Predicting Survival in Patients With Acute Decompensated Heart Failure Complicated by Cardiogenic Shock

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Keywords: cardiogenic shock, prognostication, net benefit, acute decompensated heart failure, heart replacement therapy, heart failure

Posted Date: November 20th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-111263/v1

Abstract

Background: Acute decompensated heart failure (ADHF) complicated by cardiogenic shock (CS) has unique pathophysiological background requiring specific patient stratification, management and therapeutic targets. Accordingly, the aim of this study was to derive a simple stratification tool to predict survival in patients with ADHF complicated by CS.

Methods and results: We analyzed data from a historic cohort of 87 ADHF-CS consecutive patients, eligible to heart replacement therapy (HRT), enrolled between 2015 and 2019. The association between selected independent variables (age, lactates and creatinine, ALC-shock score) and 28-day overall mortality was investigated through a multivariable logistic model. Predictive validity was assessed throughout an internal and external validation and compared to the Cardshock score. A nomogram was developed for predicting 28-day mortality.

Overall 28-day mortality was 34%. Among patients who survived, 38 (67%) were treated with HRT: heart transplantation was performed in 68%, the remaining received an LVAD. The ALC-shock score showed better discrimination (Area Under the Curve-AUC- 0.82; 95% CI 0.73-0.91) as compared to the Cardshock score (AUC 0.67; 95% CI 0.55-0.79) (p = 0.009) to predict 28-days overall mortality. In the validation cohort the AUC for the ALC-shock score was 0.66.

Conclusions: A model including age, lactates and creatinine on admission (ALC-Shock score) could be considered to predict short-term mortality in CS-ADHF patients in order to drive towards a treatment intensification.

Disclosures: Dr. Garan is supported by National Institutes of Health Grant No. KL2TR001874 and has received honoraria from Abiomed. Dr. Colombo reports institutional grant support from Abbott Vascular. None of the listed entities has had any involvement with the development of the manuscript. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Research ethics: This study was approved by the Local Ethics Committee of Milano Area 3 of the ASST Grande Ospedale Metropolitano Niguarda, Piazza Ospedale Maggiore 3, 20162 Milano (reference number: 543-23092020).

Highlights

- Patients with ADHF are often characterized by long-standing congestion and impaired perfusion.
- Dedicated scores had not yet been derived.
- A simple stratification tool including information about patient's biology (age), impaired perfusion (arterial lactate) and organ dysfunction (serum creatinine) may drive treatment intensification in this setting.

Introduction

Cardiogenic shock (CS) is a clinical challenge which results from complex and distinct pathways leading to oxygen starvation.[1–3] Despite improvements in hemodynamics with short-term mechanical support and advances in intensive care unit (ICU) management, in-hospital mortality for CS patients remains as high as 50%, and stagnant over time.[4,5]

Data from American and European registries have recently highlighted a rising prevalence of CS related to a chronic cardiomyopathy decompensation as opposed to acute myocardial infarction (AMI).[6] Since the underlying pathologies are different,[6] there is an unmet need to identify disease-specific, dedicated risk scores that are readily available upon ICU admission which might ultimately guide choice of therapies, and thereby improve outcomes and optimize allocation of scares resources.

However, data on patients with CS not related to AMI, are lacking even in large, well-reported registries[7–13] and are mostly limited to case-series,[14–22] with only one phase II study[23] and one small randomized clinical trial.[24] In addition, only one risk score has been recently validated in a cohort of patients that included a significant number of acute decompensated heart failure (ADHF)-CS patients.[25] However, this score was based not only on clinical and laboratory variables, but also on hemodynamic criteria that may not be available upon admission to the ICU.[25]

Thus, the aims of this study were:1) to derive a simple score that could predict 28-day survival of ADHF-CS patients based on easily obtained and clinically relevant variables; 2) to compare its predictive performance with a shock score (CardShock[13] score) derived in patients admitted for CS mostly related to AMI; and 3) to validate this score using two separate (internal and external) cohorts.

Methods

Study design

Derivation cohort

Data were extracted retrospectively from charts of 87 consecutive CS-ADHF patients admitted between 2015 and 2019 at Intensive Coronary Care Unit (ICCU) and Cardio-thoracic Intensive Care Unit (CICU) of ASST Grande Ospedale Metropolitano Niguarda within 12 hours of CS diagnosis.

Validation cohort

Data were extracted retrospectively from charts of 93 ADHF-CS patients, admitted between January 2011 and April 2016, who received and intra-aortic balloon pump (IABP) for hemodynamic support in the setting of CS in the ICU of the Columbia University Irving Medical Center, New York, NY.

