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TRANSFORMING HEALTHCARE

ACEi/ARB for Systolic Heart Failure: Closing the Quality Gap With a Sustainable Intervention at an Academic Medical Center

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BACKGROUND: National guidelines recommend angiotensin converting enzyme inhibitor (ACEi) or angiotensinogen receptor blocker (ARB) therapy for patients with left ventricular systolic dysfunction (LVSD), including those with symptomatic heart failure (HF). However, guideline adherence has not been optimal. The goal of this quality improvement project is to devise and implement a sustainable care-delivery model in a 920-bed academic hospital center that would improve ACEi/ARB adherence before hospital discharge.

METHODS: The Model of intervention is: (1) a computer-based daily screening program; (2) inpatient pharmacist e-flag message; and (3) alerts for inpatient care teams. Its operating algorithm: If eligible adult HF/LVSD inpatients are not on ACEi or ARB nor documentation of contraindications, a flag alert is generated; deficiency is confirmed by a pharmacist and conveyed to the patient-care teams; if alert is acted on and care brought into adherence, the screening program would not re-flag the same patients the succeeding day; if not, the patients would be re-flagged daily until reaching adherence. We compared ACEi/ARB adherence before, during, and after the intervention.

RESULTS: Baseline performance (percentage of eligible HF/LVSD patients receiving ACEi/ARB) was 87.5%. After implementation of the Model the ACEi/ARB adherence rate at the time of hospital discharge rose to 96.7% ($P < 0.002$) and was sustained for 21 months without needing additional personnel.

CONCLUSIONS: A carefully designed, computer-based care-delivery model is highly efficient and sustainable for enhancing ACEi/ARB adherence. ***Journal of Hospital Medicine*** **2011;6:156–160.** © *2010 Society of Hospital Medicine.*

KEYWORDS: ACEi/ARB guidelines, adherence, computer-based model, cost, heart failure, quality improvement.

Heart failure (HF) carries a high rate of morbidity and mortality.[1] In the past decades, the incidence of HF and HF-related hospital admissions has risen continuously, posing a formidable healthcare and economic burden.[2–4] Extensive evidence has shown that treatment of angiotensin converting enzyme inhibitors (ACEi) and angiotensin receptor blockers (ARBs) reduces morbidity and mortality and improves quality of life in patients with HF and left ventricular systolic dysfunction (LVSD).[5–7] Consequently, ACEi/ARB utilization in HF and LVSD has become one of the practice guidelines[8] and a nationally required quality performance measure by The Joint Commission (TJC, formally known as JCAHO) and Centers for Medicare & Medicaid Services (CMS).

Despite the well-demonstrated salutary effects and clear guidelines, under-utilization of ACEi/ARB for HF patients has repeatedly been demonstrated.[9–11] There seems to be a lasting "quality chasm" between the lifesaving therapy and its utilization in our practice.[12] This chasm is illustrated by a recent study of 54,453 U.S. patients who were hospitalized for HF and discharged alive, showing that use of proven therapies such as ACEi/ARBs remains far from sufficient (48% for the total HF patients and 52% for HF patients with prior myocardial infarction).[11] In large academic hospital centers, the ACEi/ARB utilization for HF patients has averaged between 83–88%.[13]

Strides have been made to bridge the chasm;[14–19] however, these efforts have been impeded by complex and multifaceted problems. One of these problems is the sheer number of HF patients. In the current economic environment, traditional methods of pouring in more resources are unsustainable. Yet, the majority of quality improvement methods tried thus far involve increasing manpower, intensifying the delivery of staff and patient education, applying multiprong intervening systems, and prolonging the duration of the patients' hospital stay.[14–22]

Although most of these measures achieve their intended goals, ongoing cost is required and the sustainability remains doubtful. Health information technology (IT) is emerging as a promising tool for improving care quality and containing cost.[23] The electronic medical record (EMR) system at Mayo Clinic Rochester is built upon an IT patient

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record platform of Last Word (formerly a product of IDX, now General Electric, Fairfield, Connecticut) and has the capability of receiving vast input from databases in each department in our institution. In recent years, Mayo Clinic also has developed an IT hospital rule (algorithm)-based system (HRBS) for comprehensive, multidisciplinary patient monitoring and cost containment (detailed in ref. 24). Pharmaceutical Care (P-Care) is 1 of the 6 subsystems under HRBS. P-care has been used primarily by inpatient pharmacists to detect situations where there is a high probability of suboptimal medication prescribing and where intervention by a pharmacist may be beneficial.

