



A combined care model using early access to specialists' off-hours to reduce cardiac admissions

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Abstract

Despite the implementation of diagnostic and treatment algorithms for many common cardiovascular (CV) complaints, identifying low- and intermediate-risk cardiac patients presenting to the emergency department (ED) who could be managed without hospital admission remains difficult. We hypothesized that the presence of an attending cardiologist in the ED after normal working hours would decrease the proportion of these patients admitted to the hospital. We conducted a retrospective study of patients seen in the ED with cardiac diagnoses identified by ICD-9 codes during the time period when the cardiologist was available (6 p.m.–midnight) compared with patients seen at other times of the day in the 12 months before and after the consultation program was implemented. The primary outcome was disposition at the time of discharge from the ED. Logistic regression was used to model the primary outcome. A difference-in-differences approach was used as the primary statistical test. Following the start of the consultation program, the odds of discharge home from the ED with or without observation increased (OR 1.69, 95% CI [1.45–1.96]). There was a significant interaction between pre-/post-intervention status and time of day in the odds of discharge home from the ED ($P=0.04$) suggesting an association between the consultation program and disposition patterns that is independent of concurrent programs aimed to reduce utilization. An ED-based cardiology consultation program may reduce the need for inpatient stays by identifying low- to intermediate-risk patients safe for discharge from the ED with or without a period of active management/observation.

Keywords Chest pain · Observation unit · Care systems · Atrial fibrillation · Congestive heart failure

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Introduction

Total spending on cardiovascular disease in the United States amounted to \$231 billion in 2013 with 60% of this going to inpatient and emergency care [1]. As the proportion of hospital admissions coming through the Emergency Department (ED) has steadily risen over the past two decades, disposition decisions made in the ED are becoming an important opportunity for potential cost savings in the treatment of patients with cardiovascular conditions [2]. Emergency Departments have responded with the development of observation units (EDOUs) that have successfully reduced admissions for a variety of cardiac conditions including: chest pain, syncope, atrial fibrillation, and heart failure [3–6].

Algorithms predicting short- and intermediate-term adverse events are often used to identify patients appropriate for EDU pathways [7, 8]. Scoring on subjective chest pain risk measures vary according to the experience of ED physicians and between cardiologists and ED physicians [9,

10] Further, the attitude among ED physicians towards risk in patients with cardiac disease such as heart failure (HF) is very conservative [11]. Data support a role for cardiologists in reducing testing and inpatient utilization for patients presenting to the ED with chest pain and atrial fibrillation [12–14].

Smulowitz et al. categorized ED visits into “emergencies”, “intermediate/complex conditions”, and “minor injury/illness”, which account for 10–16%, 31–57%, and 12–40% of all visits [15]. Included in the intermediate category are chronic conditions like atrial fibrillation and congestive heart failure, as well as acute presentations of diseases like angina and atypical chest pain. These conditions present the ED physician with decisions on the need for expensive testing and/or admission to the hospital. Strategies targeting reduction in unnecessary testing and identification of patients in the intermediate category who can be safely discharged can potentially reduce total health spending by 1.0–2.5% based on this model [15].

We developed an off-hours, attending-staffed cardiology consultation program to support the identification of such patients. The objective of this study was to evaluate possible changes in admission patterns among patients presenting to the ED with chest pain, congestive heart failure, and atrial fibrillation during the time when a cardiologist was available in the ED. We compared the study times to times of day when cardiology was available only for emergent consultation and located outside of the ED and for the 1-year periods before and after the initiation of the pilot program.

Methods

Study design and setting

Starting on August 22, 2011, the Cardiology division launched a collaborative effort with the ED staff whereby a cardiology attending physician was available in the ED for immediate consultation from 6 p.m. to midnight Monday through Friday. The program was aimed at identifying patients presenting with common cardiovascular conditions who were appropriate either for discharge home with outpatient follow-up or for accelerated work-up and management in an ED-based observation unit. While the target conditions were chest pain, heart failure (HF), and atrial fibrillation, the attending cardiologist evaluated any patient who the ED staff felt would benefit from consultation.

We conducted a retrospective study comparing patients seen in the ED during the time when the cardiologist was available compared with patients seen at other times of the day, before and after the ED consultation service was implemented. The study was performed in the Emergency

Department of an urban, academic teaching hospital with ~55,000 emergency visits per year.