The study was conducted in accordance with ethical principles based on Helsinki's Declaration,[26] International Conference on Harmonization for Good Clinical Practice, and the current ethical rules. The Strengthening the Reporting of Observational Studies in Epidemiology Guidelines (STROBE) were

followed for reporting the findings.[27] This study was approved by the Local Ethics Committee of Milano Area 3 of the ASST Grande Ospedale Metropolitano Niguarda (Piazza Ospedale Maggiore 3, 20162 Milano) and by the Ethics Committee Institutional Review Board of the Columbia University Medical Center. Since not all patients were able to give their informed consent, the Ethics Committee waived this requirement. Informed consent was sought from all surviving patients as soon as they regained their mental competence.

Definitions

The following **inclusion criteria** were adopted to define the study cohort with CS due to ADHF: 1) age ≥ 18 and < 75; 2) systolic blood pressure (SBP) < 90 mmHg or mean arterial pressure (MAP) < 60 mmHg, after an appropriate fluid challenge if there were no sign of overt fluid overload; OR need of vasoactive agents to maintain SBP > 90 mmHg or MAP > 60 mmHg; 3) reduced ejection fraction [left ventricle systolic function (LVEF) ≤ 35%]; 4) at least one of the following criteria/items of overt hypoperfusion: altered state of consciousness; sweaty and cold skin; mixed venous oxygen saturation < 60%; arterial lactates > 2 mmol/L; oliguria < 0.5 ml/Kg/h for at least 6 hours.

Patients were excluded if any of the following criteria were present: 1) CS symptoms beyond 12 hours; 2) septic shock with identified infection; 3) CS due to AMI; 4) CS due to acute myocarditis; 5) CS due to pulmonary thromboembolism; 6) constrictive pericarditis; 6) congenital heart disease; 7) CS secondary to either cardiac or non-cardiac surgery.

Data analysis

Baseline characteristics were compared between patients alive and deceased at 28-days. Continuous data are presented as mean ± standard deviation (SD) or median (interquartile range, IQR) and were compared between groups using the Student's t test or Mann-Whitney test, as appropriate. Categorical variables were compared between groups using the X^2 test.

Using logistic regression, univariable testing was performed to identify the variables potentially associated with 28-day mortality. Based on these results, as well as those of previously developed scores,[24,27] we fit a multivariable logistic model to estimate the odds ratios (OR) and the corresponding 95% confidence intervals (CI) for each variable. Predicted probabilities were calculated accordingly.

We performed internal validation by using bootstrap resampling with 200 samples. External validation was performed on the validation cohort. We then assessed model performance with Brier scores, discrimination with the c-statistics, and calibration with the calibration-in-the-large and slope statistics. Since the validation cohort included only ADHF-CS patients who were treated with IABP, we compared observed and predicted 28-days mortality between the validation cohort and the subsample of the derivation cohort which also received IABP support (62 patients) according to terciles of predicted probabilities.

Next, we compared the identified prognostic score to the CardShock[25] score in the derivation sample. Discrimination was assessed with c-statistics and calibration was assessed by comparing predicted probabilities of 28-days mortality to the observed status. Clinical usefulness of our shock score was evaluated by estimating the net benefit of using the model to risk-stratify patients according to different decision thresholds of 28-day mortality.[28] All analyses were performed using STATA version 14 (Stata Corp., College Station, TX) and R software version 3.5.1.

Results

Clinical characteristics

Derivation cohort

Three-hundred and forty patients were identified and screened from medical records; 253 patients were excluded, and 87 patients were included. Demographic, clinical, and biochemical characteristics upon admission and non-pharmacologic support during hospitalization of the study population are reported in Table 1 according to mortality at 28-days.

Table 1
Demographic, clinical, biochemical characteristics upon admission and non-pharmacologic support during hospitalization in patients included in the derivation cohort

	Overall population (n = 87)	Patients who survived (n = 57)	Patients who died (n = 30)	p value
Age, years	50.8 ± 15.2	46.7 ± 14.9	58.8 ± 12.2	< 0.001
Male sex	64 (73.5)	41 (71.9)	23 (76.7)	0.634
BMI	24.0 ± 4.4	23.9 ± 4.4	24.2 ± 4.4	0.842
Diabetes mellitus	18 (20.7)	12 (21.0)	6 (20.0)	0.908
Hypertension	22 (25.3)	10 (17.5)	12 (40.0)	0.022
Dyslipidaemia	20 (22.9)	11 (19.3)	9 (30.0)	0.259
LVEF	21.3 ± 9.6	20.7 ± 9.7	22.6 ± 9.6	0.398
CRT	32 (36.8)	13 (22.8)	19 (63.3)	< 0.001
Heart rate	94.5 ± 19.7	95.6 ± 19.3	92.4 ± 20.6	0.477
SAP, mmHg	91 ± 15.1	95.5 ± 12.4	83.6 ± 16.8	< 0.001
DAP, mmHg	54 ± 14.2	56.6 ± 14.5	49.8 ± 12.8	0.039
MAP, mmHg	67 ± 13	69.4 ± 12.6	61.2 ± 12.4	0.005
Wedge pressure, mmHg	13.8 ± 8.0	12.0 ± 6.9	17.5 ± 9.2	0.138
CVP, mmHg	12.2 ± 6.8	11.1 ± 6.2	14.6 ± 7.6	0.034
mPAP, mmHg	23.7 ± 10.1	20.7 ± 6.8	30.3 ± 13.5	0.052
SVcO2	55 ± 14.3	55.2 ± 14.4	53.6 ± 14.3	0.689
Arterial lactates, mmol/L	3.8 ± 3.5	3.1 ± 2.7	5.2 ± 4.4	0.008
Serum creatinine, mg/dl	1.76 ± 1.1	1.4 ± 0.7	2.3 ± 1.3	< 0.001

