nitrate are acceptable substitutes for patients intolerant of ACE inhibitors.^{7,8} The primary outcomes were defined as the proportion of HF patients with an active prescription for a 1) ACE inhibitor, ARB, or hydralazine/long-acting nitrate combination (vasodilator), 2) beta-blocker, and 3) a combination of a vasodilator and a beta-blocker.

Secondary objectives evaluated the association between HF problem list entry and other recommended therapies (spironolactone, diuretics, and digoxin) and those that are relatively contraindicated in patients with heart failure (nonsteroidal anti-inflammatory drugs [NSAID] and nondihydropyridine calcium channel blockers [CCB]).^{7,8}

The daily dose of ACE inhibitor was converted to an equivalent captopril dose based on target doses studied in large, prospective, randomized clinical trials.^{9,10} If a particular ACE inhibitor had never been studied in a heart failure trial, then the maximum dose stated in the package insert was considered the target dose.^{11,12} The mean captopril equivalent dose and the proportion of patients who achieved the target captopril equivalent dose (≥ 150 mg daily) were compared between groups of patients receiving ACE inhibitors.¹³

Age, gender, LVEF, serum creatinine, serum potassium, problem list entries, medications, and physician years in practice were collected for all sampled patients. Chart review established the presence or absence of several comorbid conditions with the potential to influence medication selection including diabetes mellitus, hypertension, and atrial fibrillation. The diagnosis of diabetes was defined as the presence of diabetes on the problem list, reference to diabetes in any progress note, hemoglobin A1C $\geq 6\%$, or a random plasma blood

glucose ≥ 200 mg/dl. Hypertension and atrial fibrillation were identified by the presence of a problem list entry or other reference in the medical record for either of these conditions.

Statistical Analysis

Sample size estimates were based on reported prevalence of ACE inhibitor (80%) and beta-blocker (26%) use in patients with systolic dysfunction.¹⁴ Assuming a two-sided test with an α of 0.05 and β of 0.2 (80% power), a sample size of 90 in each group was required to detect an absolute difference of 16% in the proportion of patients receiving beta-blockers. This sample was determined to be of sufficient size to also detect a meaningful difference (20%) in the proportion of patients prescribed ACE inhibitors (84% power). A simple random sample of 90 subjects from each group was selected for chart review and analysis.

All analyses were two-sided and P values $\leq .05$ were considered statistically significant. Continuous variables were described by means and standard deviations and compared using parametric (Student's t test) and nonparametric tests (Mann-Whitney-Wilcoxon test) as appropriate. The statistical significance of categorical variables was assessed using the χ^2 test. Odds ratios (OR) with 95% confidence intervals (95% CI) were used to convey the strength of association for primary and secondary objectives. A multivariate unconditional logistic regression model was used to control the primary analysis for potentially confounding variables according to the methods outlined by Hosmer and Lemeshow.¹⁵ Potential covariates considered were age, gender, LVEF, serum creatinine, serum potassium, presence of diabetes, hypertension, or atrial fibrillation, and physician years of practice. Age and gender were retained in the multivariate model regardless of their statistical significance because of their clinical relevance. Data were analyzed with SAS (version 8.1; SAS Institute, Cary, NC) and SPSS (version 11.0.1; SPSS Inc., Chicago, IL) statistical software. There were no conflicts of interest for any of the contributing authors and the study was approved by the Oregon State University and Providence Health System Institutional Review Boards.

RESULTS

A total of 793 patients within the network were identified as having an LVEF $\leq 40\%$. Of these, 431 (54.4%) patient records accurately included a diagnosis of HF in the problem list. The remaining 362 (45.6%) patient records did not contain HF in the problem list. Twenty-nine patients were excluded for not having a chart note indicating the provider's knowledge of HF. Patient characteristics of the selected samples for both groups are shown in Table 1. Age, gender, serum potassium, serum creatinine, and physician years of practice were not significantly different between groups. Patients with HF listed in their problem list had a statistically significantly lower LVEF compared to those patients in the group in which HF was omitted from their problem list (29.5% vs 31.9%; $P=.025$). The prevalence of hypertension was 56.7% among those patients with HF present in their problem list compared to 74.4% in those patients whose HF diagnosis was omitted ($P=.012$).

