Review Article

Current Emergency Department Disposition of Patients With Acute Heart Failure: An Opportunity for Improvement

DANA R. SAX, MD, MPH,[1,2] DUSTIN G. MARK, MD,[1,2] JAMAL S. RANA, MD, PhD,[2,3] MARY E. REED, DR, PH,[2] JOANN LINDENFELD, MD,[4] LYNNE W. STEVENSON, MD,[4] ALAN B. STORROW, MD,[5] JAVED BUTLER, MD, MPH, MBA,[6] PETER S. PANG, MD,[7] AND SEAN P. COLLINS, MD[5]

Oakland, California; Vanderbilt, Tennesee; Jackson,Mississippi; and Indianapolis, Indiana

ABSTRACT

Emergency department (ED) providers play a critical role in the stabilization and diagnostic evaluation of patients presenting with acute heart failure (AHF), and EDs are key areas for establishing current best practices and future considerations for the disposition of and decision making for patients with AHF. These elements include accurate risk assessment; response to initial treatment and shared decision making concerning optimal venue of care; reframing of physicians' risk perceptions for patients presenting with AHF; exploration of alternative venues of care beyond hospitalization; population-level changes in demographics, management and outcomes of HF patients; development and testing of data-driven pathways to assist with disposition decisions in the ED; and suggested outcomes for measuring success. (*J Cardiac Fail 2022;28:1545–1559*)

Key Words: Emergency department, risk stratification, shared decision making, risk tolerance, alternative venues of care.

Of the 1 million yearly emergency department (ED) visits in the United States for acute heart failure (AHF), more than 80% lead to hospitalization.[1] Notably, up to 20% of patients with AHF are readmitted within 30 days for both heart failure (HF) and non-HF-related reasons.[2] Both HF hospitalizations and readmissions increased nationally between 2010 and 2017.[3] Simultaneously, between 2000 and 2017, there was a 21% increase in age-adjusted mortality for HF which, coupled with the aging population, resulted in a 38% increase in the number of deaths due to HF.[4] The Centers for Medicare and Medicaid Services (CMS) Hospital Readmissions Reductions Program (2012–present) has aimed to improve hospital-care quality, but findings are inconclusive regarding its impact on clinical outcomes.[5–7] This paradigm of rising hospitalizations, costs and deaths due to HF highlight the significant challenges facing patients, providers and policy makers in developing strategies to improve outcomes, quality of life and the value of care for patients with AHF.

The ED plays a critical role in the initial stabilization, resuscitation and diagnostic evaluation of patients presenting with AHF. The emergency physician serves as the key decision maker in disposition decisions. Early AHF research focused primarily on hospitalized patients, but several recent studies

From the [1]Department of Emergency Medicine, Kaiser Permanente Northern California, Oakland and Richmond Medical Centers, Oakland, California; [2]Division of Research, Kaiser Permanente Northern California, Oakland, California; [3]Department of Cardiology, Kaiser Permanente Northern California, Oakland and Richmond Medical Centers, Oakland, California; [4]Department of Cardiology, Vanderbilt University Medical Center, Vanderbilt, Tennesee; [5]Department of Emergency Medicine, Vanderbilt University Medical Center, Vanderbilt, Tennesee; [6]Department of Cardiology, University of Mississippi, Jackson, Mississippi and [7]Department of Emergency Medicine, Indiana University, Indianapolis, Indiana.

Manuscript received February 24, 2022; revised manuscript received May 6, 2022; revised manuscript accepted May 12, 2022.

Reprint requests: Dana R. Sax, MD, MPH, Kaiser Oakland Medical Center, Emergency Department, 275 West MacArthur Boulevard, Oakland, CA 94611. E-mail: danar.sax@kp.org

1071-9164/$ - see front matter

https://doi.org/10.1016/j.cardfail.2022.05.006

have shifted focus to outcomes after ED discharge, providing insight into this under-studied population.[8–11] Studies demonstrate a complex population, with risks similar to those of hospitalized patients and 30-day mortality rates consistently in the 2.5% to 4% range, along with significant differences in rates of outcomes across studies.[9,10,12–14] Identifying patients at lower risk and providing safe transitions to outpatient care remain elusive goals for ED providers.

The goal of this study was to review best practices for decision making about the disposition of patients with AHF in EDs. It includes understanding the utility of AHF risk stratification for shared decision making (SDM) and describing population-level shifts in HF demographics and nonhospital venues of care options that may alter ED management options. We also highlight the need for better calibration of multidisciplinary physician and patient risk perceptions of mortality and readmission.

The article is organized into the following sections: key take-home points for each of these sections are shown in Table 1.

- ED risk assessment: physiologic and self-care assessments, patient reevaluation after initial treatments and SDM;
- Reframing risk thresholds: potential benchmarks for ED discharge, ED physician risk tolerance and risk-adjusted outcomes;
- Thinking beyond hospitalization: observation units, infusion clinics, bridging units, and health care at home;
- Population-level changes in demographics and outcomes;
- Future directions.

ED Risk Assessment

The acute evaluation and management of patients with AHF in EDs involves achieving hemodynamic balance, improving functional capacity and identifying potential causes of decompensation.[15] Specifically, ED providers must: (1) define the patient's risk of a short-term serious adverse event; (2) help the patient feel better; (3) identify and address reasons for the exacerbation; and (4) ensure a good follow-up plan. A small percentage of patients need critical hemodynamic stabilization, but most patients' treatments are aimed at relieving congestion and achieving euvolemia.

Patients with AHF most commonly present with congestion.[16] Efficient diagnosis of AHF is important because delays in care delivery are associated with increased likelihood of mortality, longer lengths of hospital stay and higher costs.[17–19] Evaluation begins with the patient's history and a physical examination, although no historical or physical examination finding on its own can reliably diagnose or rule out AHF.[20] ED evaluation includes chest radiography, electrocardiogram, biomarkers, and point-of-care ultrasound. The results of these studies help to identify AHF from other disease processes, determine severity of illness and identify precipitating factors.

Table 1. Summary of Key Take-Home Points From Each Section in the Manuscript

Manuscript Section	Key Take-home Points
ED risk assessment	ED risk stratification and disposition decision making must include accurate, personalized assessments of: physiologic risk, self-care abilities and response to initial ED treatments. This should inform shared decision making to discuss risks and disposition options.
Reframing risk thresholds	Patients in EDs with AHF have complex and heterogeneous traits and have significantly elevated baseline risks. 30-day mortality rates in patients with AHF discharged from EDs range from 2.5%–4.4% across settings. Current "acceptable" risk tolerance should be re-calibrated. Risk models paired with acceptable event rates can safely lower admission rates and establish standard of care.
Thinking beyond hospitalization	A greater focus on alternative venues of care are needed, including observation units, outpatient infusion units, bridging units, and health care at home. Smooth transitions to an outpatient care team are essential.
Population-level changes affecting ED disposition options	Increasing age, comorbidity burdens and prevalence of HFpEF Greater use of palliative and hospice care and SNFs after discharge
Future directions	Develop and test care pathways based on accepted risk thresholds, with local patient population and available resources in mind. Advocate for payment reform to promote nonhospital care. Study outcomes other than hospitalization/rehospitalization to understand how best to measure success.

AHF, acute heart failure; ED, emergency department; HfpEF, heart failure with preserved ejection fraction; SNF, skilled nursing facility.

ED management of patients with AHF is focused on ensuring hemodynamic stability and improvement of symptoms. Treatment is often based on presenting blood pressure (low, normal or high) and the degree of congestion. Vasodilators may be required to correct elevated filling pressures and/or afterload; selection is based on underlying hemodynamics. There is no strong evidence for a specific choice of vasodilator, although nitroglycerin is easily titrated and is the most commonly used.[21]

Congestion due to volume overload remains a key treatment target. Diuretics are the most common initial therapy and often lead to symptomatic improvement within hours of administration.[22] Guidelines suggest early intravenous loop diuretic administration. For a patient on long-term loop diuretics, the Diuretic Optimization Strategies Evaluation (DOSE) trial demonstrated the safety and efficacy of using $2.5 \times$ a patient's outpatient dosage on a mg-per-mg basis.[23] For example, for patients taking 40 mg furosemide twice a day, initial IV dosing would be 100 mg of furosemide intravenously. For patients not on long-term diuretics, 40–80 mg IV of furosemide or the equivalent is a reasonable empiric starting dosage.