The primary goal of this project was to improve ACEi/ARB adherence for inpatients in a manner that would be sustainable. We intended to incorporate the existing features of our EMR as well as modify and utilize the P-Care system to create a model that would improve ACEi/ARB adherence and work well with work-flows of inpatient pharmacists and patient-care teams.

Methods

Setting

Saint Mary's Hospital, a 920-bed facility of the Mayo Clinic Rochester, has 30 individual care units, 1000 staff physicians and 1900 trainees. Approximately 900 patients with a primary admission diagnosis of HF and LVSD are discharged annually. This study was approved by the Institutional Review Board.

Planning the Intervention

An ACEi/ARB team, formed in 2005, was a subgroup of the institutional HF Quality Improvement Team, comprised of quality specialists, a computer programmer from the IT department, a pharmacist, nurses, hospitalists and specialists from cardiology and nephrology.

The group identified three root causes for ACEi/ARB non-adherence: (1) Unawareness of practice guidelines; (2) information overload and distraction, especially for patients with multiple co-morbidities; eg, a low left ventricular ejection fraction (LVEF) finding might be buried among stacks of information and go unrecognized and, (3) under-documentation of legitimate ACEi/ARB intolerance in the designated area (Allergy-Intolerance Module) within the institutional EMR system.

Implementation of the Intervention

The intervention Model included three components: a computer-based daily screening program developed from the existing P-Care rule,[24] inpatient pharmacists, and inpatient care teams. The interventional algorithm is illustrated in Figure 1. The computer-based screening program that retrieved patients' LVEF data from EMR was up and running by the first quarter of 2006. A major attribute of the existing IT systems at Mayo Clinic has been that, however enormous, the data (input daily from diverse sources within the institution) are entered in a discrete, searchable and extractable format, which is critical for the data utilization. In the second quarter of 2006, we began an intense Plan-Do-Study-Act (PDSA) cycle through multidisciplinary teamwork. To monitor e-flagging efficiency, we randomly selected five units, manually monitored the number of patients who failed ACEi/ARB adherence and compared the number with that generated by the screening program. We found that the capturing rate was 100%.

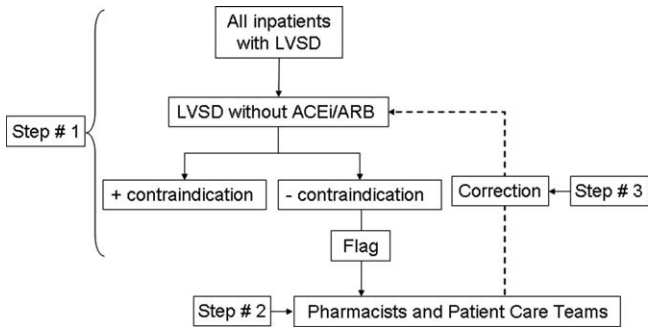

FIGURE 1. Flow diagram of the Model, including Steps 1 to 3. Step 1: The computer-based program screens all inpatients daily for HF with a left ventricular ejection fraction (LVEF) of < 40% (in the rest of this paper, this group of patients are addressed as HF/LVSD patients). Those with HF/LVSD, but not on ACEi or ARB nor documentation of ACEi/ARB contraindications, would be flagged. Step 2: The flagged patients would be examined by pharmacists, and the patient-care teams notified to address the deficiency. The notification contained a concise version of the current ACEi/ARB guidelines. The notification process was later modified to e-message. Step 3: After this communication, the patient-care team would either start the patient on ACEi/ARB or document ACEi/ARB allergy or intolerance in the EMR system (Allergy-Intolerance Module) within 24 hours after the e-message delivery. After the correction, the screening program, which re-screened all HF/LVSD patients daily, would detect the change the following day and would not re-flag the same patient. If the correction was not made, the same patient would be re-flagged and a pharmacist would contact the patient-care team.

Several problems were encountered with the model's operating process during implementation. The flagged list generated by the screening program was examined first by a pharmacist who then prepared a written note, indicating the deficiency along with a concise version of the guidelines. This note was placed in the patients' chart. Alternatively, the pharmacist might notify the patient-care team by phone or in person during the teams' on their rounds.

However, notes were sometimes lost or overlooked, and verbal communications were inconsistent. In addition, the pharmacists were sometimes unsure whether, under certain clinical conditions (eg, serum creatinine elevation amidst diuresis), a HF patient should receive ACEis/ARBs.