The institutional review board at Beth Israel Deaconess Medical Center exempted this work from further review as part of ongoing quality improvement and operational analyses.

Data

Hospital administrative data were used to identify all visits to the ED on weekdays for the 1 year period before and the 1 year period after the start of the intervention with a primary diagnosis of chest pain (International Classification of Disease-9 (ICD-9) diagnosis code of 786.5), atrial tachyarrhythmia including atrial fibrillation and other supraventricular tachycardias (ICD-9 codes 427.31, 785.1, 427.89, 785.0); or congestive heart failure (CHF, ICD-9- code 428.0). These were the most frequent ICD-9 billing codes for the patients seen by the consultation program during its 1st month and maximally enriched the study population with patients seen in consultation. Among the 662 patients seen in consultation during the intervention period, 389 patients (59%) had a primary billing diagnosis not included in the analysis. The other consultation patients seen often shared similar clinical diagnoses but were coded with less commonly used ICD-9 codes.

Visits from 8/22/10 to 8/21/11 were categorized as “pre-intervention”, while visits from 8/22/11 to 8/21/12 were “post-intervention”. Triage and discharge time stamps in the ED administrative database were used to identify patients who would have been in the ED when the dedicated cardiologist was available. These were classified as “evening” visits and comprised the intervention group, while all other visits were considered “daytime/overnight” and comprised the control group.

Study variables

Demographic and clinical data were extracted directly from the electronic medical record and the administrative billing database. Vital signs were recorded at the time of triage in the ED. Implausible values for vital signs (temperature below 90 or over 110 °F, systolic blood pressure below 40 mmHg, diastolic blood pressure below 30 mmHg, respiratory rate below 4 or greater than 60, oxygen saturation below 50 or over 100%, heart rate over 300) were considered errant and treated as missing. Laboratory variables reflect the first entry for the index visit. The Emergency Severity Index (ESI) is determined by ED staff based on the expected amount of resources needed to take care of a patient with a score of 1 indicating the highest acuity and 5 indicating the lowest [16]. For patients seen as part of the cardiology consultation program, additional clinical data including reason

for consult, final diagnosis, reason for admission if admitted, and co-morbidities were collected prospectively.

Outcome

The primary outcome for the study was disposition at the time of discharge from the ED. There were four possible dispositions: “Home”—patients who were discharged directly home from the ED; “ED Observation”—patients who met criteria for observation while in the ED, but were ultimately discharged home; “Inpatient Observation”—patients who were transferred from the ED to an inpatient floor who did not meet the criteria for an inpatient level of care; “Admission”—patients who were transferred from the ED to an inpatient floor and who met the criteria for inpatient level of care. Patients who were transferred to another facility from ED, left against medical advice, or eloped were excluded from the final analysis. Return visits to the BIDMC ED within 30 days were identified using administrative data.

Statistical analysis

Data are presented as medians with interquartile range (IQR) or as counts with proportions where appropriate and between-group differences were tested using Chi square or *t* tests as appropriate. We used a difference-in-differences approach [17, 18] as our primary analytic approach to account for secular trends in disposition decisions during the study period. Logistic regression was used to model the primary outcome in three ways: home versus other, inpatient versus other, and discharged from the ED (with or without observation) versus transferred to the inpatient floor from the ED. Dummy variables indicating the time period (pre- versus post-intervention) and time of day (evening versus other) were included in the model and an interaction term between these factors was included to evaluate whether any differences observed between the pre- versus post-period which differed for the daytime/overnight period and the evening period. The post-intervention evening period included all eligible subjects regardless of whether they were seen in consultation.

Each model controlled for indicators for the primary diagnosis as well as all clinical and demographic covariates collected. Because laboratory data were missing for ~6% of visits and vital sign data were missing for between 3% and 5% of visits, we used Markov chain Monte Carlo multiple imputation to simulate five complete data sets as previously described [19, 20]. All statistical analyses were performed in each data set separately and the results were averaged. The confidence intervals and *P* values were calculated accounting for the uncertainty in imputed estimates [20]. All statistical tests were performed using SAS software (version 9.3; SAS Institute Inc., Cary, NC).