After monitoring responses to initial treatments, ED providers plan next steps and, in particular, decide which patients need hospitalization. Patients with critical illness, including respiratory failure, cardiogenic shock, incessant ventricular tachycardia, and those in need of urgent diagnostic or therapeutic procedures, clearly need hospital admission, often to the intensive care unit. Patients with certain medical factors also usually require hospital admission, including suspected subacute hypoperfusion, diuretic resistance, advanced chronic kidney disease, uncontrolled atrial arrhythmias (atrial fibrillation/flutter), severe valvular disease, significant congestion, or new-onset HF.

Recognizing that no patients with AHF are truly at low risk, large international studies suggest that the remaining patients (up to 50%) may be considered to be at lower risk; 7-day and 30-day mortality rates are close to 1% and 2%, respectively.[10,24–26] Multiple recent studies describe characteristics that identify the patients with lower risk in EDs.[8,10,11,14,26,27] These characteristics include findings independent of the ED visit, such as younger age, lower body mass index and lower burden of important comorbidities. Further, data obtained during the ED visit can improve risk stratification. Such data include vital signs (most commonly oxygen saturation and blood pressure), laboratory values (most commonly measures of renal function, troponin and natriuretic peptides) and arrival mode (ambulance vs walk-in). Various combinations of these variables are included in recent AHF risk-stratification tools,[(8–11,27)] as described in greater detail below.

We outline a process for ED disposition decisions for these remaining "lower risk" patients. Consideration of ED discharge starts with identifying patients with low 30-day mortality risks, followed by a plan to ensure continued symptom improvement after discharge, including up-titration of HF therapy and early follow-up by providers. Together, these elements should mitigate risk of recurrent ED visit and hospitalization. Risk assessment includes AHF-specific risk, non-HF medical risk, nonmedical risk (including personal and community support), and options for monitored home care. SDM should occur after assessing patients' and caregivers' understanding of risk and care options.

We describe a process of identifying patients in an ED with AHF who may be appropriate for ED discharge in our Visual Take-Home Figure. Elements of this process were successfully implemented recently in a hospital system in Missouri[28] and were successfully used in a randomized trial of self-care strategies in patients discharged from the ED.[24] We offer a nuanced perspective of these approaches by providing an update of comprehensive risk assessment (including physiological and self-care assessment) and by highlighting the importance of symptom reassessment, SDM and potential options for nonhospital care among lower risk patients.

Accurate Physiologic Risk Assessment

The ability to predict short-term risk in the ED accurately is critical to developing safe, patient-tailored care plans while optimizing outcomes and managing resource use. Consensus guidelines recommend risk stratification but provide few objective measures to assist with decision making about disposition of patients after the ED.[29] Earlier studies focused on identifying high-risk markers that are associated with increased morbidity and likelihood of mortality.[30] However, the challenge is that as much as 50% of patients in EDs lack these features,[31] and the absence of high-risk features does not equate to lower risk.

ED providers' disposition decisions have changed little in the past decade. Recent data suggest that discharge of moderate- and high-risk patients from an ED, as well as admission of lower-risk patients, are common.[10,13] This highlights an opportunity to improve outcomes and align resource use with AHF risk through more accurate risk assessment. We focus mainly on AHF-specific risk, but it is important to note that a careful assessment of non-HF comorbid risks, in particular, chronic kidney disease, is also critical.

Several ED-specific AHF risk-stratification tools have been developed with the goal of identifying lower-risk patients amenable to safe ED discharge, most often by estimating short-term morbidity and mortality statistics (Table 2). Most tools have been developed to predict major adverse events at 30 days, because it is the common window for reporting most clinical and regulatory outcomes for patients with AHF. Among these, the Ottawa Heart Failure Risk Scale (OHFRS) (Canadian), the Emergency Heart Failure Mortality Risk Group (EHMRG) (Canadian) and the Multiple Estimation of risk based on the Emergency department Spanish Score In patients with AHF (MEESSI-AHF) (Spanish) scores have all been prospectively validated and were able to identify a lower-risk cohort with good to excellent discrimination.[9,11,27] The use of a 3-minute walk test (OHFRS) and inclusion of the Barthel index score (MEESSI-AHF) add some complexity and challenge, with implementation as part of clinical care. The EHMRG tool was derived and validated to predict risk of mortality at 7 days, although the model was later extended to include 30-day mortality. An upcoming trial across 10 hospitals in Canada will study whether use of the EHMRG tool coupled with rapid outpatient follow-up achieves better outcomes than conventional decision making.

These tools hold promise in safely identifying a cohort of patients who may be safe for discharge, but ED practice patterns in Canada and Spain are notably different from those in the United States and may limit generalizability. These differences include overall shorter lengths of stay in EDs and higher admission rates in the United States as well as varying patient populations and incentives for hospitalization and readmission.

STRATIFY stands as the sole risk-stratification tool that was prospectively derived from a U.S. population to identify patients with AHF at low risk for 30-day adverse events.[8] The dissemination and implementation of STRATIFY is being studied in large health care systems in the U.S. (R01HL157596-01). In 2020, using STRATIFY as a foundation, a Kaiser Permanente Northern California (KPNC) ED AHF risk model added 58 additional variables and machine-learning methods to increase significantly the accuracy of risk prediction.[10] Implementation and evaluation of use of the KPNC risk tool to assist with disposition decisions is being studied across EDs in that system (KPNC Delivery Science Grant). The added complexity of this model may limit generalizability to settings with less comprehensive electronic health record systems.

Choice of the optimal risk model to implement should be based on local practice patterns, the model's predictive accuracy, internal and external validation processes (cohort size, location of validation), the target outcome measure, the availability of prior records, and the ease of implementation. Ongoing implementation studies will help to define these characteristics further. A recent analysis to evaluate the additive value of the EHMRG to clinical judgment found that a combination of provider gestalt and tool use improved predictions.[9] Similar studies are underway to assess risk-tool implementation. These results will inform providers regarding ideal tool selection for their practice's settings.

Self-Care Considerations to Facilitate Safe ED Transition to the Outpatient Setting

An assessment of a patient's ability to practice self-care must occur alongside physiological risk assessment. Self-care behaviors, such as symptom monitoring, medication taking, dietary adherence, and exercise, have been associated with decreased numbers of hospital readmissions.[32–34] Barriers to self-care must be identified and addressed for patients to facilitate continued symptom improvement after ED discharge. A multidisciplinary team is critical in this process to help develop care plans for patients who are commonly elderly and have multiple comorbidities and complex social needs. Admission may be indicated if a viable home environment (including a plan for adequate caregiver support and access to healthful food and medications) is not readily available at the time of evaluation in the ED.[24]

A recent randomized trial of a self-care intervention for patients discharged after ED-based management[24] found improvement in subsequent ED and hospital visits and health status. This trial used home visits and biweekly self-care coaching calls over 3 months to teach patients sustainable methods of self-care. These interventions were designed to transition care from the acute to the home setting and, thereby, ensure patient safety and well-being and avoid unnecessary hospitalization. The trial found significant differences between the intervention and usual care arms at day 30, suggesting that self-care interventions are feasible and may improve HF-related outcomes in patients discharged after ED-based management. Significant differences did not persist through 90 days, but incorporating succinct and easily deliverable self-care interventions as part of the standard ED discharge process may be an essential component in safe, early transitions from the ED to the home setting.

