Emergency department risk assessment and disposition of acute heart failure patients: existing evidence and ongoing challenges

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Abstract

Heart failure (HF) is a global public health burden, characterized by frequent emergency department (ED) visits and hospitalizations. Identifying successful strategies to avoid admissions is crucial for the management of acutely decompensated HF, let alone resource utilization. The primary challenge for ED management of patients with acute heart failure (AHF) lies in the identification of those who can be safely discharged home instead of being admitted. This is an elaborate decision, based on limited objective evidence. Thus far, current biomarkers and risk stratification tools have had little impact on ED disposition decision-making. A reliable definition of a low-risk patient profile is warranted in order to accurately identify patients who could be appropriate for early discharge. A brief period of observation can facilitate risk stratification and allow for close monitoring, aggressive treatment, continuous assessment of response to initial therapy and patient education. Lung ultrasound may represent a valid bedside tool to monitor cardiogenic pulmonary oedema and determine the extent of achieved cardiac unloading after treatment in the observation unit setting. Safe discharge mandates multidisciplinary collaboration and thoughtful assessment of socioeconomic and behavioural factors, along with a clear post-discharge plan put forward and a close follow-up in an outpatient setting. Ongoing research to improve ED risk stratification and disposition of AHF patients may mitigate the tremendous public health challenge imposed by the HF epidemic.

Keywords Emergency department · Acute heart failure · Disposition · Isk stratification

Introduction

Heart failure (HF) has become a global public health burden and a leading cause of morbidity and mortality, particularly among those aged 65 and older [1]. It is estimated that around 6 million US citizens and as many as 15 million Europeans are currently diagnosed with HF, whereas the combined effect of an aging population and improved survival from cardiovascular diseases is expected to further increase the overall prevalence of this syndrome [2, 3]. HF is characterized by frequent hospitalizations, which account for most of the annual expenditures on HF-related healthcare [1, 4]. According to a recent Canadian study, hospital admissions due to a primary diagnosis of HF incurred a total cost of $482 million to the nation in 2013, while these costs are projected to increase to $720 million by 2030 [5]. Along the same lines, the total cost of care for HF in the USA was estimated to be $30.7 billion in 2012, and this cost is predicted to exponentially rise to a sobering $69.8 billion by 2030 [1]. Moreover, hospitalization represents a fundamental turning point in the clinical trajectory of patients with HF, resulting in a combined mortality and readmission rate of more than 30% within 90 days post-discharge [6]. Consequently, a shift in the care model, directed towards safely avoiding inpatient hospitalization, could have a major impact on the quality of life of patients with HF and overall HF-related costs [7].

Emergency physicians play a pivotal role in the management of patients with acute HF (AHF). Their diagnostic and therapeutic approach, as well as their disposition decisions,

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affects hospital length of stay, morbidity and mortality, thereby inducing a direct impact on healthcare and societal costs [8]. Unfortunately, the limited evidence base regarding management of AHF patients in the emergency department (ED), combined with the underlying heterogeneity of the AHF population, results in substantial variability in clinical practice [9]. The present review aims to provide a concise clinical overview of the evidence-based risk stratification of AHF patients in the ED setting, and ultimately propose a scheme for a disposition pathway.

The contribution of emergency departments in acute heart failure management

Shortness of breath is one of the most frequent complaints in patients presenting to EDs and its differential diagnosis is of paramount importance, requiring certain critical skills from an emergency physician's standpoint in order to deliver appropriate care expeditiously. Patients with AHF represent a small proportion of ED patients with dyspnoea and their identification may be challenging as they often present with different clinical features, combined with multiple aetiologies, precipitating factors, cardiac structural abnormalities and comorbidities [10]. Clinical history and physical examination are the key elements in the diagnostic process that will lead to an efficient diagnosis of AHF, along with natriuretic peptides (NPs), electrocardiography (ECG), chest radiography and point-of-care ultrasonography [8]. The diagnostic workup of AHF begins at the time of the first medical contact and consistently proceeds throughout the course of the initial patient pathway; the aim is to classify patients according to their clinical phenotypes, since each subgroup mandates different treatments, and simultaneously to identify and manage potentially reversible acute causes or precipitants in a timely manner [11].

To facilitate management, the recent guidelines from the European Society of Cardiology (ESC) for the diagnosis and treatment of AHF have addressed the procedures and goals of the approach in three clinical settings, namely pre-hospital, in-hospital and pre-discharge [11]. However, there are no specific recommendations regarding the management of AHF patients in the ED, which represents the main site of diagnosis and initial treatment of these patients. The absence of such recommendations actually reflects the paucity of available robust data stemming from well-designed ED clinical trials.

Once an AHF diagnosis has been reached and appropriate treatment has commenced, another crucial issue arises regarding the ultimate disposition of the patient, which constitutes one of the most demanding challenges in the decision-making process that an ED doctor is required to cope with. The options include either admission to an intensive care unit (ICU) or a general hospital ward or home discharge following or not a short period of monitoring and evaluation in an ED-dependent observation unit (OU) [10]. The appropriate use of the three main pathways of discharge from the ED, namely the inpatient admission, the observation status and the direct discharge, will eventually result in the best interest of both the patients and the healthcare system [12]. AHF patients are triaged to the appropriate level of care according to the degree of hemodynamic instability and respiratory failure. For a minority of critically ill patients, the decision for admission to a higher level of care is straightforward. However, in real-world practice, most patients with AHF are managed in the ED or the general ward [13].

