Risk stratification in patients presenting with Acute Heart Failure

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Acute heart failure (AHF) is a major public health problem and hospitalizations for AHF are associated with significant morbidity, mortality and cost. Since most patients with AHF are admitted through the Emergency Department (ED) understanding their trajectory following the initial assessment and care in the ED is important for providing safe clinical care and optimizing resource utilization (including ED and inpatient beds).[1] There are two main aspects that we should examine if we are to realize better clinical care and use of our scarce resources. The first area is to understand which AHF patients are at low risk and could potentially be safely discharged from the ED. This could be either after an initial evaluation and appropriate tests in the ED or following an observation period of 1-3 days in a dedicated Observation Unit. The second is to understand which patients with AHF are at high risk for adverse inpatient events in order to facilitate triage to the most appropriate inpatient setting.

Several prior studies have developed prognostic scores predicting adverse short-term ED or inpatient events, 7 to 30-day post-discharge mortality or serious adverse events (e.g. a composite of all-cause death, mechanical cardiac support, intubation, emergent dialysis, or coronary intervention) following an ED visit for AHF. These existing models have recently been summarized in a systematic review and meta-analysis.[2] Models derived from prospectively collected cohorts focusing on 30-day mortality include 11-13 variables and resulting c-statistics range from 0.77-0.84 in the derivation cohorts, with similar results in subsequent validation studies.[2] These data suggest that subsets of patients with AHF at low risk for 30-day mortality can be identified based on parameters commonly collected on ED patients with suspected AHF such as vital signs, basic laboratory tests and ECG findings (Table 1). Current models predicting 30-day serious adverse events have lower prognostic accuracy but may still facilitate the identification of very low risk individuals who could safely be managed as outpatients, perhaps after an observation period in the ED. Literature on specific models predicting either inpatient mortality or recurrent ED visits/HF hospitalizations after an initial ED visit are sparse and these topics warrant further investigation.

Rossello et al. now further our knowledge in this area by examining registry data, from 41 Spanish EDs collected between 2014 and 2016, of adults presenting with AHF as defined by Framingham criteria.[REFERENCE] Patients were excluded if they had a concurrent ST-segment elevation myocardial infarction. They used the MEESSI-AHF risk score which has been previously derived and validated for predicting 30-day all-cause mortality. Using the same 13 variables, the current study now evaluated additional outcomes, including in-hospital death,

7-day mortality, 30-day recurrent ED visits or hospitalizations for HF. Among 7,755 patients with AHF, 7.4% died during the index hospitalization, 4.7% within 7 days and 10.1% within 30 days based on the initial ED visit. Following hospital discharge, 30-day mortality was 4.9%, 24% represented to the ED and 16% were readmitted for AHF. The model performed well for predicting 7-day and 30-day mortality both from the ED visit and following hospital discharge. However, the MEESSI-AHF risk score performed poorly predicting 30-day ED visits or readmissions for AHF following hospital discharge (c-statistic 0.54 – 0.62).

How should we interpret the findings from this study? The current study supports the notion that risk stratification models can help identify patients at low risk for 30-day mortality based on data available at the time of presentation to the ED. These findings could be implemented in decision support strategies either through online risk calculators or decision support tools integrated in electronic medical records. Similar strategies have been successfully implemented for other conditions such as patients presenting to the ED with chest pain, leading to a reduction in hospitalizations for those patients who can safely undergo testing and observation in the ED over time.[3] For risk scores to be easily adopted, it is helpful when these scores build on variables that are readily available to clinicians or can be quickly assessed. The MEESSI-AHF risk score incorporates the Barthel index which assess activities of daily living based on 10 variables and has traditionally been applied in patients with neuromuscular or musculoskeletal disorders or oncology patients.[4] It is recommended to apply this tool based on direct patient observation, which may be difficult to accomplish in a fast-paced ED setting. In addition, it is important to note that among the current and prior ED-based AHF risk scores there is a wide range with regards to which types of patients were excluded (some excluding no patients through to studies excluding on the basis of many criteria) and which proportion of patients were discharged from the ED either directly or after an observation period (ranging from 0% to 69%; Table 1). Both of these factors should be considered when applying these risk scores in the clinical setting.