Several studies highlight additional nonpharmacologic strategies to improve patients' outcomes by focusing on the transition of care from the ED to the outpatient setting.[35–37] These transition strategies include the use of a multidisciplinary approach to improve patients' quality of life,[38] frailty and dependence.[39–42] Ideally, multidisciplinary care should be initiated in the ED and continued throughout the postdischarge period. Interventions

Table 2. Selected Recent Acute Heart Failure Risk Stratification Studies (in Chronological Order by Risk Tool) Determining Events Within 30 Days of Index ED Presentation in Cohorts That Included Patients Discharged From EDs

First author, year, study location, risk tool name	Study type	N	Predicted outcome	Variables in model (number of variables and description)	Notes
Sax DR, 2020 (U.S.), KPNC AHF risk tool[12]	E, R, D	26,189	30-day SAE (composite: acute coronary syndrome, coronary revascularization, emergent dialysis, intubation, mechanical cardiac support, cardiopulmonary resuscitation, and death)	13: original STRATIFY variables (see below) plus 58 additional variables (comorbidities, medications, health care use, changes in baseline weight/blood pressure, additional ED vital signs and laboratory values)	Multiple models tested; best-performing machine-learning model c-statistic = 0.85.
Collins SP, 2015 (U.S.) STRATIFY[9]	E, P, D	1033	5- and 30-day hierarchical SAE (acute coronary syndrome, coronary revascularization, emergent dialysis, intubation, mechanical cardiac support, cardiopulmonary resuscitation, and death)	13: Age, body mass index, ED vital signs and laboratory values, dialysis, vital signs, supplemental O2 use, and QRS duration	C-statistic = 0.68. At risk thresholds of 1%, 3%, and 5%, 0%, 1.4%, and 13.0% of patients were at lower risk, with negative predictive values of 100%, 96%, and 93%, respectively
Wussler, 2019 (Switzerland) MEESSI-AHF[86]	E, P, V (external validation of MEESSI-AHF score in Switzerland)	1247	30-day mortality	12: ED vital signs and labs, age, New York Heart Association IV, low output symptoms, episode associated with ACS, hypertrophy on EKG (calculated using alternative model with all original variables except Barthel Index score)	c-statistic: 0.80; Also compared MEESSI-AHF to EMERG score (among 849 patients with all variables available): c-statistic 0.82 vs 0.77, respectively ($P = 0.03$)
Miro, 2017 (Spain) MEESSI-AHF[11]	E, P, D, and V	4867 (D) and 3229 (V)	30-day mortality	13: Barthel Index score, ED vital signs and labs, age, New York Heart Association IV, low output symptoms, episode associated with ACS, hypertrophy on EKG	c-statistic = 0.84 and 0.83 for derivation and validation cohorts, respectively
Lee, DS, 2019 (Canada) EHMRG7 and EHMRG[10]	E, P, V	1983	7- and 30-day mortality	10: Age, arrival by ambulance, ED vital signs and laboratory values, active cancer, use of Metolazone, ischemic changes on EKG	7-day mortality c-statistic = 0.81; 30-day mortality c-statistic = 0.77; discrimination slightly improved when physicians' gestalt added to risk tools' estimates
Lee, 2012 (Canada) EHMRG7[87]	E, R, D	12,591	7-day mortality	10: Age, arrival by ambulance, ED vital signs and laboratory values, active cancer, use of Metolazone, ischemic changes on EKG	C statistic = 0.81 and 0.83 for derivation and validation cohorts, respectively

(continued)

Table 2 (*Continued*)

First author, year, study location, risk tool name	Study type	N	Predicted outcome	Variables in model (number of variables and description)	Notes
Stiell, 2017 (Canada) OHFRS[13]	E, P, V	1100	30-day SAE (death, admission to monitored unit, intubation, noninvasive ventilation, myocardial infarction) or relapse resulting in hospital admission within 14 days	10: history of transient ischemic attack or stroke, history of intubation, ED vital signs and laboratory values, arrival by ambulance, drop in oxygen saturation during walk test	Compared to actual practice, use of OHFRS score > 1 would increase sensitivity (71.8% vs 91.8%) but increase admissions (57.2% vs 77.6%). Use of threshold of > 2 would have led to a similar sensitivity but reduced admission rates.
Stiell, 2013 OHFRS (100)	E, P, D	559	30-day mortality and 14-day nonfatal SAE	10: history of transient ischemic attack or stroke, history of intubation, ED vital signs and laboratory values, arrival by ambulance, drop in oxygen saturation during walk test	C-statistic = 0.77

D, derivation; E, emergency department; I, inpatient; P, prospective; R, retrospective; SAE, serious adverse event; V, validation.

may be delivered during an office visit, virtually or in the patients' homes, and may include education, symptom monitoring, telemonitoring, medication management, cardiac rehabilitation, psychological support, and palliative care.[43]

Patient Reassessment for Symptom Improvement and Reason for AHF Exacerbation

Reassessment of patients is important after physiological risk and self-care abilities have been quantified, and early ED therapy has been delivered. Early diuretic therapy improves symptoms in most patients after 2–6 hours,[44] so that is a good time window for reassessment.

Guidelines suggest efficient titration of the diuretic dosage based upon evaluation of diuretic response using urinary sodium concentration and/or urine output as markers.[45,46] However, a urine sodium strategy has yet to be prospectively tested compared to urinary output, and accurate urinary output collection is challenging. Loop diuretics have steep dose/response curves and have little effect until a threshold is reached, beyond which the response rapidly approaches a ceiling.[46] Until we have prospective efficacy data about urinary sodium as a guide, urinary output and symptom response should be used to evaluate diuretic responsiveness and titration. Potential reasons for poor diuretic responses must be evaluated,[47] and these patients commonly need hospital admission.

In addition to reevaluating the patient's symptoms, the precipitant should be investigated. Common precipitants include dietary changes resulting in excessive salt or fluid intake, inappropriate medication use or nonadherence, arrhythmias, ischemia, and infection.

Assessing and Addressing Social Determinants of Health

Social determinants of health must be considered when determining disposition. Socioeconomic status, health care coverage, access to care, education, health literacy, social support, medication access, transportation, food and housing insecurity, local air quality, substance use, and sociodemographic disparities are associated with patients' outcomes and quality of life of patients with HF.[48–50]

EDs serve as safety nets and provide care for vulnerable patients. Lower neighborhood socioeconomic characteristics and spatial access to health care are associated with increases in numbers of ED visits because of HF.[51] Unfortunately, most EDs lack the resources to assess fully and address many of the underlying social determinants of health that may impact outcomes. Several ED-based studies describing interventions that target access to care and coverage, transitions of care, home meal delivery of medically tailored meals, and increasing transportation access have shown feasibility and acceptability and have had positive impacts on linkage to resources, downstream ED use and health outcomes.[52−54] ED systems should, thus, be empowered to work with patients to address these social determinants with the help of nurses, social workers, pharmacists, and other health care providers. Further study and resource allocation are needed to understand how to implement optimally the interventions addressing social determinants of health and their impacts on patients' outcomes. Multifaceted models of care would fit best with the ED's available resources while being tailored to the specific needs of the patients, including nurses, social workers, pharmacists, and other health care providers. Similar to a clinic visit, fully managing social determinants of health in a single ED visit is challenging.

SDM in ED Disposition Planning

Once a patient has been accurately stratified as being at lower risk and has adequate self-care capabilities, a SDM conversation can inform the optimal strategy for continued care, with input from the patient, caregiver and provider. This conversation is particularly germane to patients with AHF. SDM allows patients with chronic disease who experience intermittent worsening of symptoms to consider differing levels of treatment intensity at various points in their symptom and disease trajectory. Such shared decisions regarding treatment alternatives may be prioritized based on the patients' chronicity, goals of care, severity of HF symptoms, and social support. Those with severe acute symptoms may have several options, whereas those with chronic severe symptoms may be limited to options related to advanced HF therapies only.

Patients who present with mild AHF exacerbations may be amenable to be discharged after a brief period of ED-based management. SDM plays a key role in the discharge process with this group of patients. The unique challenges of ED-based SDM include uncertainty surrounding an individual patient's course, difficulties in engagement during the acute phase of the illness, unawareness of life-limiting potential,[55] difficulty in interpreting numeric data and statistics,[56] impaired cognitive function,[57] and the time pressures of emergent care. Having an objective, real-time and reliable risk tool providing a readily interpretable measure of 30-day events would assist in solving several of these unique challenges. In addition, particularly vulnerable ED populations, such as the elderly and those with low health literacy or numeracy, may have less interest in SDM.[58] We believe SDM will be most successful when validated physiological risk tools are combined with self-care interventions in a patient-appropriate manner for joint decision making among all stakeholders.[59]

Reframing Risk Perceptions and Optimal Care Pathways for Patients With AHF

Patients presenting to the ED with AHF are a complex and heterogeneous population. The framework for applying risk estimates, assessing self-care behaviors and using SDM to decide on disposition should be tailored to the risks in this population. For instance, 30-day mortality rates among patients discharged from an ED ranged from 0 to 14% across risk quintiles,[9] and 1-year mortality rates after an ED visit for AHF varied from 24% to 42% based on presenting phenotype (normal vs hypoperfusion and congestion vs no congestion).[16] Physicians in EDs face formidable challenges when pairing risk estimates with appropriate dispositions of patients with acute deterioration of a chronic illness that is protean in nature. These patients often have unknown baseline risks that, even during a stable period, is never zero. The background high morbidity and mortality rates of this population need to be considered as patients, caregivers and providers discuss optimal treatment options and venues of care.

