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STATE-OF-THE-ART REVIEW

Acute Heart Failure

Alternatives to Hospitalization

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CME Objective for This Article: After reading this article, the reader should be able to: 1) identify patients at high risk for readmission after a heart failure (HF) hospitalization; 2) identify factors associated with increased risk for readmission after a HF hospitalization; and 3) discuss initiatives to decrease HF hospitalizations.

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ABSTRACT

Acute heart failure (HF) is a major public health problem with substantial associated economic costs. Because most patients who present to hospitals are admitted irrespective of their level of risk, novel approaches to manage acute HF are needed, such as the use of same-day access clinics for outpatient diuresis and observation units from the emergency department. Current published data lacks a comprehensive overview of the present state of acute HF management in various clinical settings. This review summarizes the strengths and limitations of acute HF care in the outpatient and emergency department settings. Finally, a variety of innovative technologies that have the potential to improve acute HF management are discussed. (J Am Coll Cardiol HF 2017;5:329–36) © 2017 by the American College of Cardiology Foundation.

Acute heart failure (HF) is a major public health problem, resulting in more than 1 million annual hospitalizations in the United States alone (1). These hospitalizations are associated with a significant economic burden that is expected to rise, with annual costs approaching $70 billion by the year 2030 (2). Recent health policy changes mandate the public reporting of hospitals' HF readmission rates. Furthermore, these policy changes impose reductions in Medicare reimbursements for hospitals with higher-than-predicted readmission rates. As a result, there is a growing interest in novel approaches to deliver treatment for acute HF, such as the use of same-day access clinics (SDACs) for outpatient diuresis, observation units from the emergency department (ED), and transition strategies to safely reduce hospitalization and rehospitalization rates in appropriate patients with HF. In this article, we review the current state of acute HF triage and management in various clinical settings. We focus on the strengths and limitations of acute HF care, and alternative approaches to care, to inform contemporary clinical practice and trial design.

CURRENT STATE OF HF CARE

OUTPATIENT MANAGEMENT OF ACUTE HF. Patients hospitalized for acute HF remain at significant risk for readmission and mortality. Integrated outpatient care with physicians, nurses, dieticians, and pharmacists is crucial to avoid preventable readmissions. Patients with earlier follow-up after discharge for HF hospitalization have a lower risk of 30-day readmissions (3), yet this suggests that the outpatient setting is reserved for patients already stabilized after a hospital or ED visit. Historically, clinics were mainly for stable patients with chronic HF, with telephone "visits" taking the place of a clinic visit if acute symptom exacerbations occurred. The efficacy of early follow-up to reduce readmission and improve patient self-care is well supported; however, many patients who are readmitted after discharge are never seen in an outpatient setting (3–7).

As a result of these gaps in follow-up, the concept of SDAC was introduced as an intermediate step in acute HF care (**Central Illustration**). SDACs facilitate close post-hospitalization follow-up in an

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outpatient setting. Patients who are either too ill for oral diuretic agents or fail escalation oral therapy can receive intravenous (IV) diuresis in an SDAC setting. Outpatient IV diuresis has been shown to be a safe and potentially cost-effective way to reduce hospital admissions (8–11). Data on outpatient diuresis programs implemented within a hospital HF disease management plan remain limited, because few institutions to date have initiated such interventions (12).

Given the chronic nature of HF, an important part of any transitional outpatient HF program should include a multidisciplinary approach to assess psychological needs, patient support, palliative care, and medication reconciliation, all as a model of patient-centered care (13–15). As SDACs expand, they also should be integrated into the overall health care system with the ability to provide referrals to social workers, nutritionists, pharmacists, and mental health providers to manage patients' comorbidities and complex social situations. Multiple studies have shown the importance of social and information support in the management of HF (16–18). One previous study investigated the effectiveness of a post-discharge transitional care program for patients with HF, and found that 30-day readmission rates were reduced; an important part of this program included advanced practice registered nurses providing comprehensive support for patients (19).

EVIDENCE BASE. Given the relatively recent development of the SDAC model, limited data are available regarding its effectiveness at reducing hospitalization and improving patient outcomes; however, several studies have assessed the use of specialty clinics and outpatient diuresis to reduce rehospitalizations.

