

Design and Implementation of an Inpatient Disease Management Program

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Abstract

Objective: To describe the development and implementation of an inpatient disease management program.

Study Design: Prospective observational study.

Patients and Methods: On the basis of opportunities for improving quality or efficiency of inpatient and emergency department care, 4 diagnoses, including congestive heart failure (CHF), gastrointestinal hemorrhage, community-acquired pneumonia, and sickle-cell crisis were selected for implementation of a disease management program. For each diagnosis, a task force assembled a disease management team led by a "physician champion" and nurse care manager and identified opportunities for improvement through medical literature review and interviews with caregivers. A limited number of disease-specific guidelines and corresponding interventions were selected with consensus of the team and disseminated to caregivers. Physician and nurse team leaders were actively involved in patient care to facilitate adherence to guidelines.

Results: For quarters 2 to 4 of 1997, there were improvements in angiotensin-converting enzyme inhibitor use, daily weight compliance, assessment of left ventricular function, hospital costs, and length of stay for care-managed patients with CHF. Differences in utilization-related outcomes persisted even after adjustment for severity of illness. For the

other 3 diagnoses, the observational period was shorter (quarter 4 only), and hence preliminary data showed similar hospital costs and length of stay for care-managed and noncare-managed patients.

Conclusions: An interdisciplinary approach to inpatient disease management resulted in substantial improvements in both quality and efficiency of care for patients with CHF. Additional data are needed to determine the program's impact on outcomes of other targeted diagnoses.

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Interest in the use of clinical practice guidelines has been heightened in the past several years by the exponential increase in healthcare expenditures in the United States (both as dollars and as proportion of the Gross National Product),¹ and by growing concern over the quality of medical care. Researchers have noted unexplained variations in medical practice among geographic regions,² hospitals,³ and individual providers.⁴ Because of these concerns, healthcare institutions and third-party payers are increasingly profiling physicians for specific quality measures and also monitoring consumption of resources. Another route to addressing these problems has been through the development of several thousand different guidelines to standardize best practice care.⁵

Despite the numerous guidelines developed, dissemination to relevant clinicians, implementation, and adherence to guidelines are often problematic.

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Despite the use of multiple approaches,⁶⁻¹¹ the success of the guidelines in effecting actual changes in practice has been variable, and 2 large reviews of the literature have yielded different conclusions regarding their overall benefit.^{12,13} One review concluded that there is very little evidence that guidelines improve patient outcomes,¹² whereas the other found that explicit guidelines do improve practice.¹³ However, the latter study acknowledged that the size of improvements vary considerably.¹³

To address increasing costs of inpatient care and to standardize and improve the efficiency and quality of inpatient care, a Quality Disease Management Program (QDMP) was jointly developed in 1996 in the Department of Medicine of a large, urban academic medical center by department leadership and hospital administration. Although several care paths had been in place for the previous 5 to 10 years, physician adherence was typically very low and few measurable changes in patient outcome were documented.¹⁴ The objective of the QDMP was to identify medical diagnoses that accounted for a large patient volume and for which quality or costs of care could be improved. For each diagnosis, a few key interventions were developed and implemented by a physician team leader and nurse care manager. In this manuscript, we describe the design, implementation, and preliminary results of the QDMP.

... METHODS ...

Selection of Diagnoses and Program Design

A task force was assembled to develop a strategy for standardizing and improving the quality and efficiency of care for medical inpatients. The group decided to focus on the care of patients with specific diseases or diagnoses, identified by diagnosis-related group (DRG) criteria. This allowed data from the hospital's financial database to be retrieved, analyzed, and compared with other institutions in the region and in the University Hospitals Consortium (a national organization of academic medical centers).

Diagnoses were selected by subjective assessment of (1) opportunity for improvement, (2) uniformity of disease type and treatment within a DRG, and (3) interests and expertise of the faculty of the Department of Medicine. Opportunity for improvement was determined by comparing medical practice and outcomes for specific diagnoses at University Hospitals of Cleveland with those of institutions in the region and in the University Hospitals

Consortium and with those reported in the medical literature. DRGs that include one or a few diagnoses that lend themselves to common medical management (eg, pneumonia, congestive heart failure [CHF]) were favored over those that include a variety of maladies (eg, esophageal and gastrointestinal disorders, which include reflux esophagitis, constipation, and *Clostridium difficile* enteritis).