Identifying Potential Mortality Benchmarks to Guide Disposition Decisions

Earlier studies defined low-risk patients in EDs and with AHF as having 30-day readmission rates of 15%−20% and mortality rates of less than 1%.[31,60,61] More recently, an international consensus document suggested a 40% ED discharge rate for patients with AHF (in facilities able to observe patients) with goals for 30-day all-cause mortality of < 2% and 30-day ED revisit or hospitalization due to AHF of < 20%.[62] The authors acknowledge the paucity of data on outcomes of patients discharged from EDs (and at the time, no clinical studies from the U.S.) and the need for further studies to allow for potential modifications to these initial benchmarks.

We lay out key studies and outcomes after ED evaluation from Europe, China and North America during the past 15 years in Appendix Table 1. Despite differences in study cohorts, these studies suggest that ED discharge rates ranged from 20% to 35%, and 7- and 30-day mortality rates among patients discharged from EDs ranged from 0.5% to 1.3%[27,63] and 2.5% to 4.4%, respectively.[9,10,12,14] Of note, 30-day mortality risk following ED discharge remains fairly elevated, even when restricted to the subgroup of patients with lower predicted risk of adverse outcomes (1.6% in the Spanish cohort).[64] In the largest study of U.S. patients with AHF who were discharged, of whom 75% had 7-day outpatient follow-up, the 7-day and 30-day mortality rates were 1.2% and 3.9%, respectively.[14]

As risk tools and data on outcomes of patients in EDs with AHF become more available, there is an opportunity to use risk models to help establish what defines local standard of care. Implementation of a risk-prediction instrument to aid decision making in EDs and to identify a cohort of patients at lower risk is a crucial first step to provide patient and provider reassurance regarding safe discharge. In a large, multicenter study of patients in the U.S., approximately 50% of patients may be identified as low to moderate risk, with 30-day mortality rates around 2%.[25] Similarly, in a large study of Canadian patients, Lee et al. found up to 50% of patients had a $<$ 1% 7-day mortality risk based on application of the EHMRG risk model.[26] Hejjaji et al. recently implemented a pathway in which ED physicians used the EHMRG tool to identify patients with a $<$ 1% 7-day mortality threshold to assist with discharge decisions. They found that this led to an increase in safe ED discharges and more optimal matching of patient risk with intensity of care.[28] We note that an assessment of symptom improvement and the ability for continued care at home plus an identification of the reason for the exacerbation should also be included in algorithms to consider ED discharge.

Studies of risk-adjusted outcomes further support these targets. Among more than 26,000 patients in EDs with AHF, the 25% of patients in the lowest predicted risk strata, based on retrospective application of the KPNC risk tool, had an observed 30-day mortality of $<$ 1% and an observed 30-day total serious adverse event rate of $<$ 2%. Importantly, event rates were similar among admitted, observed and directly discharged patients.[25] This suggests that the use of a validated risk tool can identify truly lower-risk patients who may be safe for ED discharge and that hospitalization may not offer mortality or serious adverse event benefits for lower-risk patients.

ED Physicians' Risk Tolerance

Awareness of the baseline elevated risk among patients with AHF in EDs is essential for framing disposition decisions. Surveys of ED physicians suggest that a majority are unwilling to accept risks of an adverse event beyond 1% for most acute conditions.[61,65] However, we believe acceptable event rates among discharged patients should be patient- and disease-specific. For example, recent American College of Emergency Physicians guidelines advocate for an acceptable 30-day missed diagnosis rate of major adverse cardiac events in patients presenting to EDs with chest pain of 1%−2%.[66] Although this risk threshold is higher than ED physicians' professed acceptable risk tolerance, it acknowledges that some adverse events are not preventable, and there are risks and costs of over-testing. Similarly, we believe that risk thresholds for patients experiencing exacerbations of a highly morbid, chronic condition such as AHF must be viewed in context. This is especially important considering that physician risk aversion combined with a lack of disposition recommendations from national guidelines contribute to admission for more than 80% of patients in EDs.[1] We suggest better framing of 30-day mortality rates for patients with AHF who have been discharged from EDs. Helping ED physicians recognize current risk as high as 4.4% is pivotal in garnering acceptance of a 2% 30-day all-cause mortality benchmark. ED physicians' understanding of the increased morbidity and mortality risks in this population can help to reinforce the need for careful individual assessment and implementation of a thorough follow-up plan.

Risk stratification, followed by self-care assessment and SDM, as highlighted in the Visual Take Home Figure, has clear potential to identify lower-risk patients who are safe for discharge from an ED. Use of a risk stratification tool, with a 2% accepted 30-day mortality rate, could be expected to provide better alignment of risk and hospital admission by increasing the number of lower-risk patients being discharged (directly from the ED or after a brief observation period) and the number of higher-risk patients being admitted to the hospital. This may also simultaneously establish local standards of care to minimize subsequent medicolegal risk. However, risk estimations must be validated and tailored to specific ED settings, especially because the level of integration of follow-up and continuity of care may vary.

Thinking Beyond Hospitalization: Alternate Venues of Continued Care

Other than patients who clearly need hospitalization, it is unclear whether there are differences in outcomes or patient preferences for: (1) care in the hospital, (2) a nonhospital alternative venue of care or (3) discharge to home with close follow-up. Although the hospital is currently still the standard venue for providing acute medical care, there are significant hazards of hospitalization, particularly for elderly or frail patients. SDM may identify patients willing to accept some risk of an event (repeat ED visit, hospitalization or clinical adverse event) to be able to continue their care outside of the hospital. Given rising hospital admissions and associated costs, there is increasing focus on exploring alternative routes to provide effective care.[67]

If the decision is made to discharge a patient with AHF from an ED, robust, safe and efficient transitional care programs are essential (Fig. 1). Postdischarge models typically include clinic care (medication management), multidisciplinary care and case management. Case management and multidisciplinary care programs show positive impacts on mortality and rehospitalization.[29] Among patients with AHF who have been discharged from EDs, outpatient physician follow-up within 7 days (clinic or telemedicine) is associated with significantly lower odds of repeat short-term ED visits, all-cause hospitalizations and mortality.[14] However, moving from an 80% admission rate to discharge to home requires a stepwise process (Fig. 2).

Observation Units

An observation setting may be an ideal place to begin the transition to home. The observation unit allows simultaneous treatment with intravenous diuretics and modification of oral cardiovascular medications. Intravenous diuretics may be continued during this period of observation to determine the need for hospital admission based on diuretic and natriuretic response.[68] Further risk stratification and identification of precipitants can also occur, allowing care teams to determine clinical stability. Importantly, barriers and potential strategies to optimize self-care can be identified, and early outpatient follow-up can be arranged. Prior studies suggest that patients with AHF who are managed in an observation setting have similar outcomes and improved resource use compared to a risk-matched group of admitted patients.[69]

Outpatient Infusion Units

Outpatient infusion units for HF were previously developed and well-reimbursed to offer outpatient inotropic infusions. However, outpatient units have recently been used to administer intravenous diuretics with the intent of decreasing ED visits and hospitalizations. Several outpatient infusion units across the U.S. have found: (1) similar clinical outcomes compared to hospitalized patients among similarly matched patients; (2) patient preference for use of these units; and (3) decreases in subsequent ED and hospital use.[70,71] These units may be particularly well suited to avoid hospitalizations for the "frequent ED utilizers," such as those showing limited adherence to their medical regimens and those with end-stage disease seeking to ease congestive symptoms without hospitalization prior to transition to hospice care.

Bridging Unit into and out of the Hospital

An innovative use to guide transitions from multiple points in the continuum of care may be a bridging diuresis unit.[72] For inpatients with good diuretic response, graduating patients from a high-intensity ED or inpatient status to a less resource-intense setting to accomplish decongestion may be optimal.