In 2008, Ryder et al. (8) demonstrated the efficacy of implementing an outpatient diuresis program in the setting of a hospital-based disease management program. Another pilot study by Banerjee et al. (9) investigated the efficacy of administering IV diuresis on a cardiology day ward for symptomatic improvement in acute HF. The study showed that outpatient IV diuresis was effective at symptom improvement and avoiding hospital admission, concluding that IV diuresis in an SDAC-type setting may represent a safe and effective way to reduce hospital admissions. Other recent studies have also shown the efficacy of adopting an outpatient IV diuresis model as a part of a transitional care program for patients with HF and frequent exacerbations (10,11). More recently, Buckley et al. (20) demonstrated the efficacy of outpatient IV diuresis in a cohort of 60 patients with chronic HF and evidence of worsening congestion, all of whom received a bolus and 3-h infusion of furosemide; the study suggested that outpatient diuresis was safe and effective, and may reduce the need for hospitalization for a proportion of patients included in the study. These studies highlight the importance of establishing open lines of communication between patients and the outpatient clinic, which allows for close post-hospitalization monitoring and timely symptom management as issues arise (11).

Although previous analyses support the benefits of specialized HF and outpatient IV diuresis clinics, these earlier studies were limited by small sample sizes, heterogeneous interventions, varying follow-up assessment times, and limited descriptions of patient populations. Randomized controlled trials comparing the SDAC model with standard of care for acute HF (ED to hospital to outpatient follow-up) have not been conducted, nor is there sufficient published data about single-site experiences with this treatment model. Implementing the SDAC into the HF management paradigm may substantially reduce admissions, and has emerged as a growing clinical setting for patient-centered care.

ABBREVIATIONS AND ACRONYMS

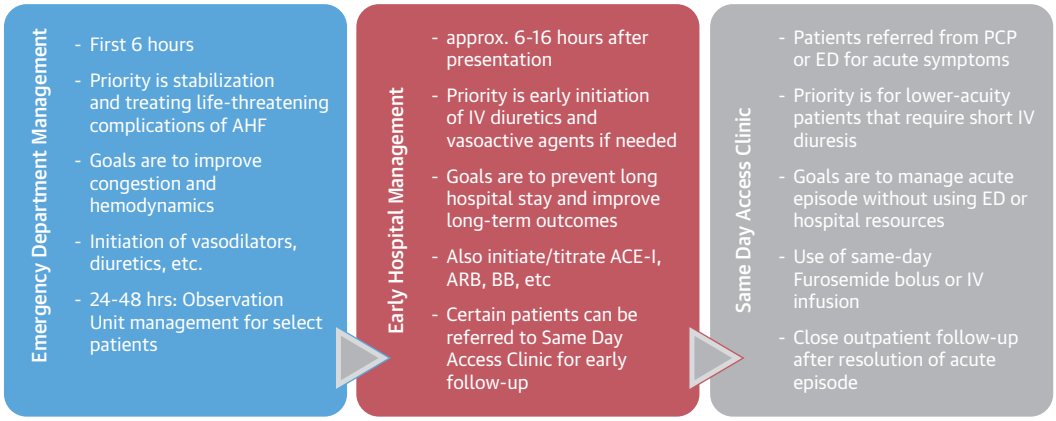
ED = emergency department
HF = heart failure
IV = intravenous
SDAC = same-day access clinic

IN THE EMERGENCY DEPARTMENT

IDENTIFICATION OF LOWER RISK. Of the 670,000 annual ED presentations for acute HF, approximately 20% of these patients are discharged directly to home, whereas the remaining 80% are either admitted or (more rarely) managed in the ED observation unit (21). These admission statistics have been largely unchanged over the past 5 years (21). Because HF SDACs are not widespread and may require capital investments, most patients with acute HF begin their clinical course in the ED, where the decision algorithm for managing these patients is often complex (22). The goals are to ensure that patients feel better, achieve hemodynamic stability, relieve congestion, improve volume status, and identify and treat precipitating factors in a timely and efficient manner. Furthermore, the outcomes of discharged patients are not well known.