Worldwide emergency care systems differ broadly with respect to infrastructure, staff and resources, thus posing several challenges to the global standardization of patient care pathways. OUs are not available in all EDs and this shortcoming has become even more evident during the Covid-19 pandemic period, which actually acted as a triggering event that revealed the existing dearth of both available isolation units and staff within the healthcare systems. Furthermore, cardiologists play a crucial role in the management of AHF patients, and any absence of their involvement as members of the ED core team may lead to unnecessary hospital admissions [10]. In turn, hospital admissions are linked to significant cost increases and expose the patients to potential hazards associated with hospitalization, such as deterioration of functional status, venous thromboembolism, delirium and hospital-acquired infections with multidrug-resistant pathogens [14, 15].

ED discharge of AHF patients: facts and pitfalls

Contrary to popular belief, most of the patients visiting EDs do not end up being admitted. Almost 90% of the annual 130 million ED visits in the USA are discharged home. However, AHF represents an exception, in view of the fact that the annual US hospitalization rate for patients presenting to the ED with AHF has been reported to be more than 80% [16]. Notably, this figure has remained largely unchanged over the last decade, despite the latest developments in diagnostic modalities and alternatives to hospitalization [16]. Analyses of administrative data suggest that up to half of AHF patients presenting to EDs could be discharged home directly or after a brief period of observation [9]. It is noteworthy that if a decrease in admissions even by a small percentage were to be attained, this would result in a substantial absolute decrease [12].

There are several reasons why emergency physicians have an inclination to be more conservative when it comes to decisions about the disposition of AHF patients. First, ED physicians work in a fast-paced environment and, since the response to AHF treatment is not immediate, time

constraints often compel them to decide rapid disposition of the patient to a safe place. Second, the short-term prognosis of AHF is poor and it is difficult for the emergency physician to accept the concept of a low-risk AHF patient [9]. Within 30 days post-discharge, nearly one-third of patients die or require rehospitalization [17]. Given the rather unstable nature and unpredictable effectiveness of self-care management in the outpatient setting, ED providers may actually assume that hospitalization exerts a protective effect on patient outcomes. Furthermore, identifying those patients, whose risk is deemed low enough to be safely discharged from the ED, remains an unmet need [18].

It is reasonable to assume that the ED-linked observation units, where available, may represent the most suitable option for patients with milder forms of AHF, considering the fact that this approach allows more time to risk-stratify patients, closely monitor clinical improvement, request cardiology consultation, provide patient education and arrange a clear post-discharge plan. Importantly, reaching a decision for direct ED discharge can be really challenging in ED environments that lack the availability of bedside echocardiography and point-of-care testing of natriuretic peptides. Moreover, the presence of an outpatient HF clinic could be highly supportive to the ED function and is therefore desirable, since it can offer ED physicians the option to safely transition suitable AHF patients from the ED to the outpatient setting by referring them for prompt follow-up to the ED-linked outpatient HF clinic [10].

To date, neither the appropriate proportion of patients who can be safely discharged home from the ED nor the acceptable rates for short-term revisits, hospital admissions and adverse events have been clearly defined. Miró et al. suggested that EDs without OUs should have discharge rates > 20%, 30-day mortality rates < 1%, 7-day ED revisits < 5% and 30-day ED revisits or inpatient admissions < 15% [19]. Nonetheless, comparison of outcomes between discharged and hospitalized AHF patients is difficult [10]. A Canadian population-based analysis showed that HF patients who were discharged from the ED displayed a substantial early mortality rate culminating from 1.3% at 7 days to 4% at 30 days. Even more so, a considerable part of the discharged patients had short-term predicted probabilities of death that were comparable to those of admitted patients. More importantly, when analysing observed mortality rates in patients with comparable predicted probabilities of death, it turned out that subsequent 90-day mortality rates were significantly higher among discharged than admitted patients [20]. Besides, in a study comparing patient outcomes among EDs with low, medium or high volume of HF cases, Brar et al. reported that HF patients presenting to low-volume EDs were more likely to be discharged home compared to medium- and high-volume EDs, but, on the other hand, patients from low-volume EDs, including

both discharged and hospitalized cases, demonstrated worse outcomes than their counterparts from medium- and high-volume EDs, mainly due to higher rates of readmission and repeat ED visits. [21]. Altogether, these data should be viewed with caution, since they are likely obscured by multiple confounders, taking into account the fact that patients discharged from the ED differ significantly from those admitted [22]. Moreover, adverse events are not necessarily associated with a wrong "discharge home" decision, but may as well indicate system failure to initiate guideline-directed medical therapy and implement a proper post-discharge follow-up scheme [10]. Additionally, a prospective, cross-sectional study from Spain demonstrated that AHF patients treated in the EDs rated the quality of care provided as high; remarkably, their positive perception of quality of care was not affected by whether they were admitted or discharged home. Interestingly, the vast majority of those discharged home stated that they agreed with the doctor's decision to discharge them, regardless of the potential adverse events that might have occurred in the short-term [23].