Results

There were 6546 eligible total visits to the ED over the entire study period with one of the primary diagnoses of interest, with 3279 occurring in the baseline period and 3267 occurring in the intervention period. Of the 2135 visits to the ED in the evening after the start of the consultation program, 348 (16.3%) were seen by the cardiology attending, while 41 of 1132 daytime/overnight patients (3.6%) were seen. Table 1 describes the baseline demographic and clinical characteristics of the cohort stratified by time of day and grouped into the pre- versus post-intervention period. The proportion of chest pain diagnoses was higher during the day. Overall, the level of acuity as measured by ESI was slightly lower during the non-evening hours (higher ESI score). The acuity level was highest (lowest ESI) among the patients seen in consultation during the intervention period and these patients were significantly older than those not seen in consultation.

Table 2 summarizes the results of the primary adjusted analyses. At baseline (pre-intervention), patients had higher odds of discharge home from the ED with or without observation during the daytime/overnight as compared to the evening (OR 2.24, 95% CI [1.85–2.70]). They also were less likely to be discharged directly home (OR 0.58, 95% CI [0.46–0.72]). Figure 1 shows the disposition of patients stratified by time of day before and after the intervention was launched. The cardiologist was present in the evening period post-intervention.

After the start of the intervention, there was a higher odds of discharge home from the ED with or without observation in the evening when the attending cardiologist was present (OR 1.69, 95% CI [1.45–1.96]). There were also lower odds of admission during the evening in the post-intervention period (OR 0.46, 95% CI [0.40–0.54]) partly accounted for by an increase in the use of inpatient observation (see Fig. 1).

There was a statistically significant interaction between pre-/post-intervention status and time of day in the odds of being admitted ($P=0.009$) and being discharged from the ED ($P=0.04$). There was no statistically significant difference in the adjusted odds of returning to the ED within 30 days of discharge from the ED among patients seen in the evening between the pre- [56/465 (5.6%)] and post- [56/541 (5.6%)] intervention periods (OR 0.86, 95% CI [0.70–1.06], $P=0.16$).

Discussion

In this study of patients discharged from the ED with a primary diagnosis of chest pain, HF, or atrial tachyarrhythmia, patients seen in the ED during the hours when cardiology consultation was offered were more likely to be discharged home from the ED when compared to a contemporaneous control group that was not subject to

Table 1 Demographics characteristics of the study population—stratified by time of day and grouped into pre- and post-intervention

Demographics, <i>n</i> (%)	Evening		Other times		Consults (<i>n</i> = 389)
	Pre (<i>n</i> = 2156)	Post (<i>n</i> = 2135)	Pre (<i>n</i> = 1123)	Post (<i>n</i> = 1132)	
Age, mean (SD)	60.4 (19.2)	60.7 (18.7)	56.1 (18.3)	57.0 (18.1)	64.2 (15.6)
Caucasian	1354 (63)	1286 (60)	622 (55)	639 (57)	249 (64)
Male	968 (45)	980 (46)	528 (47)	540 (48)	194 (50)
Insurance					
Medicare	864 (40)	851 (40)	349 (31)	359 (32)	185 (48)
Medicaid ^a	257 (12)	239 (11)	191 (17)	164 (15)	36 (9)
Other	1035 (48)	1045 (49)	583 (52)	609 (54)	168 (43)
Clinical median (IQR)					
ESI	2 [2, 3]	2 [2, 3]	2 [2, 3]	2 [2, 3]	2 [2]
ESI, mean (SD)	2.2 (0.6)	2.2 (0.6)	2.3 (0.6)	2.3 (0.6)	2.1 (0.5)
Diagnosis					
Chest pain	1320 (61)	1367 (64)	848 (76)	833 (74)	236 (61)
Atrial fibrillation or SVT	458 (18)	330 (16)	154 (14)	197 (17)	93 (24)
HF	378 (21)	438 (20)	121 (11)	102 (9)	60 (15)

SD standard deviation, ESI emergency severity index, SVT supraventricular tachycardia, HF congestive heart failure

^aIncludes self-pay

Table 2 Primary outcome: comparison of disposition of patients from the emergency department before and after implementation of the consultation program using a difference-in-differences approach based on time of day