The task force also reviewed previous efforts at University Hospitals of Cleveland, as well as quality improvement programs at other institutions. At University Hospitals of Cleveland, care paths had previously been developed for the inpatient care of patients with several diagnoses, including CHF, gastrointestinal bleeding, and asthma. These care paths had met with varied success. The asthma care path had been very successful, with more than 90% of patients with asthma treated according to the majority of care guidelines.¹⁴ The CHF care path was less successful—fewer than 25% of patients admitted with CHF were enrolled in the care path. Moreover, although length of stay and quality of care had improved somewhat for patients in the CHF care path, the results for the DRG, as a whole, did not differ from baseline.

The framework of the QDMP was based, in part, on previous studies of interventions to change physicians' practices and included factors such as education, feedback, participation of physicians in the effort, and administrative rules.¹⁵ In addition, medical housestaff, part-time faculty (private practitioners), full-time faculty, nurses, pharmacists, and therapists were interviewed and the medical literature was reviewed to identify determinants critical to the success of the new program (Table 1). Each of these issues was factored in the design of the new program, a conceptual model of which is shown in the Figure. Physician leadership was considered critical for success. Although previous care paths had been designed by physicians, a physician leader was not always involved in the implementation of the guidelines, and thus, was typically not available to discuss problems or questions related to the care path. Caregivers had to be made aware of the guidelines, and importantly, the guidelines had to be readily available for optimal effectiveness. Feedback was a key step in the process, serving to inform caregivers of the success or failure of interventions, compare performance among peers, and maintain interest in the guidelines. Another important consideration was that the guidelines be simple and easy to use and not be an added complication for caregivers. The guidelines were also likely to be more success-

ful if they were aligned with any incentives to physicians, nurses, or the hospital. A final and important determinant of success was the development of consensus among caregivers. Previous experience had shown that care paths developed by one or a handful of individuals were unlikely to be used by caregivers whose opinions varied from the guidelines and who felt disenfranchised. Other interventions, such as financial incentives and penalties, were not included at this stage.¹⁵

A “physician champion” for each diagnosis was selected from junior or senior full-time faculty members on the basis of expertise, respect of peers, and interpersonal and communication skills and was responsible for the design and implementation of care guidelines for the diagnosis. Physician champions were compensated for their time and effort, with a 20% full-time equivalent (FTE) stipend in year 1 and a 5% FTE stipend in subsequent years. Each physician champion led a disease management team that subjectively assessed opportunities for improvement and included a spectrum of caregivers (faculty and private physicians, housestaff, nurses, pharmacists, therapists) relevant to the diagnosis. Team members were expected to represent their colleagues in their practice group regarding the care of patients with the diagnosis and to serve as ambassadors for the program, encouraging their peers to use the guidelines.

Establishing Consensus

Before programs for specific diagnoses were disseminated and implemented, it was crucial to ensure that guidelines, even if developed from the evidence-based literature, were in agreement with consensus opinion. Several methods were used to achieve consensus.

First, in addition to the physician champion and nurse care manager, all disease management teams included at least one other member of the full-time faculty and representatives from each of 3 major private practice groups who admit patients to the hospital. Before drafts of guidelines were released, all team members had to support their content unanimously.

Second, a cross-section of healthcare providers involved in the management of patients with that diagnosis were interviewed to determine factors that impeded the efficiency or quality of care and to obtain informal opinions about the proposed guidelines.