During the last decade, home hospitalization has emerged as a transitional model of intermediate care between the hospital and the community. This option allows for personal monitoring of the patient by nurses and physicians, who are further assigned with the task to administer intravenous diuretics or perform additional tests. Thus, an early home discharge of selected decompensated HF patients can become feasible, provided that effective family and social support networks are brought into play. A meta-analysis has shown that home hospitalization increases the time to readmission, reduces costs and improves the quality of life in patients with AHF who require hospital admission [24]. Recently, Miró et al. added to the body of evidence that direct transfer from the ED to home hospitalization represents a safe option for a certain profile of AHF patients, even in terms of mortality, albeit the rate of effectuating such an intervention is still low [25].

Risk stratification of AHF patients

There have been numerous studies on physiologic "high-risk" features in patients with AHF. Low blood pressure, ischemic electrocardiographic changes, impaired renal function, hyponatremia and elevated cardiac biomarkers (troponin and NPs) have been consistently associated with an increased risk of morbidity and mortality [8, 26]. However, most of the risk stratification research in AHF has been retrospective and has involved hospitalized patients; hence, extrapolation to the ED setting is challenging [10]. A common strategy of identifying suitable candidates for ED discharge is to focus on patients who are free of the aforementioned high-risk characteristics. Nevertheless, caution should

be exercised with this strategy, since the absence of high-risk features does not automatically place the patient at low risk of adverse events [8–10]. Likewise, the initial clinical presentation, however acute it may be, does not always reflect the patient's short-term prognosis and does not necessarily predict the risk of subsequent adverse events [26].

In the last decade, several risk scores have been developed, supplemented by online calculators for ease of use, in order to aid ED physicians in the decision-making process regarding the patient's disposition. However, they have not been widely adopted yet. Lee et al. have developed the Emergency Heart Failure Mortality Risk Grade (EHMRG), which was derived and internally validated in 7433 and 5158 AHF patients respectively from 86 Canadian EDs, and was subsequently followed by a prospective validation study across 9 hospital EDs involving 1983 AHF patients [27, 28]. It is based on 10 simple variables that are readily available in the ED, namely age, systolic blood pressure, heart rate, O_2 saturation, creatinine, potassium, transport of the patient to the ED by emergency medical services, positive troponin, presence of active cancer and use of metolazone at home. EHMRG was designed to predict the 7-day mortality risk in non-palliative AHF patients, with the intention of providing crucial prognostic information to the clinician and thereby enabling prognostication. Accordingly, patients can be risk-stratified, based on the fact that 7-day mortality rates were found to be 0.3%, 0.3%, 0.7% and 1.9% in the corresponding lowest four deciles, compared with 3.5% and 8.2% in deciles 9 and 10 respectively [27]. The model has been extended to predict 30-day mortality (EHMRG30-ST) by including one additional variable, the presence of ST-segment depression on the 12-lead ECG [28]. A disadvantage of this tool is that it allocates points to whether or not the patient has been transported to the ED via emergency medical services. Thus, the calculated mortality risk of a patient could be unduly increased, merely because the patient has resorted to the use of emergency medical services due to lack of other available means of transport or fear of imminent clinical deterioration [22].

Ottawa Heart Failure Risk Scale (OHFRS) is another Canadian risk score, which was developed from analysis of clinical data obtained from 559 patients at 6 tertiary care EDs and was subsequently validated in an observational cohort study in 1100 patients [29, 30]. The scale is based on the following ten clinical variables: previous stroke or transient ischemic attack, history of intubation due to respiratory distress, heart rate, oxygen saturation on ED arrival, heart rate during 3-min walk test performed after ED treatment, acute ischemic changes in ECG, urea, serum CO_2, elevated troponin and increased N-terminal (NT)-proBNP levels. In the derivation study, when looking into potential independent predictors of serious adverse events, the inclusion of the aforementioned variables in the multivariate logistic

regression model yielded a moderate discriminative capacity. Interestingly, when excluding NT-proBNP from the multivariate model in a sensitivity analysis, the discriminative capacity of the risk scoring system was only slightly decreased, remaining practically unaffected [29]. The prospective clinical validation study found that the OHFRS was able to identify high-risk patients, even though leading to an increase in admission rates [30]. A limitation of this tool is that it requires a 3-min walk test after ED treatment, which is difficult to be arranged in the ED [29].

Miró et al. have developed the Multiple Estimation of risk based on the Emergency department Spanish Score In patients with AHF (MEESSI-AHF), which was derived from 34 Spanish EDs with the derivation cohort including 4867 consecutive ED patients and the validation cohort comprising 3229 patients [31–33]. The objective of this risk score was to reliably predict 30-day mortality risk in AHF patients presenting to the ED by using 13 readily available variables. The latter included the Barthel index on admission, systolic blood pressure, respiratory rate, age, NT-proBNP level, potassium, troponin, creatinine, New York Heart Association (NYHA) functional class on admission, symptoms of low cardiac output, oxygen saturation, episode associated with acute coronary syndrome and hypertrophy on ECG. This tool predicted 30-day mortality with excellent discrimination and calibration and provided a steep gradient in 30-day mortality across risk groups ($< 2\%$ for patients in the 2 lowest risk quintiles and 45% in the highest risk decile). Remarkably, the observed risk discrimination among groups was robust in both derivation and validation cohorts [31]. A potential drawback in the use of this risk calculator tool is the inclusion of variables that may be largely unfamiliar to the ED professional, such as the Barthel index and the patient's NYHA class [22].