As shown in Table 2, the use of vasodilators was statistically significantly higher (OR, 3.61; 95% CI, 1.45 to 8.99) among patients with HF present on their problem list (92.2%) compared to patients for whom the problem list entry was ab-

Table 1. Demographics

	Problem List Present (N=90)	Problem List Absent (N=90)	P Value
Age, y (SD)	73.8 (11.8)	74.6 (11.2)	.646
Ejection fraction (SD)	29.5 (7.77)	31.9 (6.91)	.025
Serum creatinine (SD)	1.3 (0.55)	1.4 (0.82)	.737
Serum potassium (SD)	4.6 (0.46)	4.7 (0.71)	.615
PCP years in practice (SD)	18.2 (8.15)	19.49 (7.7)	.279
Female gender, n (%)	35 (38.9)	39 (43.3)	.545
Diabetes mellitus, n (%)	24 (26.7)	29 (32.2)	.414
Hypertension, n (%)	51 (56.7)	67 (74.4)	.012
Atrial fibrillation, n (%)	31 (34.4)	21 (23.3)	.10

SD, standard deviation; PCP, primary care physician.

sent (76.7%). The use of beta-blockers was higher in the group of patients for whom HF was omitted from the problem list (51.1%) compared to the group in which HF was present in the problem list (42.2%), although this difference was not statistically significant (OR, 0.70; 95% CI, 0.39 to 1.26). These findings remained consistent when the analysis was confined to those beta-blockers with a Food and Drug Administration indication for the treatment of heart failure (i.e., metoprolol or carvedilol). The proportion of patients receiving the combined vasodilator and beta-blocker therapy was also similar between groups (OR, 1.10; 95% CI, 0.60 to 2.01).

Three distinct multivariate logistic regression models, and adjusted OR, were constructed for the 3 outcome variables and are presented in Table 2. After adjusting for the covariates age, gender, and LVEF in the multivariate model, the odds of being prescribed vasodilator therapy were still significantly higher among patients with HF accurately entered on their problem list compared to those with HF omitted (adjusted OR, 3.23; 95% CI, 1.28 to 8.16). In the multivariate model predicting beta-blocker use, the presence of hypertension was the only statistically significant covariate observed. The inclusion of age, gender, and hypertension in the model did not change the underlying nonsignificant finding in which patients who had accurate problem list entries were less likely to receive beta-blocker therapy (adjusted OR, 0.79; 95% CI, 0.43 to 1.45). None of the covariates were statistically significant in the multivariate model assessing combination vasodilator/beta-

Table 3. Association Between Problem Listing and Individual Medications

	Problem List Present (N=90)	Problem List Absent (N=90)	Odds Ratio (95% CI)	P Value
ACE inhibitor, n (%)	72 (80.0)	54 (60.0)	2.67 (1.37 to 5.20)	.003
ARB, n (%)	11 (12.2)	15 (16.7)	0.70 (0.30 to 1.61)	.396
BB, n (%)	38 (42.2)	46 (51.1)	0.70 (0.39 to 1.26)	.232
Metoprolol or carvedilol, n (%)	23 (25.6)	31 (34.4)	0.65 (0.34 to 1.24)	.193
Diuretic, n (%)	75 (83.3)	60 (66.7)	2.5 (1.23 to 5.07)	.01
Digoxin, n (%)	55 (61.1)	33 (36.7)	2.71 (1.49 to 4.96)	.001
Spirolactone, n (%)	24 (26.7)	12 (13.3)	2.36 (1.10 to 5.09)	.025
CCB, n (%)	6 (6.7)	5 (5.6)	1.21 (0.36 to 4.13)	.756
NSAID, n (%)	11 (12.2)	11 (12.2)	1.00 (0.41 to 2.44)	1.000

CI, confidence interval; ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blockers; BB, beta-blocker; CCB, nondihydropyridine calcium channel blockers; NSAID, nonsteroidal anti-inflammatory drugs.

blocker therapy. The OR after adjusting for age and gender was identical to the unadjusted OR (adjusted OR, 1.10; 95% CI, 0.60 to 2.02). The Hosmer and Lemeshow tests for all 3 models were not statistically significant, indicating good overall fit. No significant covariate interactions were observed.