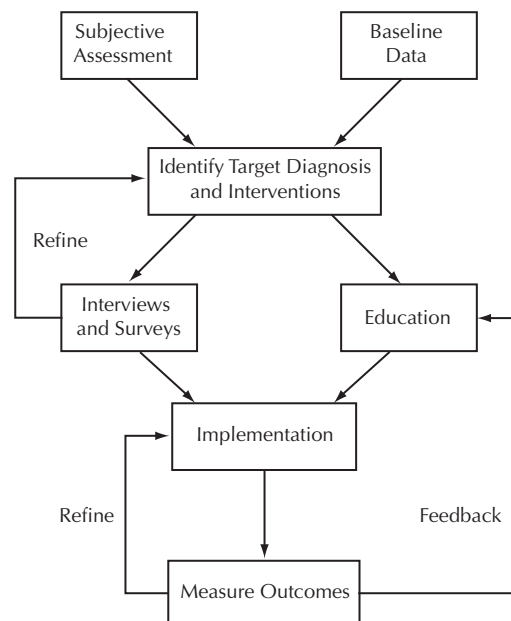
The third phase involved mailing surveys to all admitting physicians in general internal medicine,

family practice, and if applicable, specific subspecialties, using the Delphi technique.¹⁶ The purpose of the surveys was to obtain additional consensus and to provide an opportunity for all physicians to be involved in guideline development. When con-

Table 1. Factors Identified as Critical to the Success of Disease Management Programs

Physician leadership
Awareness
Availability
Feedback
Ease of use
Incentives
Consensus

Figure. Conceptual Model for Changing Physician Behavior within the Organizational Context of the Quality Disease Management Program



sensus could not be reached, alternative interventions were developed. For example, in CHF, there was agreement that optimizing drug therapy and weight recording and using echocardiography judiciously would decrease resource utilization and optimize inpatient management; however, other potential interventions, such as limiting the use of monitored beds, were not pursued because of lack of consensus on appropriate clinical criteria.

Educational Strategy

The goal of educational programs in the QDMP was to facilitate adherence of participating physicians and other healthcare providers to specific care guidelines. To accommodate geographically diverse physician groups and differences in learning styles, multiple educational components were developed, including Medical Grand Rounds, noon housestaff conferences, and monthly medical management conferences for the largest private practice group. All presentations included the background and content of guidelines, and continuing medical education credits were offered as an additional incentive to attend. Nurse care managers also presented their respective programs at the semimonthly hospital nursing leadership meetings. Finally, many of the physician leaders and nurse care managers met briefly on a monthly basis with each housestaff team to reinforce key components of their program, convey changes in design, and provide an opportunity for feedback. Because of housestaff turnover, repeated formal and informal presentations were critical for maintaining awareness of guidelines.

Another educational tool was a series of mailings, which included comprehensive guideline material contained in a 3-ring binder and pocket-sized laminated cards that summarized the guidelines. A series of audiotapes on disease management topics was developed to accommodate physicians who could not easily attend formal lectures. Each tape, recorded by program leaders and team members, was devoted to 1 diagnosis and included discussions of the care guidelines. Physicians could obtain continuing medical education credits by listening to the tape and completing a brief written examination.

Patient Accrual

Care managers screened medical records of patients whose admitting diagnosis or related symptoms suggested eligibility for the program. Because caregivers were encouraged to inform program

personnel of admissions as early as possible in the hospitalization, the care manager or physician champion was frequently contacted at the time of admission. When patients with appropriate diagnoses were not admitted to the program (noncare managed) the reason primarily was that the nurse care manager was on vacation or the patient was admitted briefly during a weekend or holiday. Patients were also not screened if the admitting diagnosis did not appear relevant or if the patient was admitted to observation status and did not appear in the admitting log.

Patients were considered to be care managed if the QDMP personnel made guideline-based recommendations, regardless of whether they were adhered to or not. Noncare-managed patients were identified after discharge through review of all records with corresponding principal diagnoses.

Analysis

For each QDMP diagnosis implemented in 1997, hospital length of stay and costs were compared between care-managed and noncare-managed patients. Because the unit of analysis was hospitalization, rather than the patient, readmitted patients were included more than once. Comparisons were made only for the quarter(s) (Q) that the program was implemented, which was April to December (Q2 to Q4) for CHF and October to December (Q4) for the other 3 diagnoses, namely, gastrointestinal bleeding, community-acquired pneumonia, and sickle-cell crisis. Hospital costs were calculated using commercially available software (Eclipsys Corporation, Delray Beach, FL) and were the sum of 9 mutually exclusive categories, including variable labor, variable supplies, variable "other," variable indirect, fixed direct labor, fixed direct equipment, fixed direct facilities, fixed direct "other," and fixed indirect. Specific categories were designated within each of the 9 cost types.