Although the aforementioned risk scores have been externally and prospectively validated for short-term mortality prediction, it needs to be emphasized that, in the decision-making process of whether to admit or discharge patients, they should not be applied in isolation, but instead, they should always be used in conjunction with the clinical judgment of a qualified medical doctor [28, 33]. This combined approach of incorporating validated risk algorithms into the course of clinical decision-making, which is predominantly guided by personal expertise, will help direct the ED physician towards the most appropriate disposition pathway and promote effective and safe discharge decisions [34, 35].

A recent study reported that approximately half of the patients discharged from the ED were actually deemed to be at increased risk based on the MEESSI-AHF risk scale [32]. Interestingly, all patients discharged directly from the ED, irrespective of their allocated risk category, carried an increased risk of hospitalization or ED revisit at 30 days compared to patients who were discharged after

hospitalization, yet the observed 30-day post-discharge mortality did not differ between these two groups [32]. In this regard, provided that patients discharged home from the ED are not exposed to a higher mortality risk, but merely run a greater risk of ED readmission and subsequent hospitalization, then one could claim that patients' desires should be seriously taken into account or even predominate and guide disposition decisions [32].

The timing of an adverse event after ED discharge is perhaps the most challenging issue that needs to be addressed. Events ensuing shortly after ED discharge, for instance within a week, are most probably related to the therapeutic interventions and disposition decisions that took place during the preceding acute episode. On the contrary, events occurring a month or later after ED discharge are not as likely to be associated with the prior acute incident [36].

It should be pointed out that the responsible precipitating factor leading to AHF decompensation has to be thoroughly sought, since its identification plays a central role not only in the AHF management, but in the final disposition decision as well. Indeed, a patient experiencing an AHF episode caused by non-compliance to dietary recommendations, such as excessive water or salt intake, will presumably be discharged after a short course of treatment with intravenous diuretics. By contrast, other aetiologies of decompensation, such as an acute coronary syndrome, tamponade, pneumonia or pulmonary embolism, will definitely require hospital admission [10]. Patients with new-onset HF should also be admitted for further investigation, since potentially reversible or modifiable aetiologies may be identified [11]. Assessment of global functional status and comorbidities are important factors to consider when estimating the risk of adverse outcomes [8, 10].

Disposition decisions should not be exclusively guided by the patient's risk of adverse events. There are also many social, behavioural and environmental factors that cannot be ignored, since they have a strong impact on the patient's ability to achieve efficient self-management of their chronic disease [37]. During the decision-making process regarding disposition, emergency physicians should always take into account and sufficiently address all potential barriers that could jeopardize patient's successful self-care, including health literacy, impaired cognition, financial resources, transportation and symptom monitoring, as well as social and caregiver support [8, 37]. Lastly, recognition of frailty, especially in older patients, has evolved as a valuable prognostic factor in AHF; however, its impact on ED disposition decision remains to be determined [38, 39].

Role of biomarkers in risk stratification

Measurement of plasma concentrations of NPs is recommended as an initial diagnostic tool in patients with symptoms suggestive of HF in order to rule in or rule out the presumed diagnosis [11]. Nowadays, NPs are immediately available upon presentation to most EDs and have already been included in the initial standard ED diagnostic workup of patients with dyspnoea. Cutoff points for AHF are 100 pg/mL and 300 pg/mL for brain natriuretic peptide (BNP) and NT-proBNP respectively [40]. Elevated NP concentrations not only support a diagnosis of HF but are also useful for prognostication [40]. However, it should be noted that there are several cardiac and non-cardiac modifiers of NPs, including atrial fibrillation, increasing age, obesity, renal failure and sepsis, which may reduce NPs' diagnostic accuracy [8, 11, 40]. In general, alterations of NP levels by more than 50% from baseline values are required to accept that the change may represent HF exacerbation; yet, significant fluctuations in NP levels can be observed within the same patient [40].

Notwithstanding the prognostic role of NPs in the stable outpatient setting or at hospital discharge, the utility of a single measurement performed in the ED setting for the purpose of risk stratification has not been proven. Therefore, it is not clear whether determination of NP concentrations has the potential to guide disposition decisions in the ED [10]. The availability of BNP measurement in the ED was not associated with better clinical outcomes in the PICASU-2 study, a Spanish multicenter retrospective study of patients with AHF [41]. Likewise, REDHOT-II (Rapid Emergency Department Heart Failure Outpatients Trial), a randomized controlled ED-based trial which evaluated the effect of BNP point-of-care testing on patient management and outcomes, failed to show any positive impact of serial BNP measurements on the length of stay, 30-day readmission or all-cause mortality in ED patients admitted for AHF [42].

Cardiac troponin is a hallmark biomarker recommended for the diagnosis of myocardial ischemia/injury in patients presenting to the ED with chest pain and/or dyspnoea. In the STRATIFY decision tool, evaluated in an AHF ED population, elevated troponin and renal function emerged as significant predictors of 30-day adverse events [43]. Not surprisingly, troponin is included in all risk instruments proposed for the identification of low-risk AHF patients, who could be eligible for ED discharge [18].

