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Review

In-hospital management of acute heart failure: Practical recommendations and future perspectives

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ABSTRACT

Acute heart failure (AHF) represents the first reason for hospitalization in the elderly and despite therapeutic advances, remains a syndrome with significant morbidity and dismal prognosis. Hospitalization for AHF, on the other hand, is the single most important contributor to the huge financial burden related to HF. As a result, there is a significant unmet need for more effective in-hospital management of patients with AHF in order to improve outcomes, reduce readmission rate and alleviate the socioeconomic burden of the syndrome. The in-hospital management of AHF patients may schematically be divided into three phases, an early phase of intensive management of congestion and/or hypoperfusion, an intermediate phase of transition to oral life-saving medications and a late phase of discharge and transition to outpatient management. In the present paper, we attempt to provide a concise and practical roadmap for each of the above phases, focusing mainly on defining clinical and laboratory criteria for the evaluation of patients and on describing therapeutic algorithms that summarize the available evidence and guidelines. In addition, we highlight some key open issues that need to be addressed by future research.

1. The burden of acute heart failure

Heart failure (HF) is a major public health problem that affects 26 million people worldwide [1]. The prevalence of HF in U.S. in 2012 was 5.7 million, representing 2.2% of the total population [2]. The projection is that HF prevalence will rise by 126% till 2030, mainly due to the population aging [2]. At the same time, HF leads to an enormous financial burden that represents 2% of the total healthcare expenditure and is expected to be 3-fold higher in 2030, summing a total of $160 billion in U.S. [1–3].

Acute heart failure (AHF) is defined as the rapid development or change of symptoms and signs of heart failure that requires urgent or emergent medical attention and usually leads to hospitalization [4,5]. Occasionally, the development of symptoms may be abrupt, as in the case of de novo AHF presenting with acute pulmonary edema, or more progressive, as in the case of decompensated chronic HF [5]. In those latter cases, the time of transition from chronic to acute HF may not be clearly defined.

Acute heart failure accounts for approximately 1 million admissions per year in USA and a similar number in Europe and represents the first reason for hospitalization in the elderly [2]. Despite therapeutic advances, AHF remains a syndrome with significant morbidity and dismal prognosis. Hospitalization for AHF is followed by unacceptably high event rates. In-hospital mortality ranges 4%–7%, post-discharge mortality during the first 2–3 months is as high as 7%–11%, and reaches 36% in a year, while readmission occurs in 25–30% of patients during the first 2–3 months and in 66% during the first year [5,6]. Interestingly, post-discharge event rates seem to be equally high in patients with reduced and preserved left ventricular ejection fraction (LVEF) [7].

Hospitalization for AHF is the single most important contributor to the huge burden related to HF, accounting for 69% of the total HF expenditure [8]. The mean cost of an episode of AHF hospitalization in a Greek tertiary/teaching hospital for a median hospital stay of 7 days was estimated to be €3200 per patient, an amount that represented only ward

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costs, laboratory investigations and drug therapy, thus excluding several other costly procedures and interventions [9]. Thus, there is a significant unmet need for a more effective in-hospital management of patients with AHF that would improve outcomes and reduce readmission rates and thus alleviate the huge socioeconomic burden of the syndrome.

The present paper attempts to provide clinicians with a concise and practical roadmap for the in-hospital management of AHF, focusing mainly on clinical and laboratory criteria that may be used for the evaluation of patients the different phases of care and on basic therapeutic algorithms that reflect the available evidence and guidelines. Some key open issues regarding AHF management that need to be addressed by future research are also discussed. It is important to note that the present work is by no means a thorough description of the available therapeutic modalities, the proposed guideline recommendations or the accumulated supporting evidence. At the same time, the paper does not primarily target the heart failure specialists but rather the broad spectrum of clinicians involved in the care of hospitalized patients with AHF in any in-patient setting.