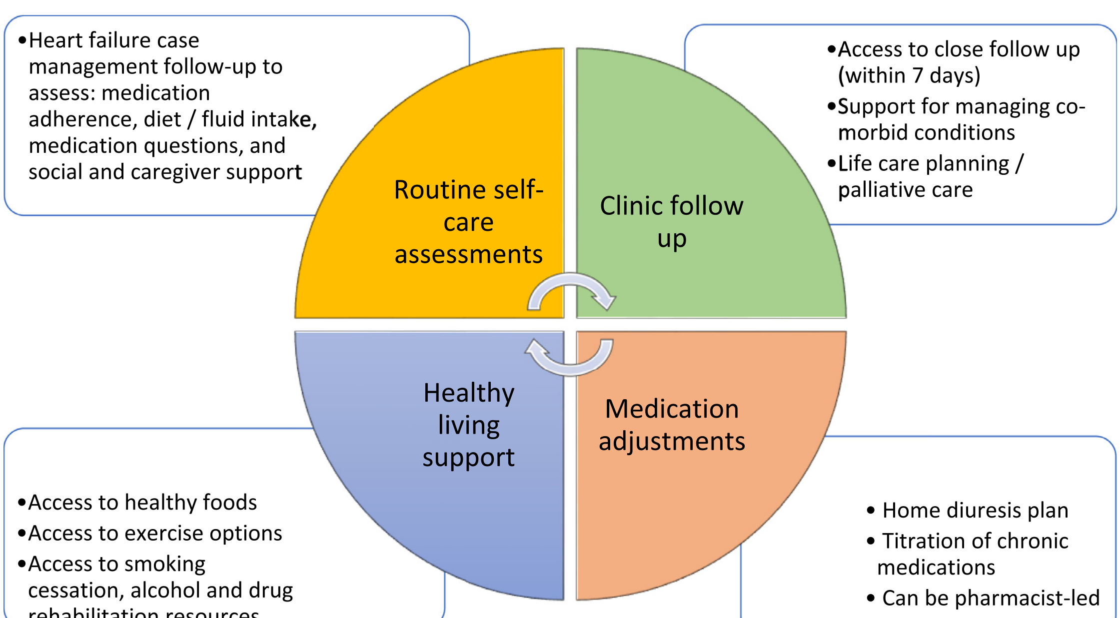

Fig. 1. Essential resources for postdischarge care (may vary depending on patient and community). An effective transition to outpatient care after an emergency department or hospital discharge must include routine self-care assessments, clinic follow-up, medication adjustments, and healthy living support.

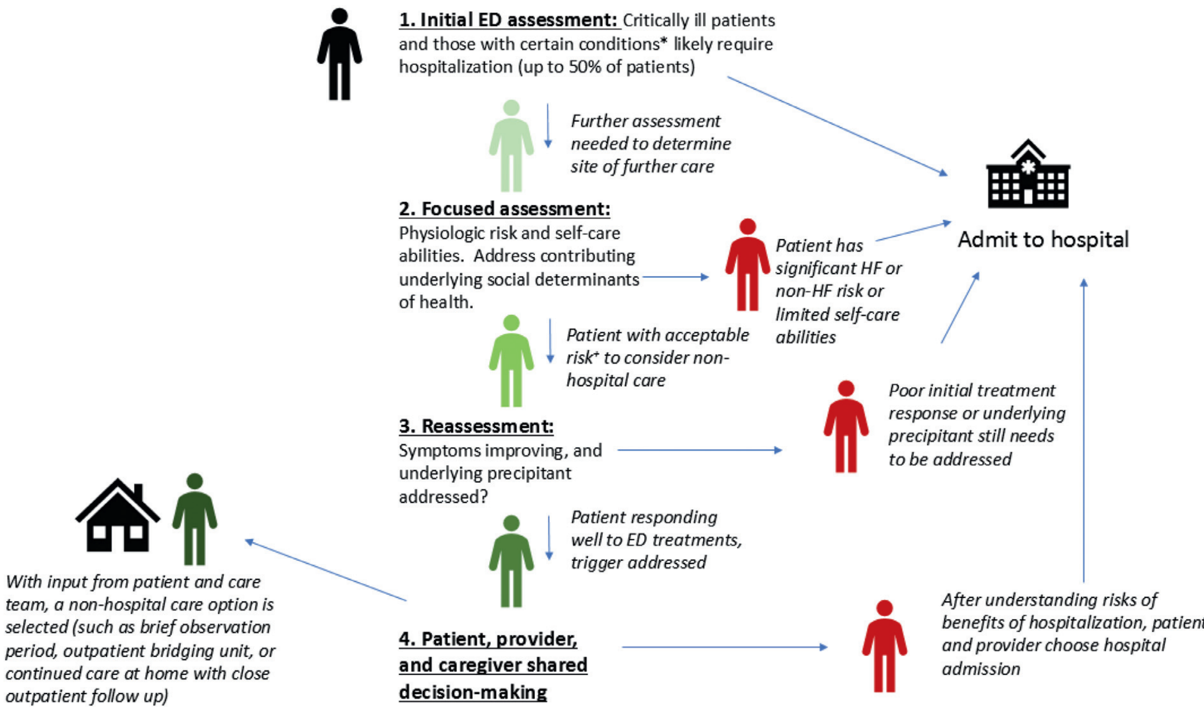

Fig. 2. Process of identifying patients in emergency departments (EDs) with acute heart failure (AHF) who may be appropriate for safe outpatient care. *Patients with certain medical factors usually require hospital admission; such factors includ suspected subacute hypoperfusion, diuretic resistance, advanced chronic kidney disease, uncontrolled atrial arrhythmias (atrial fibrillation/flutter), severe valvular disease, significant congestion, or new-onset HF. Health systems, with the support of professional societies, should establish acceptable risk thresholds for considering discharge. Consensus papers support using a 2% or less predicted 30-day mortality risk to consider ED discharge of appropriate patients with safe discharge plans, including close follow-up. Several ED AHF risk tools have been developed, and 3—EHMRG, OHFRS and MEESSI-AHF—have been externally validated, have high accuracy, are publicly available, and may be used to help guide site-of-care decision making. Currently these tools should be considered as options for disposition decision making. Implementation of the EHMRG, STRATIFY and KPNC AHF risk scores, as well analysis of their impacts on key patient outcomes are ongoing, and more data will be available soon to guide decisions about choosing a risk tool to implement.

Patients with good natriuretic response to diuretics and large reservoirs of peripheral fluid to be mobilized might be particularly appropriate candidates. For patients closer to euvolemia, repeated outpatient infusions and assessment might extend into a "Camp HF" setting in which patient education, medicine reconciliation and palliative care planning could also be offered. Investigation into mobile HF care units as a different bridging option for intravenous diuretics and skilled assessment daily in the home to decrease ED admissions safely is promising.[53] To ease the transition between the ED, inpatient units and home, bridging units could be located adjacent to the site of postdischarge follow-up, providing an opportunity for early course correction if congestion recurs after discharge.

Home Hospitalization

Last, an emerging option for lower-risk patients after ED evaluation and stabilization is care via a "hospital at home." This option is not yet available in most U.S. health care settings, but early studies show promise regarding clinical outcomes, health care use, quality of life, and costs.[73–75] In addition, CMS recently announced the Acute Hospital Care at Home program, providing eligible hospitals with regulatory flexibility to treat appropriate patients at home. Patients with AHF were identified by CMS as potentially ideal candidates for this program.[76] Further research is needed to better define AHF eligibility criteria, options for close outpatient physician and case management follow-up, reimbursement processes, and transitions from acute to chronic, stable care.

Population-level Changes in Demographics, Management, and Outcomes of Patients With HF

Several notable changes in demographics, therapeutics and outcomes in patients with HF over the past 20 years may have implications in ED management and disposition. The decision to admit a specific patient should be personalized, but these broad, population-level shifts may change the current paradigm of admission for nearly all patients.

Patients presenting with AHF are older and have a larger burden of comorbidities, particularly obesity, diabetes, chronic renal failure, and atrial fibrillation, but less ischemic heart disease.[39] A recent study of patients with AHF and known ejection fraction in EDs found that two-thirds of patients had heart failure with preserved ejection fraction (HFpEF), and 30-day adjusted mortality among HFpEF patients was significantly higher compared to patients with heart failure with reduced ejection fraction (10.2% vs 8.4%; $P < 0.05$).[77] Treatment options for both acute and chronic management have expanded, and recent international guidelines highlight these important changes.[78,79]

There have also been notable changes in resource use and end-of-life care that may impact acute and postacute care. U.S. hospital lengths of stay are shorter,[80] and increasingly, patients admitted for AHF are discharged to a skilled nursing facility.