Identifying the patients that qualify for an observation unit setting or are safe for discharge is a key first step to reduce unnecessary admissions. Unfortunately, no prospectively validated, facile risk instrument for the ED exists, although there are several that show promise (23). Given the high post-discharge event rate in acute HF, few patients can definitely be considered low risk, but some patients are definitely

CENTRAL ILLUSTRATION **Early Clinical Management of Acute HF**



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The role of the emergency department (ED), hospital, and same-day access clinic (SDAC) in the care of patients presenting with acute heart failure (HF). ACE-I = angiotensin-converting enzyme inhibitor; ARB = angiotensin receptor blocker; BB = beta-blocker; IV = intravenous; PCP = primary care physician.

lower risk than others, and targeting patients without known high-risk features is a first step.

EARLY MANAGEMENT. Hospitalization is the costliest resource in health care (24), is a landmark event in the journey of patients with HF, and is independently associated with worse outcomes (25,26). ED decisions to avoid unnecessary hospitalization assume the ability to appropriately discriminate risk, and ensure robust transitions of care.

Initial assessments made in the ED often carry forward; therefore, diagnostic accuracy is critical. A combination of history, physical, radiographs, electrocardiogram, laboratory work, biomarkers, and novel assessment methods (e.g., lung ultrasound) represent a multimodal approach to diagnosis. Despite these modalities, the diagnosis occasionally remains in doubt. In these situations, time and response to therapy often provides affirmative information or mandates a revised differential diagnosis. A corollary to diagnosis is identification of the precipitant of acute HF. Careful consideration of common precipitants, such as infection, ischemia, noncompliance, and arrhythmia, is mandatory.

COMPREHENSIVE RISK STRATIFICATION. Identifying low-risk patients for possible early discharge or a short stay in an observation unit may lead to reduced health care use. Up to 50% of patients with acute HF might be eligible for discharge to home or a brief observation stay (27). Because most patients are admitted to the hospital, ED-based risk models are often confounded by the effects of hospitalization. Consequently, risk models have largely been developed for hospitalized patients, and these models are less useful in the ED setting (28).

Given the high proportion of patients currently admitted to the hospital from the ED, it is doubtful that an ED-to-home-based strategy would be readily adopted (29). Rather, an ED-to-SDAC-to-home or an ED-to-observation unit-to-home strategy is recommended as an initial step (27,30). There are several "high-risk" markers associated with poor clinical outcomes: a low systolic blood pressure (<100 mm Hg), hyponatremia (<135 mEq/l), and ischemic cardiomyopathy (new electrocardiogram changes); and elevated blood urea nitrogen, creatinine (blood urea nitrogen >40 mg/dl or creatinine >3 mg/dl), and cardiac biomarkers (troponin T >0.1 ng/ml or troponin I >0.3 ng/ml), among others (31). Although the absence of higher risk features does not equal low risk, it likely identifies lower risk; early work on risk stratification models is promising and remains an area of active inquiry (**Table 1**) (32–36). Currently, there are 2 ongoing studies (STRATIFY [Identifying High- and Low-Risk HF Patients in the ED] and DECIDE [Determining When Patients Hospitalized With Acute HF Can Be Safely Sent Home]) that have been funded by the National Heart, Lung, and Blood Institute to investigate risk stratification and early decision-making for acute HF (37).

Importantly, not all ED visits are "biological" in nature; psychosocial and self-care issues are

TABLE 1 AHF ED Risk Stratification Models From Last 6 Years

First Author (Year) (Ref. #)	Setting	Predicted Outcome	Model Variables
Lee et al. (2012) (23)	Population-based ED cohort	7-day mortality	Creatinine, BP, O_2 saturation, troponin, home metolazone, EMS transport
Stiell et al. (2013) (32)	Convenience sample from ED	30-day mortality and 14-day adverse nonfatal events	History of stroke/TIA, history of intubation for respiratory distress, HR, O_2 saturation, ECG, urea, CO_2, troponins, NT-proBNP
Lassus et al. (2013) (33)	AHF patients presenting to ED or CCU	30-day and 1-yr mortality	CRP, NT-proBNP, BNP, MR-proANP, MR-proADM, sST2
Peacock et al. (2008) (34)	Consensus recommendations for hospital vs. observation unit vs. direct discharge	30-day mortality	Troponins, BUN, creatinine, serum sodium, SBP, ECG, BNP/NT-proBNP
Hsieh et al. (2008) (35) Validation of the AHF Index (2005) (36)	Retrospective cohort of patients hospitalized from ED and discharged with a diagnosis of HF	30-day mortality, adverse events, inpatient mortality	pH, HR, renal function, WBC, glucose, serum sodium