The association between individual medications and entry of HF on the problem list were also evaluated (see Table 3). The odds of being prescribed an ACE inhibitor (2.67; 95% CI, 1.37 to 5.20), diuretic (2.5; 95% CI, 1.23 to 5.07), digoxin (2.71; 95% CI, 1.49 to 4.96), and spironolactone (2.36; 95% CI, 1.10 to 5.09) were all significantly higher among patients who had HF on their problem list compared to patients who did not. The proportion of patients who were prescribed medications that are known to exacerbate HF symptoms was also compared between the groups. Analysis found no significant difference in the prescribing of CCB or NSAID in the group of patients with an HF diagnosis present in the problem list compared to those with an omitted diagnosis.

After converting individual ACE inhibitor doses to their respective captopril equivalent, the average daily dose for patients with HF present in the problem list was 106 mg compared to 95 mg for those patients who had HF omitted from the problem list ($P=.416$). The proportion of patients reaching a target dose of greater than or equal to 150 mg daily was not significantly different between groups. Of the 72 patients on an ACE inhibitor in the group with HF on the problem list, 26 were at a target dose (36.1%) compared to 15 of the 54 (27.8%) pa-

Table 2. Primary Outcome

	Problem List Present (N=90)	Problem List Absent (N=90)	Unadjusted OR* (95% CI)	Adjusted OR* (95% CI)
Vasodilator therapy [†]	83 (92.2)	69 (76.7)	3.61* (1.45 to 8.99)	3.23* (1.28 to 8.16)
Beta-blocker [‡]	38 (42.2)	46 (51.1)	0.70 (0.39 to 1.26)	0.79 (0.43 to 1.45)
Vasodilator and beta-blocker [§]	35 (38.9)	33 (36.7)	1.10 (0.60 to 2.01)	1.10 (0.60 to 2.02)

* $P < .05$.

[†]Adjusted for age, gender, and ejection fraction.

[‡]Adjusted for age, gender, and hypertension.

[§]Adjusted for age and gender.

OR, odds ratio; CI, confidence interval.

tients on an ACE inhibitor in the problem list-absent group ($P=.323$).

DISCUSSION

The results of this study demonstrate that patients with systolic dysfunction whose medical record problem list accurately contains the diagnosis of HF are more likely to be prescribed recommended medications as compared with patients whose problem list omits the diagnosis. It is also likely that patients with accurate problem lists received more thorough follow-up as evidenced by the trend toward higher ACE inhibitor doses, a finding supported by Simborg et al.⁶ Although we cannot definitely attribute the benefits seen in this study to accurate problem list entry, patients in this arm of the study would be expected to have survival and hospitalization benefits as a result of higher rates of recommended medication use.^{7,9,16} Meta-analysis of large, long-term randomized controlled trials of patients with systolic dysfunction indicates that ACE inhibitor therapy confers a 1.7% annual absolute risk reduction of death over placebo equaling a number-needed-to-treat value of 59 patients per death avoided over 1 year.¹⁶ If the 20% risk difference in ACE inhibitor prescribing seen in this analysis is truly due to maintaining accurate problem lists, we estimate that for every 295 patients with accurate inclusion of HF, 1 death due to lack of ACE inhibitor therapy would be avoided over 1 year. Additional morbidity and mortality benefits might be seen with improved spironolactone, diuretic, and digoxin therapy.