Occasionally, care teams objected to the calls and viewed visits by pharmacists as interruption of their work flow resulting in awkward, and sometimes ineffective communications. Thus, the model seemed to have generated sizable extra work for the pharmacists and there was a notable time-lag

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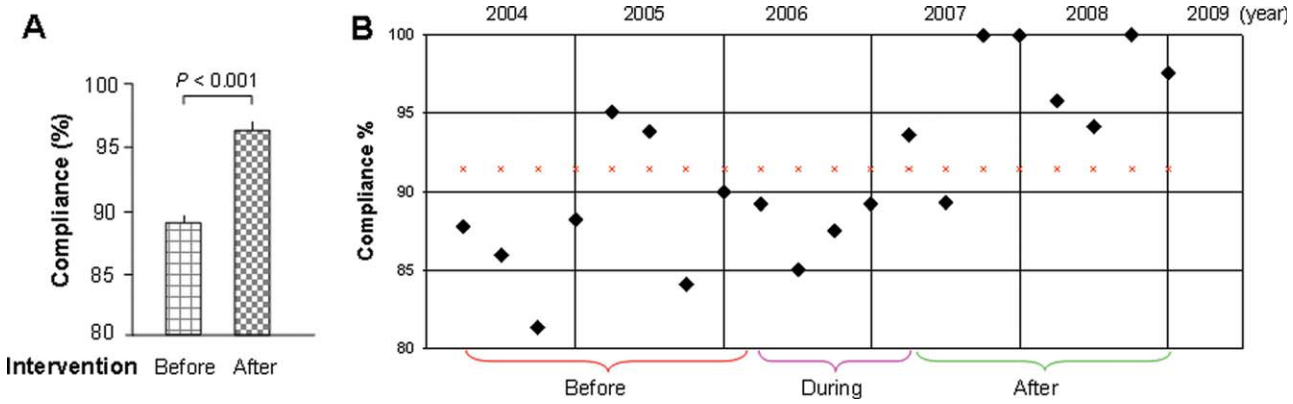

FIGURE 2. The percentage ACEi/ARB adherence before (2004 to March 2006), during (April 2006 to March 2007) and after (April 2007 to December 2008) the implementation of the model. A: The percentage adherence before and after the intervention. B: The quarterly sensor (indicated by ♦) of the percentage adherence from 2004 to 2008. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

between the generation of the flag-list and the successful delivery of the message.

To solve these problems, with the advantage of a programmer on the team, we created an electronic message (e-message) delivery function within our EMR. When a patient-care physician accesses the patient's information in EMR, a prompt indicating e-message would appear. This modification allowed pharmacists' verification and an e-message to be semiautomatically delivered to the patient-care team. If the problem (non-compliance to ACEi/ARB guidelines) was not addressed within 24 hours after the e-message delivery, a pharmacist would then contact the team by phone or face-to-face. Additionally, an inpatient nephrologist was made available to answer any clinical questions that the pharmacists might have. We found that with these modifications the vast majority of the flags were corrected within 24 hours and pharmacists' workload was markedly reduced. After several initial communications between pharmacists and the nephrologist, the input by the nephrologist became minimal as pharmacists grew more accustomed to the majority of case scenarios.

Through such PDSA cycles, the operating process improved progressively. By March 2007, the implementation was complete and the model ran smoothly to the satisfaction of the team and other stakeholders.

Methods of Evaluation

To determine the effectiveness of the model, we examined the number of patients whose ACEi/ARB status changed as a result of the model and the overall ACEi/ARB guideline adherence at the time of hospital discharge in HF/LVSD patients with a primary admission diagnosis of HF. These guideline adherence data in this patient population, reported periodically to TJC and CMS as part of inpatient quality measurement, were collected by methods in accordance with the Population and Sampling Specifications set forth by CMS (www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQne tTier4&cid=1203781887871). Because the adherence data were not collected specifically for our project, we eliminated the potential bias from data collection.

Statistical Analysis

We compared the institutional data from before, during, and after the implementation of the model. We closely tracked the timing of the intervention and the corresponding outcomes. Pearson's chi-square test was employed for comparison among three groups, and Fisher's Exact test for pairwise comparisons. All data are expressed as mean frequency (in %) and a 2-tailed P value of < 0.05 was considered statistically significant.

Results

Rate of the Screening Program Utilization

Daily census was 650 to 700 patients; eligible patients with LVSD (but lacking ACEi/ARB therapy) ranged between 200 to 300 per month. They were captured by the screening program and ~95% of them were brought into ACEi/ARB compliance directly related to the function of the model. Approximately 5% were not reconciled due to hospital discharge before the model was inacted.

Percentage ACEi/ARB Adherence With the Intervention

The mean percentages of ACEi/ARB adherence in the periods before, during, and after the model implantation were 88.4%, 88.8%, and 97.6% respectively. Significant differences were detected between the three periods by Pearson's chi-square test ($P < 0.001$). Fisher's Exact Test was used for comparing the periods before and after ($P < 0.001$, Figure 2A) and during and after ($P < 0.001$). Figure 2B shows the quarterly sensors of the adherence rate. Notably, after the implementation, the compliance rate remained high and the variations lessened.