AHF = acute heart failure; BNP = b-type natriuretic peptide; BP = blood pressure; BUN = blood urea nitrogen; CCU = critical care unit; CRP = C-reactive protein; ECG = electrocardiography; ED = emergency department; EMS = emergency medical services; HF = heart failure; HR = heart rate; MR-proADM = mid-regional proadrenomedullin; MR-proANP = mid-regional proatrial natriuretic peptide; NT-proBNP = N-terminal prohormone of brain natriuretic peptide; SBP = systolic blood pressure; sST2 = somatostain receptor 2; TIA = transient ischemic event; WBC = white blood cell.

significant contributors not only to ED visits, but also to admission and readmission (18). Despite substantial efforts to reduce admissions, ED visits have increased by 21 million in the last decade. Many of these visits are by patients who come to the ED 2 or more times per year (38). In a cohort study of 113,033 patients, 31% of ED patients with acute HF had ≥3 visits in <1 year (39). These patients accounted for 58% of near fatal events, and were more likely to be of non-Hispanic black race, Hispanic ethnicity, and lower socioeconomic status. Despite improved access to health care resulting from recent national policy changes, ED use has either increased or remains unchanged (40).

Future directions for learning how to reduce frequent ED visits may include qualitative studies directed toward analyzing why certain patients frequently use the ED, and identifying potentially preventable ED visits. Preliminary investigations will provide the foundation for future prospective studies targeting interventions in those patients at highest risk. Important interventions would include increasing primary care and specialty clinic access and developing care management plans separate from the ED. In addition, addressing psychosocial, caregiver, health literacy, and self-care needs is critical.

ED use, in and of itself, is not the problem; rather, 3 broad themes outline areas where the problem stems from, and all 3 of these areas need to be further investigated. First, inappropriate use of the ED is common. On the basis of the widespread use of EDs, the way physicians and patients define appropriate use of the ED is clearly different. Furthermore, hindsight bias is flawed in terms of determining the appropriateness of care (41). The second theme has to do with discrepancies in risk tolerance. Emergency physicians are extremely intolerant of risk, especially for patients with HF (29). By contrast, HF physicians are less risk averse despite the fact they manage the sickest of patients with HF. As a result, patients often get mixed messages in terms of what risks should be legitimately tolerable. Third and finally, finding safe and practical alternatives to admission is always challenging, and considering alternatives goes hand-in-hand with risk tolerance. One potential solution to these 3 challenges is presented next.

OBSERVATION UNITS. Observation units already manage HF throughout the country. Although not nearly as widespread as chest pain units, the concept is similar: risk stratification combined with continued improvement in response to therapy (30). Currently, the Centers for Medicare & Medicaid Services defines an observation unit stay as no more than 48 h, with the goal of <24 h. Although patients with acute HF have poor longer term outcomes, most do not require immediate ED-based life-saving interventions. Similar to SDAC patients, many require aggressive decongestion with subsequent implementation of proven life-saving therapies, once stabilized. In an observation unit, patients can rapidly receive aggressive diuresis and improve their hemodynamic status. Furthermore, the goal of a streamlined observation unit model should be for providers to also ensure medicine reconciliation, assessment of self-care, health literacy, and patient education before discharge. Although observation units are currently being used in clinical practice, there are no randomized controlled trials evaluating observation units versus inpatient care. Observational studies suggest that patients with acute HF managed in the observational unit have similar

outcomes to risk-matched admitted patients, at a lower cost (42,43).