Severity of illness was determined for each patient with the all patient refined diagnosis-related group (APR-DRG) classification, a diagnosis code-based measure that was developed to predict resource consumption for a given DRG.¹⁷ The APR-DRG categorized each patient's illness by complexity subclasses consisting of levels 1 (minor), 2 (moderate), 3 (major), and 4 (extreme). Severity distribution, process measures, and outcomes were compared between care-managed and noncare-managed patients with the chi-square and Wilcoxon rank sum tests for categorical and continuous variables,

respectively. In addition, length of stay and hospital costs among patients with CHF at each illness severity level were compared with the Wilcoxon rank sum test. Because of the skewed distribution of length of stay and hospital costs, averages were expressed as median and interquartile range (Q1, Q3).

...RESULTS...

Congestive Heart Failure

CHF is the medical DRG associated with the largest patient volume at University Hospitals of Cleveland and accounts for more than 700 discharges annually. Because a care path for CHF had previously been developed, the QDMP for this diagnosis was the first to be implemented. In addition to the generic goals of reducing length of stay and costs, 3 disease-specific goals were identified (Table 2). Data from Q2 through Q4 of 1997 indicate that compared with noncare-managed patients (n = 126), care-managed patients (n = 283) had a higher rate of angiotensin-converting enzyme (ACE) inhibitor use on discharge (95% vs 75%; $P < .001$), increased compliance with daily weight-monitoring guidelines (69% vs 50%; $P < .001$), and increased documentation of left ventricular function (81% vs 58%; $P < .001$). A comparison of the care-managed and noncare-managed groups revealed that during the 9 months that the QDMP was implemented, average length of stay was approximately 2 days shorter in the care-managed group (mean, 3.8 vs 5.7 days; median 3 vs 5 days; [Q1, Q3], 2, 5 vs 3, 8 days; $P < .001$), and average hospital costs were approximately \$2000 lower (mean, \$3452 vs \$5735; median, \$2934 vs \$4830; [Q1, Q3] \$1991, \$4251 vs \$3168, \$7099; $P < .0001$). An annual savings of \$700,000 was projected based on the cost reduction in care-managed patients.

Length of stay and hospital costs did not appear to decrease with time. For example, the median lengths of stay for care-managed patients in Qs 2, 3, and 4 were 3, 4, and 3 days, respectively, and for noncare-managed patients, 4.5, 5, and 6 days, respectively. The corresponding values for costs were \$2863, \$3246, and \$2781, respectively, for care-managed patients and \$4800, \$4589, and \$5848, respectively, for noncare-managed patients.

After severity of illness was adjusted for with the APR-DRG system, care-managed patients were shown to have less severe illness than noncare-

managed patients (Table 3). As shown in Table 3, however, length of stay and costs were lower among care-managed patients within the 3 highest severity classes, suggesting that overall differences could not be ascribed solely to case-mix.

Gastrointestinal Bleeding

Guidelines initially focused on upper gastrointestinal tract hemorrhage, because of the greater consensus for care of this illness within the gastroenterology community (Table 2). Processes targeted to optimize quality and efficiency of care were decreased time to endoscopy to provide early risk