Discussion

The results of this study show that the computer-based quality improvement tool was associated with improved

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adherence to the ACEi/ARB guidelines for patients with LVSD/HF. This was accomplished without the need for additional, ongoing expenses in a system fitting our EMR capabilities and work flow.

Specific studies on the improvement of ACEi/ARB utilization for LVSD patients are limited.[16,21] One randomized controlled trial evaluated an inpatient HF intervention without a post-discharge care plan.[21] The intervention included inpatient guidelines for the use of ACEi, echocardiogram, daily weights and a consultative service provided by a nurse care manager and cardiologist. The consultative service included patient education, treatment recommendations, and discharge planning. This intervention significantly improved ACEi use at discharge.

Another randomized controlled study of 98 patients showed that compared to routine care, those who received multidisciplinary care (inpatient and outpatient education and intense telephone and clinic follow-up), ACEi usage was maximized and re-hospitalization and HFrelated death was significantly reduced at three months.[16] Although effective, such interventions require substantial ongoing cost and sustainability is again called into question. Our initiative is unique in that incorporating a computer-based semiautomatic system into the care-delivery process has enhanced care quality without incurring ongoing extra cost (we have neither hired extra personnel nor created a heavier work burden for pharmacists and patientcare teams, as the model has been diffused into their daily routine) thus maximizing its longterm sustainability.

Notwithstanding the positive aspects, this study has several limitations. First, it is not a randomized, controlled trial, and unidentified external factors may have had some influence. However, in the examination of all potential external effects, we could not identify any factor that would have the capacity to substantially and consistently influence the results. Second, pre–post study design is less ideal than randomized, controlled trials on the study design hierarchy. However, given the unsatisfactory adherence rate, anticipated positive effects with the model, and the pressing need for improving the adherence, a randomized trial was not an option at that juncture. Third, we could not precisely compare the difference in the awareness of ACEi/ARB guidelines among different classes of trainees during the study period. We did have a one-time online, non-mandatory education program for all providers. However, new trainees rotated in and- out on a monthly basis. This factor is unlikely to have caused a sustained change. Fourth, we did not have the outcome data for patients in whom HF was their secondary admission diagnosis. These patients were equally flagged by the model, and their ACEi/ARB status, when flagged, was obliged to be corrected. We suspect that these patients most likely benefited even more by the model because they were likely in a compensated state of HF, and the care-teams tended to be more focused on their primary issue, leaving room for overlooking LVSD-related issues.

Finally, we report the outcomes in the first 21 months after the full implementation of the model. We still need to monitor the long-term outcome, although a reasonable length of time has elapsed. There has been no sign of decay in its effectiveness and we have no compelling reason to anticipate a significant regression.

Under ideal conditions, the outcome should consistently be 100% based on the design. In reality the adherence had been oscillating with an average of ~97%. We noted two main scenarios that had contributed to this outcome. First, some LVSD/HF patients were taken off ACEi/ARB temporarily before discharge because of worsening pre-renal azotemia with diuresis. They were discharged off ACEi/ARB with a plan to resume it. These patients would not have been labeled as ACEi/ARB-intolerant but were classified as those without meeting the guidelines. Second, some patients had their echocardiogram on the same day or within 24 hours of discharge. A fraction of them had LVEF $< 40\%$, but ACEi/ARB had not been initiated before discharge.

The rising volume of patients with increasing age and comorbidities, combined with constraints in healthcare resources, compels us to explore high-efficiency care-delivery models. Although computerized technology is well understood and readily available, the challenge we face is how to fully utilize the technology. A recent study shows that the improvement of IT infrastructure and research on implementation are interdependent and both can be translated to better patient care.[25] Our experience serves as another example demonstrating that, when carefully conceived and properly executed, computer-based care-delivery prompts can be highly efficient and effective, suitable for large hospital settings with a heavy patient load like ours.

Moreover, because of the availability of basic IT platforms, similar algorithm-based model systems can foreseeably be adopted by hospitals of comparable size and structure and also be applied to other care-delivery settings including out-patient clinics, chronic dialysis units and various long-term care facilities.

Developing efficient, IT-based quality improvement tools that facilitate the application of evidence-based care and improve quality without significant additional resources is imperative in today's economic climate. Strategies such as our e-messaging intervention with ACEi and ARB demonstrate sustainable improvement, can be applied to other conditions, and should be vigorously pursued.

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