	<i>N</i> (%) ^a	Odds ratio (95% CI)	<i>P</i> interaction
	Discharged from the ED	Discharged from the ED versus not discharged from the ED	
Pre-intervention			0.04
Evening	989 (46%)	Reference	
Daytime/overnight	758 (67%)	2.24 (1.85–2.70)	
Post-intervention			
Evening	1165 (55%)	1.69 (1.45–1.96)	
Daytime/overnight	795 (70%)	2.87 (2.37–3.48)	
	Admission	Admission versus home or observation ^b	
Pre-intervention			0.009
Evening	958 (44%)	Reference	
Daytime/overnight	287 (26%)	0.50 (0.41–0.61)	
Post-intervention			
Evening	694 (33%)	0.46 (0.40–0.54)	
Daytime/overnight	247 (22%)	0.34 (0.28–0.42)	
	Home	Home versus observation or admission ^b	
Pre-intervention			0.19
Evening	521 (24%)	Reference	
Daytime/overnight	230 (20%)	0.58 (0.46–0.72)	
Post-intervention			
Evening	566 (27%)	1.27 (1.07–1.51)	
Daytime/overnight	232 (20%)	0.60 (0.48–0.75)	

^aPre-intervention evening = 2156; pre-intervention daytime/overnight = 1123; post-intervention evening = 2135; post-intervention daytime/overnight = 1132

^bObservation includes ED observation and admission for observation

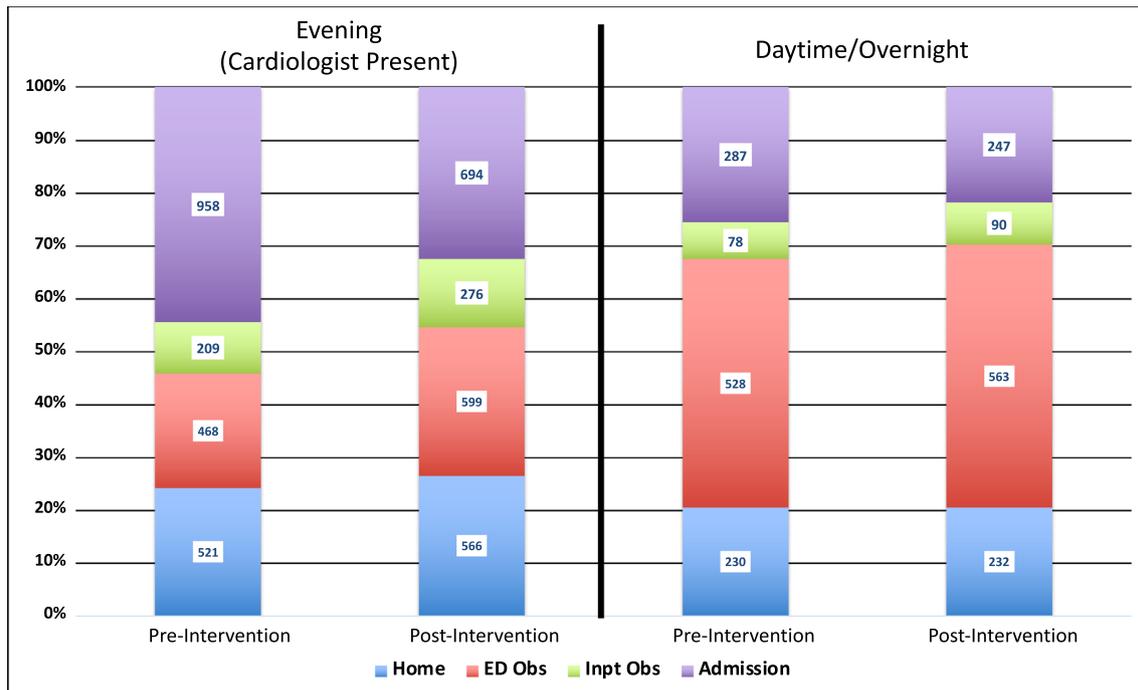


Fig. 1 Disposition of patients by time of day before and after launching the evening cardiologist program

the intervention. Importantly, there was also a significant decrease in inpatient admissions. While both discharge home from ED without observation and discharge home from the ED with or without observation both increased in the evening in the post-intervention period, the trend was directionally stronger for discharge home with or without observation than it was for discharge home without observation (OR 1.69 versus 1.27). This suggests that the primary impact of the cardiologist was to identify intermediate-risk patients safe for observation in the ED rather than admission to the floor. There was also a directional increase in odds of discharge from the ED in the non-evening hours (OR 2.24 pre-intervention to 2.87 post-intervention). This is in part due to an increased use of ED-based observation over the study period but may also reflect a spill-over effect of the management strategies recommended by the evening cardiologist to the daytime/overnight hours.