In the AHF setting, lactate levels, readily available in most ED environments, have been firmly established as a marker of hypoperfusion. Even though elevated lactate levels have been correlated to poor outcomes, so far, lactate has not been included in risk stratification scores proposed for ED discharge decision-making [44, 45].

Emerging biomarkers, such as copeptin, mid-regional pro-adrenomedullin (MR-pro ADM) and procalcitonin, may facilitate the diagnosis of AHF, especially in complex cases presenting to the ED with undifferentiated AHF-like symptoms. However, their utility in the AHF disposition pathway from the ED still remains unclear [10, 46]. Other

promising biomarkers for clinical use in AHF are the soluble suppression of tumorigenicity 2 protein (sST2) and galectin-3 (Gal-3). Recently, the use of a multimarker approach, incorporating NPs, sST2 and Gal-3, has been proposed for a more comprehensive patient management and decision-making in the ED. It has been advocated that patients should be considered at high risk and thus hospitalized when their NT-proBNP, BNP, sST2 and Gal-3 levels are above 3000 pg/mL, 1000 pg/mL, 70 ng/mL and 17.8 ng/mL respectively, even more so when these values remain persistently elevated after 72 h of treatment. According to the same approach, patients should be managed in the OU and re-assessed after 24 h when they fall into the "grey zone" area, characterized by intermediate levels of NPs (higher than normal but below 1000 pg/mL for BNP and below 3000 pg/mL for NT-proBNP), sST2 (50–70 ng/mL) and Gal-3 (< 17.8 ng/mL). On the other hand, an early discharge option may be considered for low-risk patients who have been stabilized after ED treatment, whenever values of all aforementioned biomarkers are under certain thresholds (< 500 pg/mL for BNP, < 1500 pg/mL for NT-proBNP, < 50 ng/mL for sST2 and < 17.8 ng/mL for Gal-3) [46].

Role of imaging in risk stratification

Echocardiography and lung ultrasound (LUS) allow real-time evaluation of cardiac filling pressures and pulmonary congestion and can be performed sequentially using the same machinery and probe [47, 48]. Hence, echocardiography and LUS may be useful for determining the baseline hemodynamic phenotype in AHF, as well as for monitoring and individually guiding treatment [49]. Moreover, immediate echocardiography is recommended during the initial evaluation of AHF patients who are hemodynamically unstable, in order to search for specific causes that need to be treated urgently [50].

A recent small pilot study aimed to guide treatment in AHF patients by employing a cardiothoracic ultrasound protocol, which combined LUS with echocardiography focused on cardiac filling pressure measurements (E/e′ and inferior vena cava index); the study concluded that the implementation of such a protocol was safe and feasible, leading to a more effective resolution of congestion within a shorter hospitalization period and without any increase in adverse events, and might thus be related to a better post-discharge prognosis [49]. In a systematic review of studies which used LUS to explore dynamic changes of pulmonary congestion (expressed as the number of B-lines) and examine their prognostic value in HF, it was demonstrated that AHF treatment led to a rapid decrease in the number of B-lines within less than 3 h. Additionally, in AHF patients, the presence of more than 15 B-lines on a 28-zone LUS at discharge indicated an increased risk of subsequent adverse outcomes,

since it was associated with a greater than five-fold risk of HF readmission or death [51]. Similarly, Cortellaro et al. have shown that LUS could serve as a potentially useful tool for monitoring response to therapy in cases of cardiogenic pulmonary oedema, considering that LUS could detect the rapid clearance of extravascular lung water, as well as its distribution across the lung fields, even in the early hours following admission of AHF patients [52].

Thus far, the role of ultrasound in the ED setting has not been well described. In the recently published BLUSED-AHF study (B-lines Lung Ultrasound-Guided Emergency Department Management of Acute Heart Failure), AHF treatment guided by LUS did not outperform treatment based on structured usual care. Indeed, the use of LUS in an effort to target pulmonary congestion in the ED was not accompanied by any significant reduction in the number of B-lines within the first 6 h of treatment compared to usual care. However, a trend towards a more rapid resolution of congestion in LUS-guided patients was observed at 48 h, suggesting that this patient population could be candidates for aggressive OU management [53]. ED-based large-scale studies are warranted to determine the actual utility of integrating ultrasonography markers in future risk stratification tools.

Observation unit for AHF management

The majority of AHF patients require decongestion with intravenous diuretics in a monitored setting until symptoms and signs of congestion improve. These patients may be suitable candidates for OUs. The latter are dedicated units, which are independent from the actual location of EDs, albeit connected to them. In fact, they act as an extension of emergency care, allowing monitoring, short-term treatment, assessment and re-evaluation of the patient before coming to a final disposition decision about discharging or admitting the patient for further treatment. Initially, OUs were established based on the assumption that the majority of patients would require observation for less than 24 h [54]. However, over the course of time, observation length of stay has increased. Indeed, a retrospective descriptive study conducted at a tertiary academic medical centre showed that observation care lasting less than 24 h does not represent the typical pattern any more. As a matter of fact, mean observation length of stay was 33.3 h, with the adult general medicine patients accounting for more than half of all observation stays and exhibiting longer lengths of stay, often exceeding 48 h [55].