2. In-hospital management

The management of AHF may often be a challenge for the clinician. As congestion is the hallmark of AHF, therapy essentially aims to the alleviation of the symptoms of congestion. Despite therapeutic advances in Cardiovascular Medicine, the basic AHF management has not changed significantly over the past decades and still comprises intravenous (iv) loop diuretics with or without vasodilators [10]. The more recently introduced sophisticated mechanical circulatory support or renal replacement systems are only needed in a minority of patients. Decongestion is often incomplete, a fact that increases the risk of readmission [6], while it has become clear that there are several additional issues in the management of AHF than just decongestion.

The in-hospital management of patients with AHF may schematically be divided into three phases, the early phase of intensive management of congestion, the intermediate phase of transition to oral medications and the late phase of discharge and transition to outpatient management (Table 1). Suggested algorithms summarizing the management of AHF patients are outlined in Figs. 1 and 2.

2.1. Early phase management

In the early phase, the primary goals are the management of acute symptoms of congestion along with stabilization of hemodynamics, the preservation of tissue perfusion and oxygenation and the protection from further cardiac, renal and other organ damage [10]. This is primarily accomplished by intravenous therapies including loop diuretics, vasodilators, inotropes and/or vasopressors.

Inotropic agents, including beta adrenergic receptor agonists, phosphodiesterase III inhibitors and the calcium sensitizer levosimendan, are effective in relieving symptoms, increasing cardiac output and decreasing filling pressures in critically ill patients. However, those beneficial effects are compromised by significant adverse events including mainly arrhythmias and myocardial ischemia, which lead to neutral or even adverse outcomes in terms of prognosis [11]. Therefore, inotropes should only be used in the presence of clear indications and more specifically in patients with low cardiac output (cardiac index <2.0 Lt/min/m^2), in the presence of elevated filling pressures (pulmonary capillary wedge pressure >18–20 mm Hg, and right atrial pressure >10–12 mm Hg) [12,13]. Moreover, inotropes are also used in critically ill patients with abnormal

Table 1
Key criteria for guiding therapy in acute heart failure.

Phase	Main goal	Key criteria
Early phase	Intensive management of congestion and/or hypo-perfusion	Treatment guidance criteria: • Symptoms/signs of congestion[a]/hypoperfusion[b] • Vital signs (SBP, MAP, HR, RR) • SpO_2 • Urine output Additional assessments: • NP, troponin, Hb, ABGs, lactate, renal function tests • Echo-Doppler • Pulmonary artery catheter in selected cases
Intermediate phase	Transition from intravenous to oral medication	Stabilization criteria: • Resolution of symptoms/signs of congestion/hypoperfusion • Improvement/preservation of vital signs (SBP, HR, RR) • Improvement/preservation of SpO_2 • Adequate diuresis • Body weight reduction towards "dry" values Additional criteria: • Improvement of dyspnea scales • NP reduction • Improvement of Echo-Doppler parameters (mitral E/e′, IVC) • Improvement of invasive parameters (PCWP, cardiac index)
Late phase	Discharge and transition to outpatient care	Readiness for discharge criteria: • Complete resolution symptoms/signs of congestion • Vitals: SBP ≥ 90 mm Hg, HR < 80/min (<100/min if in patients with AFib) • SpO_2 ≥ 95% (≥90% in COPD) • Effective diuresis with oral diuretic regimen stable for ≥24 h • Discontinuation of vasodilators for ≥24 h • NP reduction ≥30% • Initiation/titration of life-saving therapies • Evaluation for further therapies (eg. CRT, ICD) • Assessment of comorbidities • Patients' education • Determination of specific post-discharge plan

SBP, systolic blood pressure; MAP, mean arterial pressure; HR, heart rate; RR, respiratory rate; NP, natriuretic peptides; Hb, hemoglobin; ABGs, arterial blood gases; PCWP, pulmonary capillary wedge pressure; IVC, inferior vena cava diameter; AFIb, atrial fibrillation; COPD, chronic obstructive pulmonary disease; CRT, cardiac resynchronization therapy; and ICD, implantable cardioverter defibrilaltor.

[a] Dyspnea, peripheral edema, distended jugular veins, hepatomegaly, hepatojugular reflux, and ascites.

[b] Cold extremities, mottled skin, narrow pulse pressure, mental status impairment, and oliguria/anuria.