Table 2. Principal Targets for the Inpatient Disease Management Program

<p>Congestive Heart Failure</p> <ul style="list-style-type: none"> • Increase use of angiotensin-converting enzyme (ACE) inhibitors. • Increase practice of monitoring weight daily before morning physician rounds. • Avoid echocardiograms for patients with previous assessment of left ventricular function. <p>Upper Gastrointestinal Bleeding</p> <ul style="list-style-type: none"> • Eliminate routine use of intravenous histamine-2 receptor blockers. • Perform endoscopy early to triage risk of rebleeding. • Eliminate routine use of chest and abdominal radiographs. • Test for and treat <i>Helicobacter pylori</i> infection in patients with bleeding peptic ulcers. • Educate patients about the risk of aspirin and nonsteroidal anti-inflammatory drugs for ulcer recurrence and rebleeding. <p>Community-Acquired Pneumonia</p> <ul style="list-style-type: none"> • Administer intravenous antibiotics on a routine basis in the emergency department. • Switch to oral antibiotics as soon as a patient is clinically stabilized. • Make appropriate use of bacterial cultures and chest radiographs. <p>Sickle-Cell Crisis</p> <ul style="list-style-type: none"> • Develop individualized pain management protocols. • Discourage use of meperidine in favor of morphine, hydromorphone, and levorphanol. • Use buprenorphine for patients with known or suspected narcotic dependence.
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stratification, decreased use of specific medications (eg, intravenous histamine-2 blockers) and ancillary tests (eg, radiographs) that were of questionable benefit and that led to large aggregate costs, and enhanced patient education to modify risk factors for bleeding recurrence. More recently, interventions designed to increase rates of *Helicobacter pylori* testing have been implemented.

Because the program was not implemented until the latter part of 1997, only limited severity-adjusted outcome data were available (40 care-managed and 45 noncare-managed patients). For Q4, the care-managed and noncare-managed groups were similar with respect to hospital length of stay (median, 3 vs 3 days; Q1-Q3 2, 6 vs Q1-Q3 2, 4; $P = .34$) and costs (median, \$3206 vs \$2855; Q1-Q3 2536, 5077 vs Q1-Q3 2237, 5318; $P = .46$). Severity of illness in the 2 groups of patients was similar (2.5, care managed vs 2.4, noncare managed; $P = .61$). The guidelines, however, were successful in reducing the use of intravenous histamine-2 blockers from 52% to 30% of patients ($P < .001$), with an average decrease in units used from 6.8 to 3.6 per

patient ($P < .001$). Radiograph use was unchanged (91% vs 90%; $P = .9$). Other interventions such as *H pylori* treatment and educating patients to avoid ulcerogenic drugs were expected to impact posthospitalization outcomes, such as readmission for bleeding ulcers, but these data were not available.

Community-Acquired Pneumonia

The community-acquired pneumonia program was designed for patients without suspicion of aspiration or immunocompromised status, and specific goals were defined (Table 2). The major strategy was to establish an emergency department protocol for administering intravenous antibiotics within 3 hours of presentation, compared with a baseline of 8 hours. To promote early use of antibiotics in patients admitted from a physician's office, a supply of parenteral antibiotics was also stocked on selected medical units. Early antibiotic therapy and obtaining a blood culture before antibiotic administration were previously shown to improve patient outcomes after pneumonia.¹⁸

For the fourth quarter of 1997, which is the only time period that severity-adjusted comparisons were available, there were 62 care-managed and 46 noncare-managed patients. The care-managed and noncare-managed groups were similar for average length of stay (median, 4 days vs 4 days; Q1-Q3 3, 6 vs 3, 6; $P = .95$) and costs (median, \$3924 vs \$4035; Q1-Q3 \$3025, \$4893 vs Q1-Q3 \$2459, \$6121; $P = .91$). Severity of illness was comparable between care-managed and noncare-managed patients (2.5 vs 2.6; $P = .39$). The program was able to reduce the average time to antibiotic administration to 2.75 hours and 4.25 hours for emergency department and office admissions, respectively, from a baseline of 8.7 hours ($P < .001$).