More than a decade ago, the Society of Cardiovascular Patient Care (previously known as the Society of Chest Pain Centers) published recommendations for risk stratification and disposition of ED patients with AHF, mainly based on

Table 1 Inclusion criteria for disposition of acute heart failure patients to the observation unit [8, 19, 26, 57]

Previous history of CHF
At least partial clinical improvement following initial ED treatment
High likelihood of further clinical improvement within 24 h
Rather stable vital signs (SBP > 100 mmHg, RR < 32 breaths/min, HR < 130 bpm)
Pulse oximetry > 90% on room air after initial treatment or correctable to > 92% on supplemental oxygen by nasal cannula
Absence of acute precipitants (e.g. ACS, pneumonia)

ACS acute coronary syndrome, *bpm* beats per minute, *CHF* chronic heart failure, *ED* emergency department, *HR* heart rate, *RR* respiratory rate, *SBP* systolic blood pressure

expert opinion [26]. It was suggested that patients who do not meet high-risk criteria, including low blood pressure, impaired renal function, hyponatremia, ischemic electrocardiographic changes, elevated troponin and NPs, should be considered eligible for an OU stay (Table 1). The latter criteria have been externally validated in a secondary analysis of a prospective ED-based study, which demonstrated that ED patients who do not present with high-risk characteristics are at low risk for subsequent morbidity and mortality [36]. On the other hand, there are clinical features available upon ED presentation that would preclude an OU stay, including signs of poor perfusion, high respiratory rate (> 32 breaths/min), need for non-invasive ventilation and need for intravenous vasoactive infusions which require active titration [26] (Table 2). In addition, the patient's history of past hospital admissions should be taken into account; a pattern of frequent admissions and prolonged length of stay should be regarded as an alarming indicator that prompts the need for hospitalization and inpatient management [22].

Although prospective randomized controlled trials evaluating observation care are lacking, a preliminary analysis of safety and cost revealed that AHF patients managed in OUs had similar outcomes to those of a risk-matched group of patients admitted directly to the inpatient setting, while having incurred less total hospital costs [56]. Early and aggressive treatment is necessary in order to provide sufficient symptom relief to the patients and facilitate ED discharge [18] (Table 3). Peacock et al. have prospectively demonstrated that the option of a short course of intensive HF therapy in an ED OU is associated with lower ED revisits and inpatient hospitalization rates, when protocol-driven [57]. A retrospective cohort study by Schrager et al. has shown that selected AHF patients discharged from an OU following a rapid treatment protocol demonstrated similar readmission rates at 30 or 90 days, when compared with patients admitted to the hospital, while displaying at the same time favourable utilization of overall healthcare resources, as evidenced by fewer total hospital bed-days [58]. Both studies raise the importance of implementation of a protocol that can prevent possible delays and omissions in diagnostic procedures and therapy and facilitates standardization of care. Indeed, timing of intravenous furosemide administration in the ED has

Table 2 Exclusion criteria for disposition of acute heart failure patients to the observation unit [8, 19, 26, 57]

New-onset HF
Clinical deterioration despite ED treatment
Unstable vital signs (SBP < 100 mmHg or resistant hypertension > 180 mmHg, RR > 32 breaths/min, HR > 130 bpm or < 50 bpm)
Compromised airway or need for > 4 L/min supplemental O₂ by nasal cannula to maintain pulse oximetry > 90%
Temperature > 38.5 °C
Acute confusion
Clinically significant arrhythmia or ventricular tachycardia
ECG suggestive of myocardial ischaemia/infarction
Elevated troponin suggestive of myocardial ischaemia/injury
Need for iv inotropes/pressors or ongoing titration of iv vasodilators
Need for non-invasive ventilation/intubation
Presence of acute precipitants (e.g. ACS, pneumonia)
Abnormal laboratory findings (Hb < 8 g/dL, Cr > 3 mg/dL, Na < 135 mmol/L)
Elevated natriuretic peptides above 50% of patient's baseline values
Significant home/self-care barriers not addressable within 24 h

ACS acute coronary syndrome, *bpm* beats per minute, *Cr* creatinine, *ECG* electrocardiogram, *ED* emergency department, *Hb* haemoglobin, *HF* heart failure, *HR* heart rate, *iv* intravenous, *Na* sodium, *RR* respiratory rate, *SBP* systolic blood pressure

Table 3 Observation unit management protocol [8, 11, 19, 26, 57, 64]

Monitoring

Weight recording upon arrival, monitoring of fluid intake and output

Continuous monitoring of vital signs

Serial ECGs and troponin measurement according to the 3-h algorithm

Measurement of creatinine and electrolytes every 6 h or as needed

Diagnostic procedures

Focused echocardiography

Lung ultrasound

Chest X-ray

Therapy

Intensification of therapy with diuretics/vasodilators* in patients with persistent congestion and SBP > 110 mmHg

Consultation/education

Cardiologist or HF specialist consultation

Optimize HF GDMT in the outpatient setting, medication compliance

Dietary recommendations, smoking cessation, vaccination

Personalized clear discharge instructions

ECG electrocardiogram, *GDMT* guideline-directed medical therapy, *h* hour, *HF* heart failure, *SBP* systolic blood pressure

*Caution in patients with left ventricular hypertrophy and severe aortic/mitral stenosis

been shown to be crucial, in view of the fact that delaying furosemide administration, until after serum creatinine laboratory results become available, has been associated with a 41% lower probability of successful discharge home. It is noteworthy that the association between timing of furosemide administration and likelihood of successful discharge was most potent in low-acuity AHF patients [59].