Predicting, and perhaps more importantly, preventing readmissions for AHF and other serious adverse events among these patients may prove more difficult. We may need to use separate prediction models with different variables and data from the time at hospital discharge rather than the initial ED visit to predict these more complex subsequent events or find ways to integrate updated information into the models.[5, 6] Finally, integration of other measures of HF

status, such as degree of congestion measured by lung ultrasound, may further prove useful in risk stratification.[7]

Although patients with AHF represent a high-risk group of HF patients, there are opportunities to optimize the care of and resources utilized by these patients depending on their risk profile. Future research will need to focus on the implementation of risk assessment tools such as that developed by Rossello et al. [REFERENCE] in the clinical setting. Beyond the correct categorization of low risk patients with AHF, their initial treatment regimen in the ED and optimal outpatient follow up will be essential for safe patient care. Similarly, identification of novel strategies for AHF patients at particularly high risk based on characteristics identified in the ED has the potential to improve outcomes in these particularly vulnerable individuals.

Conflict of interest

Dr. Platz' employer has received support from Novartis for consulting work and she has consulted for scPharmaceuticals outside of the submitted work. She has received research support from NHLBI and NIDDK outside of the submitted work. Dr Jhund's employer, the University of Glasgow has received support from the DAPA-HF and DELIVER trials and Novartis for the PARADIGM-HF and PARAGON-HF trials. He has received speakers, advisory board or consulting fees from AstraZeneca, Novartis, Boehringer Ingelheim and grant funding from Boehringer Ingelheim.

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Table 1. Select prediction models in patients presenting with AHF to the Emergency Department

	30-day mortality		30-day serious adverse events	
	EHMRG30-ST[8] (n=8,772)	**MESSI-AHF [REF] (n=7,755)**	**OHFRS[9] (n=559)**	**STRATIFY[10] (n=1,033)**
Country (years)	Canada (2004-2007)	Spain (2014-2016)	Canada (2007-2010)	USA (2007-2011)
Patients discharged from ED (%)	26.8%	--	61.9%	7.7%
In-hospital mortality (%)	-	7.4%	4.2%	-
Overall 30-day mortality (%)	8.3%	10.1%	2.3%	4%
Overall 30-day serious adverse events (%)	-	-	11.6% [a]	12% [b]
Number of variables (n)	11	13	10	13
Types of variables	Age; active cancer; taking Metolazone; SpO2; heart rate; systolic BP (triage); creatinine; potassium; elevated Troponin; ST depression on ECG; arrival by ambulance	Age; SpO2; systolic BP; respiratory rate; low output symptoms; ACS; NYHA class IV; creatinine; elevated Troponin; NT-proBNP; LVH on ECG; Barthel index on ED arrival	Stroke/TIA; prior intubation for respiratory distress; SpO_2; heart rate (rest); heart rate (walking); BUN; serum CO_2; elevated troponin; NT-proBNP; ischemic changes on ECG	Age; BMI; dialysis; ACE inhibitor; respiratory rate, on supplemental O_2; diastolic BP; SaO2; BUN; Sodium; Troponin; BNP; QRS duration

Main exclusion criteria	DNR on arrival, paced rhythm, complete bundle branch block, on dialysis	Concurrent STEMI	SpO2 < 85%; heart rate ≥120; systolic BP <85 mmHg; confusion / disorientation / dementia; concurrent ACS / STEMI; death expected within weeks from chronic illness; from nursing home or chronic care facility; on hemodialysis	--
C-statistic (derivation cohort)	0.80	0.84	0.77	0.68
Lowest risk category	0.74% 30-day mortality (95% CI: 0.39, 1.27)	2% 30-day mortality	2.8% 14-day serious adverse events	13% of patients with <5% risk of 30-day adverse events

Legend:

ACS: Acute coronary syndrome, BMI: Body mass index, BP: Blood pressure, DNR: Do not resuscitate, STEMI: ST-elevation myocardial infarction, (NT-pro)BNP: (NT-pro)Brain-type natriuretic peptide, LVH: Left ventricular hypertrophy; SpO2: Oxygen saturation; SaO2: Arterial oxygen saturation

a) Death from any cause within 30 days of the ED visit, or any of the following within 14 days of the index ED visit: 1) Admission to a critical care or acute monitoring unit. 2) Endotracheal intubation or need for noninvasive ventilation after hospital admission, unless on non-invasive ventilation at home. 3) Myocardial infarction. 4) Major procedure: coronary artery bypass graft, percutaneous coronary intervention, other cardiac surgery, or new hemodialysis. 5) Relapse and hospital admission for patients who were discharged on the initial ED visit.

b) Death, acute coronary syndrome, cardiopulmonary resuscitation, mechanical cardiac support, mechanical ventilation, emergent dialysis, and emergency revascularization.