Sickle-Cell Crisis

Sickle-cell anemia is a disorder that primarily mani-

Table 3. Case-Mix and Severity-Adjusted Length of Stay and Costs for Care-Managed and Noncare-Managed Patients with Congestive Heart Failure

Severity Level	Care Managed (n = 283)	Noncare Managed (n = 126)	P
No. of patients (%)			
1	16 (5.7)	4 (3.2)	.001
2	152 (53.7)	41 (32.5)	
3	94 (33.2)	62 (49.2)	
4	21 (7.4)	19 (15.1)	
Median (Q1, Q3) Length of Stay (days)			
1	3 (2, 4)	2.5 (2, 3.5)	.88
2	3 (2, 4)	4 (2, 5)	.04
3	4 (3, 5)	6 (4, 8)	.0001
4	5 (3, 7)	7 (5, 10)	.02
Median (Q1, Q3) Total Costs (\$)			
1	2317 (1575, 3278)	2409 (2053, 3270)	.67
2	2552 (1797, 3744)	3541 (2277, 4854)	.009
3	3457 (2567, 4605)	5395 (3513, 6699)	.0001
4	4528 (2648, 6897)	8378 (6927, 10,419)	.002

fects as pain crisis. Because of the subjective nature of pain, varied response to pain medications, and psychosocial barriers that may be present in some patients, it was difficult to design a truly standardized care plan for sickle-cell pain crisis, in contrast to the other diagnoses. Additionally, although the overall incidence of narcotic addiction and dependence may be low, 9 patients with sickle cell disease accounted for more than 50% of the inpatient admissions at our institution, as well as a large number of emergency department visits for pain control. Thus, one of our goals was to promote the use of analgesics that cause less euphoria. An advantage of sickle-cell anemia, with respect to developing and implementing a care path, is that patients can be readily identified and cared for by a limited number of attending physicians, primarily hematologists. Individualized care plans were constructed for frequently admitted patients and were entered into the hospital's main-frame computer for easy access by housestaff and attending physicians (Table 2).

For the limited study period (58 care-managed and 9 noncare-managed admissions), unadjusted hospital length of stay (care managed: median, 3.5 days; Q1-Q3 2, 4; noncare managed: median, 4 days; Q1-Q3 3, 4; $P = .54$) and costs (care managed: median, \$2920; Q1-Q3, \$1969, \$3907; noncare managed: median, \$3157; Q1-Q3, \$2896, \$3952; $P = .32$) were similar between groups. Severity of illness was similar (care managed, 2.1 vs noncare managed, 1.9; $P = .45$). Nonetheless, the program was successful in reducing the use of the nonguideline narcotic meperidine from 82% to 18% ($P < .001$) without an apparent increase in perceived pain. Other targets, such as reduced emergency department visits and hospital readmissions, were longer-term objectives.

... DISCUSSION ...

A multitude of studies have evaluated the impact of clinical decision aids, prediction rules, and other interventions on outcomes of inpatients with a variety of diagnoses. Interventions have ranged from continuing medical education⁶ to ongoing active care management⁷⁻¹³ and have met with varied success. The scope of individual programs has also varied, ranging from specific, well-defined interventions¹⁹⁻²⁴ to comprehensive care management programs.¹⁴

Our program, which entailed active daily involvement by a nurse care manager and faculty physician team leader, resulted in measurable improvements

in the quality and efficiency of care for hospitalized patients with CHF. Although only limited data were available for the QDMPs for the other 3 diagnoses that were implemented later, changes in disease-specific process measures (eg, time to administration of intravenous antibiotics) were observed. Care paths implemented approximately 2 years earlier in our institution for other medical diagnoses, however, had not led to any changes in measured outcomes, suggesting that in our hospital, the presence of guidelines alone is not sufficient to effect change, and that active team involvement appears necessary. Rather than assuming care of the patient, the nurse care manager wrote daily notes in the chart and made recommendations based on consensus guidelines. The physician team leaders were available to assist in clinical decisions related to the guidelines (eg, whether to use ACE inhibitors in a patient with renal dysfunction) and to intervene with attending physicians who did not embrace the guidelines. The faculty member did not serve as a formal consultant, however, and for patients with complex illness, frequently recommended a subspecialty consultation.