As a patient's clinical profile may change during OU management, close monitoring and frequent re-assessment are imperative in order to ensure that the patient's condition is heading towards the right direction of decongestion and clinical stability [26] (Table 3). Diuretic response should be assessed as soon as diuretic therapy has started, and is considered satisfactory when the hourly urine output is above 100–150 mL/h during the first 6 h and/or when a spot urine sodium content is above 50–70 mEq/L after 2 h [11]. Inadequate diuretic response or lack of improvement in vital signs indicates the need for inpatient management. With regard to NPs, data pertaining to changes observed in their levels after ED or OU treatment are lacking, and therefore routine serial NP testing in the OU is not yet recommended in daily clinical practice [26]. Furthermore, the impact of clinical response to initial therapy on subsequent risk of adverse events has not been thoroughly evaluated. Dyspnoea resolution, which is a key goal of therapy, correlates poorly with in-hospital worsening HF and post-discharge events [60, 61], rendering it a problematic marker to rely on as the sole index of unloading. In this context, LUS may represent a valid
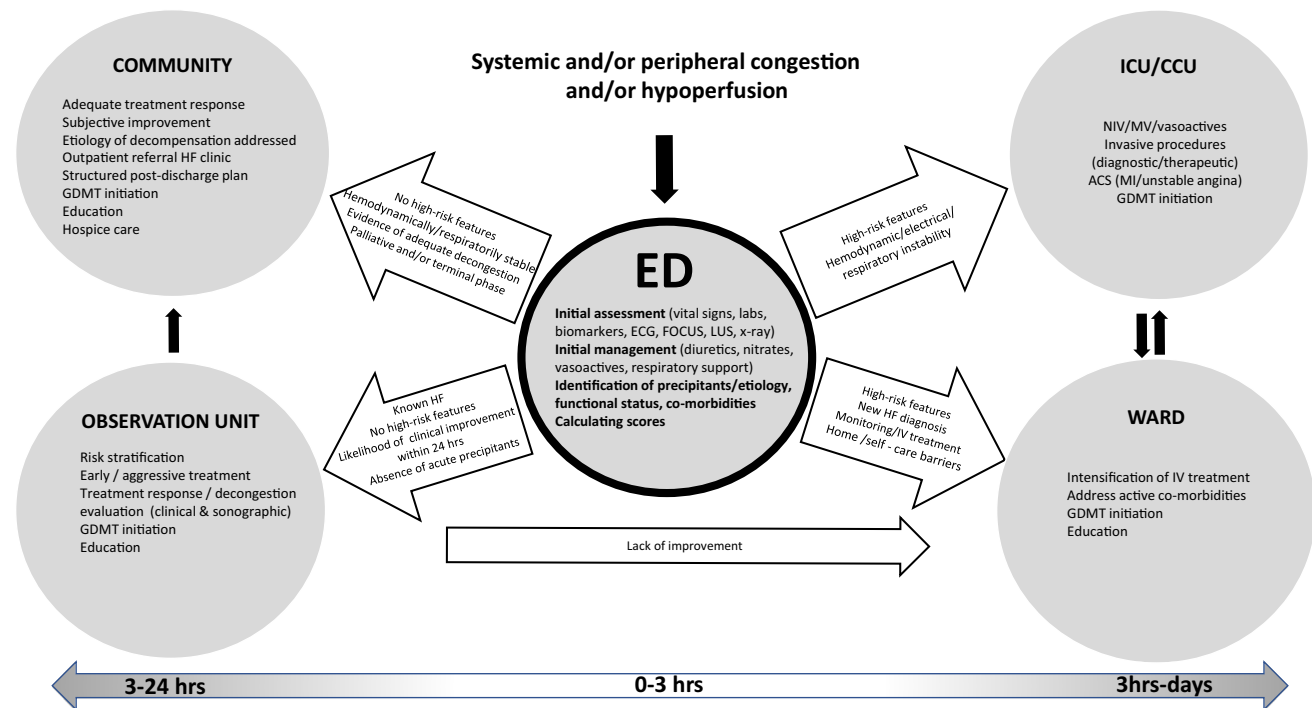

Fig. 1 Proposed pathway for ED disposition of AHF patients. *ACS*, acute coronary syndrome; *CCU*, cardiac care unit; *ECG*, electrocardiogram; *ED*, emergency department; *FOCUS*, focused ultrasound; *HF*, heart failure; *GDMT*, guideline-directed medical therapy; *ICU*, intensive care unit; *IV*, intravenous; *LUS*, lung ultrasound; *MI*, myocardial infarction; *MV*, mechanical ventilation; *NIV*, non-invasive ventilation

Table 4 Emergency department/observation unit discharge criteria [10, 19, 57]

Subjective improvement—no orthopnoea or chest pain, ambulatory without hypoxia
No clinically significant arrhythmia
SBP > 100 mmHg or SBP as on stable status, no orthostatic hypotension
Resting HR < 100 bpm, RR < 20 breaths/min
Room air saturation (unless on home O_2) > 92%
Evidence of adequate decongestion (adequate diuresis*, decrease in JVD, LUS, decrease in weight)
Negative serial ECGs and troponin for ischemia
No significant alterations in renal function/electrolyte profile
Reason for decompensation has been addressed

bpm beats per minute, *ECG* electrocardiogram, *HR* heart rate, *JVD* jugular vein distention, *LUS* lung ultrasound, *RR* respiratory rate, *SBP* systolic blood pressure

*Adequate diuresis defined as a urinary spot sodium ≥ 50–70 mEq/L after 2 h or urine output ≥ 100–150 mL/h after 6 h[11]

and potentially valuable bedside tool to monitor cardiogenic pulmonary oedema and the clearance of the associated interstitial syndrome after the first hours of treatment in the OU setting [52].