NEW FRONTIERS IN HF CARE

MOBILE HEALTH AND TELEMEDICINE. Modern technology has created an environment ideal for advancements in mobile health and noninvasive medical technology. Wireless medical technology, which can be delivered via a sensor, implantable device, and so forth, allows for a body sensor to transmit information about a specific physiological parameter to an intermediate receiver, such as a smartphone. The signal can then be transmitted to the Internet, processed, and sent on to any desired location, including a physician or monitoring facility. This concept may be especially useful in acute HF, where providers would be able to remotely monitor the status of their patients through wireless technology, to optimize patient care.

Remote telemonitoring is also a topic of increased interest that can be applied to the acute HF community. Telemedicine is the transmission of medical information via electronic communication and has been used for patients with HF in various ways to prevent an acute episode and hospital stay. Telemonitoring studies have used various interventions, such as telephone consultations with medical providers, recording of vital signs (via implantable or noninvasive sensors) with results collected at a central monitoring station, and video consultations. Studies have shown a modest benefit of telemonitoring in reducing the frequency of acute episodes and hospitalizations, and a slight economic advantage. Some research has also shown an improvement in patient quality of life and a decrease in annual medical costs (44–46). A recent meta-analysis of multiple systematic reviews on the effectiveness of home telemonitoring demonstrates relative risk reductions for all-cause mortality and HF-related hospitalizations compared with usual care. Risk reductions in mortality and hospitalizations are greater in patients discharged after a recent HF exacerbation (hazard ratio: 0.62; 95% confidence interval: 0.42 to 0.89) (47). However, another systematic review of telemonitoring technologies suggested that many of the studies were low-to-intermediate quality, with small sample sizes and lack of control subjects. These studies also did not report 95% confidence intervals or p values, making it difficult to assess the significance of reported effects. Therefore, the effectiveness of telemonitoring remains controversial (48). Although telemonitoring seems to be an acceptable method of monitoring in patients with HF, the published data should be interpreted cautiously in light of the risk of bias within the available data. As a result, additional large randomized trials are needed to confirm these findings and develop proper guidelines for the implementation of telemonitoring.

DEVICE THERAPY. In terms of integrating technology and telemonitoring for the treatment of HF, there are a few things on the horizon, including implantable wireless hemodynamic monitors (e.g., the CardioMEMS HF System [CardioMEMS, Inc., Atlanta, Georgia]) and implantable intrathoracic impedance monitoring. CardioMEMS ia a sensor that is implanted into the pulmonary artery to directly measure pulmonary artery pressure. Providers have access to the wireless data measures by the pulmonary artery sensor, allowing preemptively managed treatment of patients with worsening HF. The CHAMPION (CardioMEMS Heart Sensor Allows Monitoring of Pressure to Improve Outcomes in NYHA Class III Heart Failure Patients) trial demonstrated a significant reduction in hospitalizations for patients who were managed with the wireless sensor (49). The IN-TIME (Implant-based Multiparameter Telemonitoring of Patients with Heart Failure) trial was another trial that showed benefits of daily, implant-based telemonitoring in preventing acute episodes and keeping patients out of the hospital (50,51). Implantable intrathoracic impedance monitoring is another form of device therapy targeting early diagnosis of an acute episode to prevent hospitalization. This technology has emerged as a promising technique for the detection of imminently acute HF (52). Yet to date, randomized trials have been unsuccessful in determining the extent to which the use of this technology can prevent hospitalizations. Studies are still ongoing to determine whether the use of impedance fluid monitoring with alerts can reduce HF decompensation and health care use (53,54).

CONCLUSIONS

Optimal management of acute HF is challenging. Patients are complex with multiple cardiovascular and noncardiovascular comorbid conditions, requiring close collaboration with multiple providers. When patients decompensate or experience HF for the first time, a new heterogeneous and multidisciplinary group of providers and loci of care emerge, including specialized outpatient clinics, the ED, primary care offices, and hospital-based interventions. Reducing hospitalization and rehospitalization for HF requires broadly based comprehensive teamwork. For the ED, improved risk stratification algorithms are an unmet

need, and further data are necessary to quantify the need for observation unit use or discharge to an SDAC model. Rather than a transaction of care, EDs have an important role in the overall patient journey. Finally, SDACs pose an exciting area of growth that could significantly reduce hospitalizations for acute HF. As new technologies emerge with numerous innovative and integrative solutions on the horizon, the future holds significant opportunities to improve the management of patients with acute HF.

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