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Review

Emergency department triage of acute heart failure triggered by pneumonia; when an intensive care unit is needed?

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ABSTRACT

Community acquired pneumonia (CAP) is a frequent triggering factor for decompensation of a chronic cardiac dysfunction, leading to acute heart failure (AHF). Patients with AHF exacerbated by CAP, are often admitted through the emergency department for ICU hospitalization, even though more than half the cases do not warrant any intensive care treatment. Emergency department physicians are forced to make disposition decisions based on subjective criteria, due to lack of evidence-based risk scores for AHF combined with CAP. Currently, the available risk models refer distinctly to either AHF or CAP patients. Extrapolation of data by arbitrarily combining these models, is not validated and can be treacherous. Examples of attempts to apply acuity scales provenient from different disciplines and the resulting discrepancies, are given in this review. There is a need for severity classification tools especially elaborated for use in the emergency department, applicable to patients with mixed AHF and CAP, in order to rationalize the ICU dispositions. This is bound to facilitate the efforts to save both lives and resources.

1. Article main text

Community acquired pneumonia (CAP) is a frequent precipitating factor of acute heart failure (ACF), in the sense of destabilizing a chronic cardiac dysfunction. Most of these patients require admission to the hospital, through an emergency department (ED). CAP is recognized as the exacerbating factor in 17–30% of patients presenting at the ED with symptoms of AHF [1,2]. Moreover, patients usually report AHF symptoms to be present almost simultaneously with CAP, on the very first day the latter breaks in [3,4].

CAP can exacerbate chronic heart failure and destabilize a previously clinically stable patient, through multiple pathways. CAP-resulting hypoxemia decreases oxygen delivery to the myocardium, while increasing pulmonary vascular resistance, thus the afterload of the right ventricle. On the other hand, inflammation per se exerts a negative inotropic action, through circulating cytokines [5].

The most important effect of inflammation, however, is exerted on the endothelium of the alveolar-capillary membrane, resulting in increased permeability [5]. This injury of the alveolar-capillary interface causes the loss of regulation of fluid-flux, allowing hydrostatic pressures lower than the osmotic pressure, to create alveolar congestion, clinically manifested as acute respiratory distress.

When examined separately, both AHF and CAP are characterized by increased rates of hospital admissions. Approximately 84% of AHF patients are hospitalized [6]. Among these patients, the rates of admittance to the Intensive Care Unit (ICU) vary depending on the hospital, often exceeding 32% [7,8]. Every ICU admittance relates to increased mortality, due to both disease severity and in-hospital complications. Medication errors, delirium, thrombosis, muscular atrophies and hospital-acquired antibiotic-resistant infections are the most common sequelae of an ICU admission. In addition to that, the resulting financial burden is extremely cumbersome, worldwide. The ICU daily hospitalization cost exceeds that of the common ward by 3–6 times. In USA, for example, the average daily cost for an AHF patient occupying an ICU bed is $2573, while in Canada it is estimated to be $1500 per day [7].

Among CAP patients presenting in the ED, 42–55% will require hospitalization; 24% of these patients are admitted directly to the ICU [9,10]. Data from European Registries demonstrate that the mean cost and duration of ICU hospitalized patients with CAP, are €15,115 for 15.2 days, while the mean cost and duration of non-ICU hospitalized patients are €4742 for 6.2 days, respectively [11]. The majority of CAP episodes (64%) and costs (76%) occur among those aged ≥50 years. Unfortunately, multinational data concerning the rates of hospitalization of patients

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with concomitant AHF and CAP (AHF-CAP), especially in ICUs, as well as the resulting economic burden, are currently lacking [1].

2. Emergency department disposition decision

The ED physician is the exclusive key stake holder, entrusted with making the disposition decisions. In the chaotic ED environment, physicians straggle to save lives and put their often limited resources in good use. In the case of AHF-CAP, a multidisciplinary integrated approach is necessary, including cardiologists, pulmonologists, internists, laboratory medicine specialists and nurses [12,13]. Application of a parsimony law in this setting is impossible [14].

Most of the subspecialties dealing with the ED triage, are forced to make disposition decisions, based mainly on their expertise and intuition. However, risk assessment of AHF-CAP patients based on subjective criteria, can be slippery. There is a necessity for robust and validated risk stratification tools, designed exclusively for the ED setting, able to assist the physician in relation with the ICU prioritization triage of AHF-CAP patients [1,12,15]. Unfortunately, such tools are completely lacking. Currently, ED physicians willing to apply evidence-based criteria while dealing with an AHF-CAP patient, have to rely on existing risk models for either AHF or CAP, combining them, when possible, and extrapolating to assess the risk of his patient. In addition to that, most of these risk scores have not been sufficiently updated and refer to hospitalized patients. Thus, extrapolation of the estimated scores to assess the risk of patients presenting at the ED is rather precarious.