Future Directions

Development and Testing of Data-Driven Care Pathways to Assist With Disposition Decisions

We believe the next important steps are for hospital systems to develop and test pathways for ED disposition planning and then, after iterative improvements, educate providers and broadly implement these pathways throughout the hospital system as part of usual care. Pathways must include accurate risk stratification, an assessment of symptom improvement, identification of reasons for the exacerbation, and a safe transition to outpatient care. Importantly, local context should be considered when choosing the risk-stratification tool and pathway for implementation. Further, multispecialty providers (in combination with patient groups and legal experts) need to discuss and agree on acceptable targets for adverse-event rates in discharged patients based on published outcomes so they can establish an evidence-based standard of care. Establishing these predefined safe harbors is being explored in other acute conditions in EDs.[81]

Providers' adoption of novel care pathways may be challenging.[28] Implementation strategies that consider barriers and facilitators to the use of risk tools are crucial. Prior implementation studies of ED risk-stratification tools for other conditions suggest feasibility and highlight the need for provider education and promotion to increase uptake. For example, uptake of a risk tool for pediatric patients with abdominal pain in EDs was close to 70% among EDs with on-site promotion and education.[82] Similarly, provider uptake for a risk-stratification tool for patients with pulmonary embolism in EDs was close to 70%, and implementation was associated with safe increases in outpatient management.[83] Qualitative studies suggest clinicians' attitudes and trust in the evidence and guidelines, the usefulness of the guidelines in real-time workflows, the quality of interdisciplinary relationships (for example between EDs and hospitalists and consulting cardiologists), and an organizational ethos of transparency and accountability also impact providers' readiness to adopt risk-based pathways.[84,85]

Success may be measured by changes in admission rates stratified by patient risk, patient-reported symptom improvement, short-term mortality, use of a risk tool and paired order sets in eligible patients, recurrent ED visits or hospitalization, and adherence to guideline-directed medical therapy. Studies implementing risk tools and guidance concerning disposition decisions must also carefully assess for adverse outcomes, including increased sociodemographic disparities in appropriate care. Further study is needed to identify the patients who might stand to benefit most from hospitalization and how to personalize postdischarge care in this heterogeneous population. In particular, as the proportion of patients with HFpEF increases, risk models and transition plans may have to be modified and tested in this unique population. Health systems will have to experiment with different implementation strategies and benchmarks, depending on the patient population, local practice patterns and risk tolerances and the availability of outpatient follow-up. Last, health systems should advocate for reimbursement strategies supporting nonhospital venues of care for appropriate lower-risk patients.

Conclusion

We challenge the current ED disposition process by reviewing recent outcome data for patients treated for AHF in EDs, currently accepted physician risk thresholds for ED discharge, population-level demographic changes affecting ED disposition options, and emerging venues of care outside of the hospital. Based on these data, we propose a data-driven approach to identify patients who may be good candidates for safe outpatient management. This approach includes an accurate assessment of physiological risk and self-care abilities and SDM conversations. Our approach defines patients at lower risk for mortality, higher thresholds for repeat ED visits and hospital admissions should be accepted but with benchmarks tailored to the health system's specific resources and the specific needs of each patient. Ultimately, in a robust infrastructure tailored to match patient preferences with best possible care, patients with AHF who are discharged from EDs and who return for further treatment should not be viewed as failures of the system but, rather, indicate patients who require intensification of therapy. Such advances in processes of care require changes in perspectives to shift the current and persistent paradigm away from high admission rates toward safe and efficient ED discharge.

Lay person introduction

Emergency department (ED) providers play critical roles in the evaluation, stabilization and coordination of next steps in care for patients presenting with acute heart failure (AHF). We present a framework for disposition decision making, which should center on accurate risk stratification, including acute physiologic and self-care assessments and response to treatment. Up to 50% of patients may be considered to be at lower risk, and alternative venues of care should be considered for appropriate patients. The development and testing of pathways based on risk stratification, shared decision making and safe transitions to outpatient care can help to inform a shift in care delivery for these patients.

Disclosures

Drs. Sax, Mark, Reed, and Rana were funded in part for this work by the Kaiser Permanente Northern California Delivery Science Program. Drs. Storrow and Collins received grant support from AHRQ, NIH, and PCORI. Dr. Pang is or has been a Consultant to the Heart Initiative (DSMB)] and has received research or other support from: Roche as in-kind support for an NHLBI funded study and AHRQ. He is a site investigator for studies funded by OrthoDiagnostics, Abbott, and Beckman Coulter. Dr. Butler has served as a consultant to Abbott, Amgen, Applied Therapeutics, Array, Astra Zeneca, Bayer, Boehringer Ingelheim, CVRx, G3 Pharma, Impulse Dynamics, Innolife, Janssen, LivaNova, Luitpold, Medtronic, Merck, Novartis, NovoNordisk, Relypsa, Sequana, and Vifor. Drs. Stevenson and Lindenfeld have no conflicts of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.cardfail.2022.05.006.

References

1. Storrow AB, Jenkins CA, Self WH, Alexander PT, Barrett TW, Han JH, et al. The burden of acute heart failure on U.S. emergency departments. JACC Heart Fail 2014;2:269–77.
2. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. N Engl J Med 2009;360:1418–28.
3. Agarwal MA, Fonarow GC, Ziaeian B. National trends in heart failure hospitalizations and readmissions from 2010 to 2017. JAMA Cardiol 2021. https://doi.org/10.1001/jamacardio.2020.7472. Accessed 2/23/21.
4. Sidney S, Go AS, Jaffe MG, Solomon MD, Ambrosy AP, Rana JS. Association between aging of the US population and heart disease mortality from 2011 to 2017. JAMA Cardiol 2019;4:1280–6.
5. Fonarow GC, Konstam MA, Yancy CW. The hospital readmission reduction program is associated with fewer readmissions, more deaths: time to reconsider. J Am Coll Cardiol 2017;70:1931–4.
6. Gupta A, Allen LA, Bhatt DL, Cox M, DeVore AD, Heidenreich PA, et al. Association of the hospital readmissions reduction program implementation with readmission and mortality outcomes in heart failure. JAMA Cardiol 2018;3:44–53.
7. Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, et al. Heart disease and stroke statistics-2021 update: a report from the. American Heart Association. Circulation 2021;143:e254–743.
8. Collins SP, Jenkins CA, Harrell FE, Liu D, Miller KF, Lindsell CJ, et al. Identification of emergency department patients with acute heart failure at low risk for 30-day adverse events. JACC Heart Fail 2015;3:737–47.
9. Lee DS, Lee JS, Schull MJ, Borgundvaag B, Edmonds ML, Ivankovic M, et al. Prospective validation of the emergency heart failure mortality risk grade for acute heart failure. Circulation 2019;139:1146–56.
10. Sax DR, Mark DG, Huang J, Sofrygin O, Rana JS, Collins SP, et al. Use of machine learning to develop a risk-stratification tool for emergency department patients with acute heart failure. Ann Emerg Med 2020;77 (2):237–48.
11. Stiell IG, Perry JJ, Clement CM, Brison RJ, Rowe BH, Aaron SD, et al. Prospective and explicit clinical validation of the ottawa heart failure risk scale, with and without use of quantitative NT-proBNP. Acad Emerg Med 2017;24:316–27.
12. Miró Ò, López-Díez MP, Rossello X, Gil V, Herrero P, Jacob J, et al. Analysis of standards of quality for outcomes in acute heart failure patients directly discharged home from emergency departments and their relationship with the emergency department direct discharge rate. J Cardiol 2021;77:245–53.
13. Miró Ò, Rossello X, Gil V, Martín-Sánchez FJ, Llorens P, Herrero-Puente P, et al. Analysis of how emergency physicians' decisions to hospitalize or discharge patients with acute heart failure match the clinical risk categories of the MEESSI-AHF scale. Ann Emerg Med 2019;74:204–15.
14. Sax DR, Mark DG, Hsia RY, Tan TC, Tabada GH, Go AS. Short-term outcomes and factors associated with adverse events among adults discharged from the emergency department after treatment for acute heart failure. Circ Heart Fail 2017;10(12):e004144.
15. Weintraub NL, Collins SP, Pang PS, Levy PD, Anderson AS, Arslanian-Engoren C, et al. Acute heart failure syndromes: emergency department presentation, treatment, and disposition: current approaches and future aims: a scientific statement from the. American Heart Association. Circulation 2010;122:1975–96.
16. Javaloyes P, Miró Ò, Gil V, Martín-Sánchez FJ, Jacob J, Herrero P, et al. Clinical phenotypes of acute heart failure based on signs and symptoms of perfusion and congestion at emergency department presentation and their relationship with patient management and outcomes. Eur J Heart Fail 2019;21:1353–65.
17. Hsieh M, Auble TE, Yealy DM. Validation of the Acute Heart Failure Index. Ann Emerg Med 2008;51:37–44.