The program also differed from previously developed care paths, which had included comprehensive orders related to all aspects of patient care, in that no more than 5 key clinical guidelines were implemented for each diagnosis. These recommendations, which were based on the medical literature and consensus among caregivers, provided an evidence-based approach to inpatient care. The use of a finite number of guidelines, rather than a complex care path, was also more conducive to caregiver education (both in the context of formal presentations and printed materials). Future efforts will involve integrating the guidelines with the hospital's computerized order entry system, which may provide for real-time feedback and a more systematic method of tracking resource utilization. This approach, for example, has been successful at other institutions in reducing specific antibiotic use.²⁵

Although the development and implementation of the program is associated with fixed costs, primarily care manager and physician salaries, the potential benefits in reducing costs and improving quality of care are greater. In addition to the projected annual savings of \$700,000 for CHF alone, qualitative measures such as patient satisfaction and functional status are also anticipated to improve. Moreover, with increased managed care penetration, which will include a larger at-risk population, interventions such as ACE inhibitor use and *H pylori* treatment

should reduce readmission rates and thereby decrease long-term costs.

In general, the most consistent success in previous studies has been observed for care of patients admitted to the hospital with chest pain. Interventions consisting of concurrent audit and feedback^{19,20} with opinion leader support¹⁹ have reduced length of stay without adversely affecting quality of care. By contrast, despite the development of well-designed practice guidelines for pneumonia²¹ and CHF,²² implementation of these programs has not led to measurable changes in length of stay.^{23,24} Thus, interventions that have relied only on distribution of critical pathways or algorithms have not been as successful as those that included active involvement.

Several reasons may account for the variation in the effectiveness of interventions. First, an illness such as CHF, which includes both systolic and diastolic dysfunction and for which underlying causes vary, may lend itself less to protocol-driven care and more to individualized input. Despite the failure of a previously developed care path for CHF, this study shows that individualized active intervention by a nurse care manager and physician champion can result in significant improvement in both quality and efficiency of care. Second, practice patterns, including thresholds for admission and discharge may be continually changing, independently of care guidelines. Third, the effectiveness of interventions can vary substantially depending on design—continuing medical education⁶ and audit and feedback^{7,8} are generally less effective than academic detailing¹⁰ or the use of physician opinion leaders.¹¹ We therefore adopted a multipronged approach for our program. Finally, because of differences in practice patterns, prevailing attitudes, or case-mix, guidelines may not be universally applicable.²⁶ Therefore, although we used the medical literature to identify the best practice for our program, other methods such as interviews with key caregivers, mail surveys, formal and one-on-one (ie, academic detailing) educational presentations, and concurrent and summary feedback were included to ensure consensus and feasibility. Many of these techniques were adopted from the literature on effecting changes in physician behavior.¹⁵

We recognize 4 potential limitations of the study. First, the APR-DRG system for severity adjustment, which uses diagnosis codes to measure comorbid conditions and extent of disease,¹⁷ is imperfect and may be biased by random or systematic errors in

coding. Moreover, it does not include physiologic measures (eg, left ventricular ejection fraction or orthostatic changes with acute hemorrhage). The APR-DRG score, however, is a nationally used severity measure and was associated with both hospital length of stay and costs for patients with CHF. Second, unmeasured severity of illness may have accounted for some of the differences in hospital length of stay or costs between care-managed and noncare-managed patients with CHF. Third, the program was implemented at a single academic medical center and may not be generalizable to other settings. Fourth, because of the small sample size associated with 3 of the diagnoses, the power to detect statistically significant differences was limited. For example, the calculated power for measuring differences in length of stay was no higher than 40% (7% for gastrointestinal hemorrhage, 25% for pneumonia, and 40% for sickle-cell crisis), and for hospital costs was no higher than 50% (11% for sickle-cell crisis, 13% for pneumonia, and 50% for gastrointestinal hemorrhage).

In summary, we have developed and implemented an inpatient disease management program, with the goal of optimizing both quality of care and resource utilization. For the CHF program, which was implemented first, measurable changes in both resource utilization and quality outcomes were documented. Within the limited study period for the other 3 diagnoses, outcomes of patients were similar, but more data are needed to determine the long-term impact of the programs. Future challenges for the program will be to include more admitting physicians, add other diagnoses, and incorporate ongoing changes in the local healthcare system.

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