Finally, OUs represent a unique setting where appropriate bedside education, outpatient medication adjustment and arrangement of close outpatient follow-up may be accomplished. While a patient is symptomatic, it is more likely that education provided in the OU environment will yield more fruitful results and effectuate long-lasting lifestyle modifications. Besides, the OU time window may be suitable for developing personalized strategies to overcome adherence issues and self-care barriers [37, 57] (Table 3).

Post-discharge plan

Successful discharge from the ED mandates a multidisciplinary approach, in close collaboration with cardiologists and HF clinics. For patients being discharged from the ED, a clear post-discharge plan connecting stable patients to a HF management program represents a necessity and should be systematically pursued with an eye to preventing early readmissions and improving quality of life. However, adherence to a post-ED discharge follow-up care plan is highly dependent on patients' and physicians' behaviour and is thus unpredictable [8].

Outpatient follow-up either at the HF referral clinic or through a nurse phone call program should occur early, ideally within 72 h to 1 week [62]. Key attributes of the follow-up visit should include monitoring of HF signs and symptoms and assessment of vital signs and volume status, as well as evaluation of renal function, electrolytes, iron status and probably NT-proBNP. Based on clinical and laboratory findings, initiation or further optimization with uptitration of guideline-directed medical therapy of HF with reduced ejection fraction should occur [11].

Proposed disposition pathway

Based on the current evidence and other expert opinion documents published in the particular field [8, 10, 19, 26], we propose a general pathway to be followed during the decision-making process regarding ED disposition of AHF patients (Fig. 1). The pathway focuses on the identification of high-risk clinical and laboratory features and incorporates objective indices of decongestion. Patients at high risk for serious adverse events should be admitted to the hospital, while an ICU admission is warranted for those with respiratory failure or cardiogenic shock who require invasive monitoring and therapeutic interventions. Patients without high-risk features, but with poor response to initial treatment, should be further monitored in an OU and stratified according to their active comorbidities and self-care barriers. In the event that decongestion, active comorbidities and self-care barriers are not addressable within 24 h in the OU, inpatient management is generally dictated. Candidates for ED discharge are those with a rapid and adequate response to ED therapy, who maintain stable vital signs, lack high-risk features based on laboratory measurements and point-of-care ultrasonography and have no significant comorbidities or self-care barriers (Table 4). Home hospice could be an option for elderly patients with decompensated HF, with frailty, marked to severe functional limitation and comorbidities, who are not candidates for further diagnostic procedures or interventions, or those who are in the palliative phase, provided that they are hemodynamically and respiratorily stable upon discharge and have adequate support network [25, 63].

Conclusion and future challenges

Emergency care management of AHF patients should not be merely viewed as the brief period during which the patients receive treatment in the ED, but should rather be appreciated

in a wider context, since its impact extends far beyond the strict boundaries of an ED setting. Given the fact that HF hospitalization represents a pivotal event along the HF trajectory with important implications in both the patient's quality of life and the economic burden imposed to the healthcare system, it is more than obvious that the primary challenge for ED management of patients with AHF lies in the identification of those who can be safely discharged either directly or after a brief period of observation, instead of being admitted. An OU strategy is consistent with the emerging trend in healthcare administration, which favours the creation of appropriate structures and bundles that would support the care of patients in the outpatient setting. The optimal clinical management of patients with AHF in EDs and OUs should include well-defined local treatment protocols, discharge criteria and referral pathways [10]. There is an ever growing need for a strategic framework to be implemented that has the potential to reduce avoidable admissions and improve chronic disease management. This could be achieved by combining clinical gestalt with physiologic and imaging markers for comprehensive risk stratification, while promoting at the same time a collaborative interaction between patients and caregivers, and introducing strategies to overcome home and self-care barriers. Future studies are needed to determine whether risk prediction instruments can improve discharge decisions and associated outcomes.

Author contribution J.P., K.F. and E.P. made substantial contributions to conception and design of the manuscript; A.D. and K.G. contributed to evidence collection and analysis; K.F. drafted the manuscript; E.P. contributed to the final layout of the tables and figure, J.P. provided fundamental guidance; and I.V. performed editing and critical revision of the manuscript. All authors have read and approved the final version of the paper.

Availability of data and materials This declaration is not applicable.

Declarations

Ethics approval This declaration is not applicable.

Competing interests K.F., I.V., A.D., K.G. and E.P. declare they have no financial interests. J.P. has received honoraria for lectures and consultancy on advisory board meetings from Roche Diagnostics.

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