18. Wong GC, Ayas NT. Clinical approaches to the diagnosis of acute heart failure. Curr Opin Cardiol 2007;22:207–13.
19. Weintraub NL, Collins SP, Pang PS, Levy PD, Anderson AS, Arslanian-Engoren C, et al. Acute heart failure syndromes: emergency department presentation, treatment, and disposition: current approaches and future aims: a scientific statement from the. American Heart Association. Circulation 2010;122:1975–96.
20. Martindale JL, Wakai A, Collins SP, Levy PD, Diercks D, Hiestand BC, et al. Diagnosing acute heart failure in the emergency department: a systematic review and meta-analysis. Acad Emerg Med 2016;23:223–42.
21. Alexander P, Alkhawam L, Curry J, Levy P, Pang PS, Storrow AB, et al. Lack of evidence for intravenous vasodilators in ED patients with acute heart failure: a systematic review. Am J Emerg Med 2015;33:133–41.
22. Matsue Y, Damman K, Voors AA, Kagiyama N, Yamaguchi T, Kuroda S, et al. Time-to-furosemide treatment and mortality in patients hospitalized with acute heart failure. J Am Coll Cardiol 2017;69:3042–51.
23. Felker GM, Lee KL, Bull DA, Redfield MM, Stevenson LW, Goldsmith SR, et al. Diuretic strategies in patients with acute decompensated heart failure. N Engl J Med 2011;364:797–805.
24. Collins SP, Liu D, Jenkins CA, Storrow AB, Levy PD, Pang PS, et al. Effect of a self-care intervention on 90-day outcomes in patients with acute heart failure discharged from the emergency department: a randomized clinical trial. JAMA Cardiol 2020;6(2):200–8.
25. Sax DR, Mark DG, Rana JS, Collins SP, Huang J, Reed ME. Risk-adjusted 30-day mortality and serious adverse event rates among a large, multi-center cohort of emergency department patients with acute heart failure. J Am Coll Emerg Physicians Open 2022. in press.
26. Lee DS, Stitt A, Austin PC, Stukel TA, Schull MJ, Chong A, et al. Prediction of heart failure mortality in emergent care: a cohort study. Ann Intern Med 2012;156:767–75. W-261, 2.
27. Miró Ò, Rossello X, Gil V, Martín-Sánchez FJ, Llorens P, Herrero-Puente P, et al. Predicting 30-day mortality for patients with acute heart failure in the emergency department: a cohort study. Ann Intern Med 2017; 167:698–705.
28. Hejjaji V, Scholes A, Kennedy K, Sperry B, Khariton Y, Dean E, et al. Systemizing the evaluation of acute heart failure in the emergency department: a quality improvement initiative. Circ Cardiovasc Qual Outcomes 2020;13:e006168.
29. Yancy CW, Jessup M, Bozkurt B, Butler J, Casey DE, Drazner MH, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2013;62:e147–239.
30. Auble TE, Hsieh M, McCausland JB, Yealy DM. Comparison of four clinical prediction rules for estimating risk in heart failure. Ann Emerg Med 2007;50:127–35. 135.e1-2.
31. Collins SP, Lindsell CJ, Naftilan AJ, Peacock WF, Diercks D, Hiestand B, et al. Low-risk acute heart failure patients: external validation of the Society of Chest Pain Center's recommendations. Crit Pathw Cardiol 2009;8:99–103.
32. Jovicic A, Holroyd-Leduc JM, Straus SE. Effects of self-management intervention on health outcomes of patients with heart failure: a systematic review of randomized controlled trials. BMC Cardiovasc Disord 2006;6:43.
33. DeWalt DA, Malone RM, Bryant ME, Kosnar MC, Corr KE, Rothman RL, et al. A heart failure self-management program for patients of all literacy levels: a randomized, controlled trial [ISRCTN11535170]. BMC Health Serv Res 2006;6:30.
34. O'Connor CM, Whellan DJ, Lee KL, Keteyian SJ, Cooper LS, Ellis SJ, et al. Efficacy and safety of exercise training in patients with chronic heart failure: HF-ACTION Randomized Controlled Trial. JAMA 2009;301:1439–50.
35. Cowie MR, Anker SD, Cleland JGF, Felker GM, Filippatos G, Jaarsma T, et al. Improving care for patients with acute heart failure: before, during and after hospitalization. ESC Heart Fail 2014;1:110–45.
36. Fermann GJ, Levy PD, Pang P, Butler J, Ayaz SI, Char D, et al. Design and rationale of a randomized trial of a care transition strategy in patients with acute heart failure discharged from the emergency department: GUIDED-HF (Get With the Guidelines in Emergency Department Patients With Heart Failure). Circ Heart Fail 2017;10:e003581.
37. Lee DS, Stukel TA, Austin PC, Alter DA, Schull MJ, You JJ, et al. Improved outcomes with early collaborative care of ambulatory heart failure patients discharged from the emergency department. Circulation 2010; 122:1806–14.
38. Whitaker-Brown CD, Woods SJ, Cornelius JB, Southard E, Gulati SK. Improving quality of life and decreasing readmissions in heart failure patients in a multidisciplinary transition-to-care clinic. Heart Lung 2017; 46:79–84.
39. Llorens P, Javaloyes P, Martín-Sánchez FJ, Jacob J, Herrero-Puente P, Gil V, et al. Time trends in characteristics, clinical course, and outcomes of 13,791 patients with acute heart failure. Clin Res Cardiol 2018; 107:897–913.
40. Martín-Sánchez FJ, Llopis García G, Llorens P, Jacob J, Herrero P, Gil V, et al. Planning to reduce 30-day adverse events after discharge of frail elderly patients with acute heart failure: design and rationale for the DEED FRAIL-AHF trial. Emerg Rev Soc Espanola Med Emerg 2019;31:27–35.
41. Martín-Sánchez FJ, Rodríguez-Adrada E, Vidan MT, García GL, Castillo JG del, Rizzi MA, et al. Impact of frailty and disability on 30-day mortality in older patients with acute heart failure. Am J Cardiol 2017;120:1151–7.
42. Vitale C, Uchmanowicz I. Frailty in patients with heart failure. Eur Heart J 2019;21:L12–6.
43. Morton G, Masters J, Cowburn PJ. Multidisciplinary team approach to heart failure management. Heart 2018;104:1376–82.
44. Mebazaa A, Pang PS, Tavares M, Collins SP, Storrow AB, Laribi S, et al. The impact of early standard therapy on dyspnoea in patients with acute heart failure: the URGENT-dyspnoea study. Eur Heart J 2010; 31:832–41.
45. Mullens W, Damman K, Harjola VP, Mebazaa A, Brunner-La Rocca HP, Martens P, et al. The use of diuretics in heart failure with congestion: a position statement from the Heart Failure Association of the European Society of Cardiology. Eur J Heart Fail 2019;21:137–55.
46. Felker GM, Ellison DH, Mullens W, Cox ZL, Testani JM. Diuretic therapy for patients with heart failure: JACC state-of-the-art review. J Am Coll Cardiol 2020;75:1178–95.