Our results do not support an advantage for beta-blocker prescribing in the group with accurate problem list entries. Additionally, the study does not provide an explanation for the discordant results between beta-blockers and other recommended therapies for HF. There are several potential reasons for this unexpected finding. Cardiologists may more commonly initiate beta-blocker therapy in systolic dysfunction, as compared to primary care physicians. In our study population, cardiologists did not have access to the problem lists maintained by primary care physicians. A second alternative explanation is that beta-blocker use was confounded by the higher prevalence of hypertension found in the group of patients with HF missing from their problem list. Beta-blockers have long been recommended as initial therapy for patients with uncomplicated hypertension.¹⁷ While the inclusion of hypertension in the multivariate model reduces the association by 13% (unadjusted OR, 0.70; adjusted OR, 0.79), it did not completely explain the trend. Beta-blockers were relatively new therapeutic options for HF at the cross-section date, although evidence supporting their use has been available as early as 1996.¹⁸ Their uptake by primary care physicians was still relatively low (roughly 47% overall) and their use may have still been avoided in HF by some physicians. Finally, neither the adjusted nor unadjusted ORs were statistically significant, indicating that chance could have played a role in producing this unexpected finding.

This study was conducted in a practice-based research network in which all clinics utilize a common EMR. The question arises whether the results are generalizable to ambulatory care settings still using paper charts. The EMR used by these clinics, Logician, is constructed to emulate the appearance and function of a traditional paper record. The problem list is displayed on a "summary page" along with lists of the patient's

medications, allergies, and advance directives. Problem lists are constructed and maintained manually by physicians. Although the EMR can be used to facilitate disease management activities through electronic searches of the problem list database for patient candidates, no such use of this EMR occurred in the study population to affect the prescribing outcomes for HF during or prior to the time period of this study. Based on the similarities in appearance and maintenance of problem lists, we submit that the clinical benefit of accurate problem list entry is also applicable to patients whose ambulatory record is paper based.

This study has several limitations. The cross-sectional design of this study has many well-recognized limitations.¹⁹ Because exposure (HF problem list entry) and outcome (target HF medication) were measured simultaneously, causality is difficult to establish. Through the use of multivariate regression analyses we were able to control for identified confounders. Unfortunately, other unidentifiable confounders may exist. For example, patients with more symptomatic disease could prompt providers to maintain more accurate problem and medication lists. New York Heart Association functional class, which is not always correlated to LVEF, could not be obtained from patient records and therefore was not evaluated in this study.⁷ The severity of systolic dysfunction, as assessed by LVEF, was statistically significantly different between groups. It is conceivable that the 2 groups were also not similar in functional class. There was also a concern that the difference in the 2 groups resulted from some unmeasured physician practice characteristic. Thus, a physician practice characteristic (e.g., compulsiveness) might be the true causal factor contributing to both variation in HF therapy prescribing and completeness of the patient problem list.

Finally, this study did not attempt to assess clinical outcomes associated with problem list omissions, but instead examines prescribing rates as surrogate markers for clinical outcomes. Process-related measures known to impact clinical outcomes are also demonstrated valid indicators of health care quality.²⁰

Conclusion

Patients with physician-acknowledged systolic dysfunction whose ambulatory medical record problem list accurately contains an entry for HF have a higher utilization of vasodilators, digoxin, and spironolactone compared with similar patients whose problem lists omit such an entry. Additional research is needed to evaluate and quantify the true benefits of an accurate problem list on the care of patients.

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12:00-1:00 pm: Interest Group IT09: Geriatrics Interest Group Meeting

Session Coordinator: C Bree Johnston, MD, Associate Professor, University of California, San Francisco

1:30 to 3 pm: Abstract Session D4 Geriatrics. Session Moderators: Claudia Beghé, MD and Christine K. Cassel, MD

5:00-7:00 pm: Poster Session 1

All the geriatrics posters will be grouped together and presented during this session.

7:00-9:00 pm

Keynote Lecture and Reception

If Generalists Defined Quality of Care: What the World Needs From Us

Christine K. Cassel, MD

Friday, May 13, 2005

7:00-8:30 am: Walking Poster Session: Dr. Cassel will lead a "walk and talk" tour of the posters first presented on Thursday evening.

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