3. Acute heart failure risk models

The majority of risk scores for the assessment of AHF severity are derived from Canada. Among them, Emergency Heart Failure Mortality Risk Grade (EHMRG) is the most widely used one [16]. This risk model (Table 1) has been adjusted for the conditions of an ED, it has been validated and a medical calculator is available on line. Various parameters are assessed at presentation of the patient in the ED: age, transportation by Emergency Medical Services, systolic blood pressure, heart rate, blood values of creatinine, potassium and troponin, presence of an active cancer and, finally, use of diuretics at home (metolazone in the original version, other habitual diuretics in the applicate model). Each of the above parameters corresponds to a predetermined rate of severity, with the assigned points having either a positive or a negative sign. In order to calculate the final score, an adjustment factor is added in the end. According to the EHMRG score, the 7-day mortality rate of an AHF patient presenting in the ED can be predicted, for each one of the five resulting classes. Thus, class 5b with a score threshold >89.4%, relates to a 7-day mortality of 8.5%, rendering the patient a candidate for ICU admission.

Table 1
EHMRG 7-day mortality risk score.

Variable	Units	Grading component
Age	y	2 × age
Transported by EMS	If 'yes'	+60
SBP	mm Hg	−1 × SBP
Heart rate	beats/min	−1 × heart rate
Oxygen saturation	%	−2 × oxygen saturation
Creatinine	mg/dl	20 × creatinine
Potassium	4.0 to 4.5 mEq/l	0
	≥4.6 mEq/l	+30
	≤3.9 mEq/l	+5
Troponin	>ULN	+60
Active cancer	If 'yes'	+45
Diuretics at home	If 'yes'	+60
Adjustment factor		+12
Total		EHMRG score

Legend: EHMRG, Emergency Heart Failure Mortality Risk Grade; EMS, emergency medical services; SBP, systolic blood pressure; ULN, upper limit of normal.

Another risk tool aspiring to estimate the severity of AHF, is based on the criteria of Enhanced Feedback for Effective Cardiac Treatment-Heart Failure (EFFECT) Study [17]. The study included hospitalized AHF patients, aiming at predicting their 30-day mortality. Although this time range does not but loosely correlate with the ED disposition decision, the score has been widely used for the emergent evaluation of an AHF acuity. Web calculators are also available. This model shares three parameters with EHMRG: age, systolic blood pressure and presence of cancer. The rest include respiratory rate, blood values of urea, hemoglobin and sodium, presence of cerebrovascular diseases, chronic obstructive pneumonopathy, dementia and hepatic cirrhosis. Each one of the parameters is graded and the final score reflects the 30-day AHF mortality rate. Scores between 121 and 150 points as well as over 150 points correspond to high mortality (26%–33% and 50%–59%, respectively), necessitating the patient's admission to the ICU [18].

In addition to the aforementioned AHF risk scores, a European Society of Cardiology-Acute Cardiovascular Care Association position paper proposes an algorithm, aiming to assist the ED physician to determine which AHF patients are candidates for ICU admission [15]. This position paper incorporates data from the EHMRG, the EFFECT and other studies [19]. The following parameters are included: use of accessory respiratory muscles, need for intubation or non-mechanical ventilation, need for invasive or continuous monitoring, administration of intravenous vasodilators or inotropic agents, and signs of hypoperfusion such as oliguria, cold peripheries, lactate >2 mmol/l and mixed venous oxygen saturation < 65%. Should this newly proposed risk scale perform well in prospective validation, it could serve as a useful guide for ED triage.

4. Community-acquired pneumonia risk scores

Similarly to AHF, the ED estimation of the severity of CAP is based on risk scores derived from hospitalized patients, aiming to predict their 30-day mortality. Some of these scores have been applied to the ED patients, in order to assist disposition decisions. The most widely used severity score for CAP in the ED originates from CURB-65 Study (confusion, urea, respiratory rate, blood pressure, age ≥ 65 years) [20]. When three or more of these parameters coexist, the predicted 30-day mortality rate mounts up to 22% and the patient should be hospitalized with consideration for ICU admission (Table 2).

Another similar acuity evaluation for CAP in the ED is based on an improved version of the 2007 criteria of IDSA/ATS (Infection Disease Society of America/American Thoracic Society) [21,22]. This risk score proposes as major criteria of severity the need for invasive mechanical ventilation, septic shock requiring vasopressors and arterial pH < 7.30. Furthermore, the following minor criteria are taken into consideration: confusion, uremia (BUN ≥ 20 mg/dl), respiratory rate ≥ 30/min, blood pressure < 90–60 mm Hg, PF ratio (Partial oxygen pressure/fraction of inspired oxygen) ≤ 250, multilobar infiltrates, leucopenia with WBC < 4000 cells/mm^3, thrombocytopenia (platelet

Table 2
CURB-65 risk score for CAP.

Confusion	
Urea >20 mg/dl	
Respiratory rate ≥ 30/min	
Blood pressure (SBP <90 mm Hg or DBP ≤60 mm Hg)	
Age ≥ 65 years	
Total score	30-day mortality
0–1	1.5%
2	9.2%
>3	22%

Legend: CURB-65 confusion, urea, respiratory rate, blood pressure, age ≥ 65 years; SBP and DBP, systolic and diastolic blood pressure respectively; CAP, community acquired pneumonia.