47. Doering A, Jenkins CA, Storrow AB, Lindenfeld J, Fermann GJ, Miller KF, et al. Markers of diuretic resistance in emergency department patients with acute heart failure. Int J Emerg Med 2017;10:17.
48. White-Williams C, Rossi LP, Bittner VA, Driscoll A, Durant RW, Granger BB, et al. Addressing social determinants of health in the care of patients with heart failure: a scientific statement From the American Heart Association. Circulation 2020;141:e841–63.
49. Patel SA, Krasnow M, Long K, Shirey T, Dickert N, Morris AA. Excess 30-day heart failure readmissions and mortality in black patients increases with neighborhood deprivation. Circ Heart Fail 2020;13:e007947.
50. Pinheiro LC, Reshetnyak E, Sterling MR, Levitan EB, Safford MM, Goyal P. Multiple vulnerabilities to health disparities and incident heart failure hospitalization in the REGARDS Study. Circ Cardiovasc Qual Outcomes 2020;13:e006438.
51. Huang Y, Meyer P, Jin L. Neighborhood socioeconomic characteristics, healthcare spatial access, and emergency department visits for ambulatory care sensitive conditions for elderly. Prev Med Rep 2018;12:101–5.
52. Walter LA, Schoenfeld EM, Smith CH, Shufflebarger E, Khoury C, Baldwin K, et al. Emergency department−based interventions affecting social determinants of health in the United States: a scoping review. Acad Emerg Med 2021;28:666–74.
53. Collins SP, Liu D, Jenkins CA, Storrow AB, Levy PD, Pang PS, et al. Effect of a Self-care intervention on 90-day outcomes in patients with acute heart failure discharged from the emergency department: a randomized clinical trial. JAMA Cardiol 2021;6:200–8.
54. Riviere A, Connelly NM, Green J, Longarini R, Powers JB, Sawyer D, et al. Home meal delivery reduces hospitalizations and ED visits in high-risk heart failure patients. J Am Coll Cardiol 2021;77:1481. −11.
55. Remme WJ, McMurray JJV, Rauch B, Zannad F, Keukelaar K, Cohen-Solal A, et al. Public awareness of heart failure in Europe: first results from SHAPE. Eur Heart J 2005;26:2413–21.
56. McNaughton CD, Collins SP, Kripalani S, Rothman R, Self WH, Jenkins C, et al. Low numeracy is associated with increased odds of 30-day emergency department or hospital recidivism for patients with acute heart failure. Circ Heart Fail 2013;6:40–6.
57. Zuccalà G, Marzetti E, Cesari M, Lo Monaco MR, Antonica L, Cocchi A, et al. Correlates of cognitive impairment among patients with heart failure: results of a multicenter survey. Am J Med 2005;118:496–502.
58. Kiesler DJ, Auerbach SM. Optimal matches of patient preferences for information, decision-making and interpersonal behavior: evidence, models and interventions. Patient Educ Couns 2006;61:319–41.
59. Collins SP, Storrow AB. Moving toward comprehensive acute heart failure risk assessment in the emergency department: the importance of self-care and shared decision making. JACC Heart Fail 2013;1:273–80.
60. Heart Failure Diagnosis Subcommittee Heart Failure Executive Committee, Peacock WF, Fonarow GC, Ander DS, Maisel A, et al. Recommendations for the evaluation and management of the observation stay acute heart failure patient: a report from the Society of Chest Pain Centers Acute Heart Failure Committee. Crit Pathw Cardiol 2008;7:83–6.
61. McCausland JB, Machi MS, Yealy DM. Emergency physicians' risk attitudes in acute decompensated heart failure patients. Acad Emerg Med 2010;17:108–10.
62. Miró Ò, Peacock FW, McMurray JJ, Bueno H, Christ M, Maisel AS, et al. European Society of Cardiology: Acute Cardiovascular Care Association position paper on safe discharge of acute heart failure patients from the emergency department. Eur Heart J Acute Cardiovasc Care 2017;6:311–20.
63. Lee DS, Schull MJ, Alter DA, Austin PC, Laupacis A, Chong A, et al. Early deaths in patients with heart failure discharged from the emergency department: a population-based analysis. Circ Heart Fail 2010;3:228–35.
64. Miró Ò, Gil V, Rosselló X, Martín-Sánchez FJ, Llorens P, Jacob J, et al. Patients with acute heart failure discharged from the emergency department and classified as low risk by the MEESSI score (multiple risk estimate based on the Spanish emergency department scale): prevalence of adverse events and predictability. Emerg Rev Soc Espanola Med Emerg 2019;31:5–14.
65. Than M, Herbert M, Flaws D, Cullen L, Hess E, Hollander JE, et al. What is an acceptable risk of major adverse cardiac event in chest pain patients soon after discharge from the emergency department?: a clinical survey. Int J Cardiol 2013;166:752–4.
66. American College of Emergency Physicians Clinical Policies Subcommittee (Writing Committee) on Suspected Non−ST-Elevation Acute Coronary Syndromes, Tomaszewski CA, Nestler D, Shah KH, Sudhir A, Brown MD. Clinical policy: critical issues in the evaluation and management of emergency department patients with suspected non-ST-elevation acute coronary syndromes. Ann Emerg Med 2018;72:e65–106.
67. Desai AS, Stevenson LW. There must be a better way: piloting alternate routes around heart failure hospitalizations. J Am Coll Cardiol 2013;61:127–30.
68. Collins SP, Jenkins CA, Baughman A, Miller KF, Storrow AB, Han JH, et al. Early urine electrolyte patterns in patients with acute heart failure. ESC Heart Fail 2018;6:80–8.
69. Storrow AB, Collins SP, Lyons MS, Wagoner LE, Gibler WB, Lindsell CJ. Emergency department observation of heart failure: preliminary analysis of safety and cost. Congest Heart Fail Greenwich Conn 2005;11:68–72.
70. Buckley LF, Stevenson LW, Cooper IM, Knowles DM, Matta L, Molway DW, et al. Ambulatory treatment of worsening heart failure with intravenous loop diuretics: a four-year experience. J Card Fail 2020;26:798–9.
71. Makadia S, Simmons T, Augustine S, Kovell L, Harris C, Chibungu A, et al. The diuresis clinic: a new paradigm for the treatment of mild decompensated heart failure. Am J Med 2015;128:527–31.
72. Greene SJ, Mentz RJ, Felker GM. Outpatient worsening heart failure as a target for therapy: a review. JAMA Cardiol 2018;3:252–9.
73. Tibaldi V, Isaia G, Scarafiotti C, Gariglio F, Zanocchi M, Bo M, et al. Hospital at home for elderly patients with acute decompensation of chronic heart failure: a prospective randomized controlled trial. Arch Intern Med 2009;169:1569–75.
74. Patel H, Shafazand M, Ekman I, Höjgård S, Swedberg K, Schaufelberger M. Home care as an option in worsening chronic heart failure: a pilot study to evaluate feasibility, quality adjusted life years and cost-effectiveness. Eur J Heart Fail 2008;10:675–81.
75. Levine DM, Ouchi K, Blanchfield B, Saenz A, Burke K, Paz M, et al. Hospital-level care at home for acutely ill adults. Ann Intern Med 2019;172:77–85.
76. CMS Announces Comprehensive strategy to enhance hospital capacity amid COVID-19 surge,| CMS 2021

Accessed 10/18/21. https://www.cms.gov/newsroom/press-releases/cms-announces-comprehensive-strategy-enhance-hospital-capacity-amid-covid-19-surge.
77. Sax DR, Rana JS, Mark DG, Huang J, Collins SP, Liu D, et al. Outcomes among acute heart failure emergency department patients by preserved vs. reduced ejection fraction. ESC Heart Fail 2021;8(4):2889–98.
78. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J 2021;42:3599–726.
79. McDonald M, Virani S, Chan M, Ducharme A, Ezekowitz JA, Giannetti N, et al. CCS/CHFS Heart Failure Guidelines Update: defining a new pharmacologic standard of care for heart failure with reduced ejection fraction. Can J Cardiol 2021;37:531–46.
80. Dunlay SM, Roger VL. Understanding the epidemic of heart failure: past, present, and future. Curr Heart Fail Rep 2014;11:404–15.
81. Blumstein JF, McMichael BJ, Storrow AB. Constraints on medical liability through malpractice safe harbors. JAMA Health Forum 2020;1:e200961.
82. Ballard DW, Vemula R, Chettipally UK, Kene MV, Mark DG, Elms AK, et al. Optimizing clinical decision support in the electronic health record. Appl Clin Inform 2016;7:883–98.
83. Vinson DR, Mark DG, Chettipally UK, Huang J, Rauchwerger AS, Reed ME, et al. Increasing safe outpatient management of emergency department patients with pulmonary embolism: a controlled pragmatic trial. Ann Intern Med 2018;169:855–65.
84. Shibl R, Lawley M, Debuse J. Factors influencing decision support system acceptance. Decis Support Syst 2013;54:953–61.
85. Liberati EG, Ruggiero F, Galuppo L, Gorli M, González-Lorenzo M, Maraldi M, et al. What hinders the uptake of computerized decision support systems in hospitals? A qualitative study and framework for implementation. Implement Sci 2017;12:113.
86. Wussler D, Kozhuharov N, Sabti Z, Walter J, Strebel I, Scholl L, et al. External Validation of the MEESSI Acute Heart Failure Risk Score. Ann Intern Med 2019;170(4):248–56.
87. Lee DS, Stitt A, Austin PC, Stukel TA, Schull MJ, Chong A, et al. Prediction of heart failure mortality in emergent care: a cohort study. Ann Intern Med 2012;156(11):767–75. W-261, W-262.