Guidelines support the use of observation units for the evaluation of low-risk chest pain using serial electrocardiograms, measurements of troponin, and confirmatory stress testing [21]. In over 85% of these patients, stress testing is expected to be negative [22]. This has led some to question the utility of routine noninvasive testing in these patients [17]. Three studies involving over 3000 patients have demonstrated the safety of at least deferring confirmatory testing to the outpatient setting in appropriate clinical circumstances [12, 13, 23]. Similar to our intervention, cardiologists were

directly involved in the protocols in the two largest studies [13, 23].

There is less data supporting the routine use of ED-based observation units in the management of patients with HF and cardiac dysrhythmias. Efficacy and safety of “observation units” in the ED for evaluation and management of patients presenting with decompensated HF who meet low-risk criteria have been proposed [8]. Preliminary data suggests that this may be a cost-saving alternative for appropriate patients [24]. Despite these efforts, > 80% of patients presenting to the ED with HF are still admitted, in part due to limitations in ability to assess short-term morbidity and mortality [25, 26]. Use of the recently validated Emergency Heart Failure Mortality Risk Grade tool may facilitate discharge of low-risk HF patients from the ED [27]. Zimetbaum et al. reported a reduction in admission rates for atrial fibrillation from 74 to 38% with the implementation of a treatment algorithm which involved cardiology input [14]. Similar protocols have yielded optimistic results at other institutions [4].

The increase in in-hospital observation seen over the course of this study mirrors a national trend that has been a subject of controversy particularly affecting Medicare beneficiaries [28]. The primary drivers of this trend include the Recovery Audit Contractor program [29] that penalizes hospitals for billing above an appropriate level of care, penalties levied by Medicare’s Readmission Reduction Program [30], and incentives in global payment/shared savings contracts to reduce inpatient hospitalizations. The differential increase in

the assignment of patients for in-hospital observation in the evening is multifactorial and at least in part due to extension of the case managers' evening hours in January 2011 to support decision making on appropriate level of care for patients being sent to the floor from the ED.

Limitations

In the post-intervention period, cardiology was consulted in only 17% of the patients in the evening cohort. The decision to consult cardiology was made at the discretion of the ED attending. Because we could not control for unmeasured clinical features associated with consultation, we elected to perform an intention to treat analysis that included all potential patients seen during the post-intervention period. We would expect this approach to decrease our power to detect significant changes. Along with the inclusion of a small proportion of consult patients in the non-evening period, these limitations would bias our results towards the null.

Clinical outcomes in this study were limited to return visits within 30 days. A structured chart review for adverse events for all patients included in this analysis was not feasible in this study. Additionally, given the retrospective nature of the study, we could have missed events occurring at other hospitals. Consideration was given to linking to the social security death index, but the study was underpowered to detect a mortality difference. A prospective randomized study of involvement of cardiology attendings in the ED can be considered to overcome these limitations.

Conclusion

We have described a cooperative effort between ED and cardiology staff aimed at facilitating early diagnosis and care plan implementation while identifying low- to intermediate-risk patients with cardiovascular diagnoses who can be transitioned to the outpatient setting. We found a higher use of ED-based and floor-based observation with concomitantly higher rates of discharge from the ED and lower use of inpatient stays as compared with contemporaneous controls. Our results suggest that this might be one promising approach for optimizing the use of the hospital for patients presenting with important cardiovascular complaints.

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Compliance with ethical standards

Conflict of interest The author(s) declare that they have no conflict of interest.

Statement of human and animal rights All procedures performed were in accordance and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards and ethical approval was obtained from the Beth Israel Deaconess Medical Center Institutional Review Board.

Informed consent Informed consent for this retrospective study was waived by the Beth Israel Deaconess Medical Center Institutional review board given no more than minimal risk to the privacy of individuals given protection of health information identifiers.

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