Data are reported as mean and standard deviation or number and percentage.

BMI: Body Mass Index; CRF: history of Chronic Renal Failure; CVP: Central Venous Pressure; CVVH: Continuous VenoVenous Haemofiltration; DAP: Diastolic Arterial Pressure; ECMO: ExtraCorporeal Membrane Oxigenation; IABP: IntraAortic Ballon Pump; LVEF: Left Ventricle Ejection Fraction; MAP: Mean Arterial Pressure; mPAP: mean Pulmonary Artery Pressure; NIMV: Non-Invasive Mechanical Ventilation; SAP: Systolic Arterial Pressure.

*1 patient had missing data

	Overall population (n = 87)	Patients who survived (n = 57)	Patients who died (n = 30)	p value
Serum bilirubin, mg/dl	1.98 ± 1.7	1.7 ± 1.5	2.4 ± 2.0	0.109
INR	2.2 ± 1.2	2.1 ± 1.1	2.4 ± 1.4	0.206
Haemoglobin, gr/dl	12.2 ± 1.9	12.4 ± 2.0	11.9 ± 1.6	0.223
Platelet count, $x10^9/L$	234 ± 93	241 ± 96	219 ± 87	0.288
Diuresis, ml/Kg/h	1 ± 0.8	0.7 ± 0.9	0.5 ± 0.6	0.235
CRRT	6 (6.9)	4 (7.0)	2 (6.7)	0.969
Mechanical ventilation	40 (45.9)	24 (42.1)	16 (53.3)	0.157
NIMV	36 (41.4)	21 (36.8)	15 (50)	0.487
IABP*	62 (71.3)	45 (78.9)	17 (56.7)	0.029
ECMO	22 (25.9)	14 (24.6)	8 (26.7)	0.830
Data are reported as mean and standard deviation or number and percentage.				
BMI: Body Mass Index; CRF: history of Chronic Renal Failure; CVP: Central Venous Pressure; CVVH: Continuous VenoVenous Haemofiltration; DAP: Diastolic Arterial Pressure; ECMO: ExtraCorporeal Membrane Oxigenation; IABP: IntraAortic Ballon Pump; LVEF: Left Ventricle Ejection Fraction; MAP: Mean Arterial Pressure; mPAP: mean Pulmonary Artery Pressure; NIMV: Non-Invasive Mechanical Ventilation; SAP: Systolic Arterial Pressure.				
*1 patient had missing data				

The most reported etiology was non-ischemic dilated cardiomyopathy, followed by ischemic dilated cardiomyopathy. In this derivation cohort, 30 patients (34%) had expired at 28-days and 57 (66%) were alive; among them, 19 (33%) experienced improvement that allowed discharged on medical therapy and 38 (67%) were bridged to heart replacement therapy [12 patients to left ventricle assist device (LVAD), 24 patients to heart transplantation (HT) and 2 patients to HT after LVAD]. Patients' flow is detailed in **Fig. 1**. Patients who survived were younger, suffering less frequently of hypertension and chronic renal failure. Hypotension and increased creatinine values upon admission were more frequent in patients who died, as well as higher arterial lactates and central venous pressure. Among non-pharmacological support, IABP was more frequently implanted in patients who survived.

Validation cohort

The validation cohort included 93 patients with ADHF and hemodynamic evidence of CS who underwent IABP implantation. Baseline characteristics are reported in Table 2. Thirty patients (32%) died at 28-days

follow up, whereas 63 (68%) survived, 21 experiencing improvement and discharged on medical therapy (33%) and 42 bridged to heart replacement therapy (67%) [4 patients to HT and 38 patients to LVAD].

Table 2
Demographic, clinical, biochemical characteristics upon admission of the patients included in the validation cohort

	Overall population (n = 93)	Patients who survived (n = 63)	Patients who died (n = 30)	p value
Age, years	58.5 ± 13.8	56.0 ± 14.0	63.7 ± 12.2	0.011
Male sex	77 (82.8)	52 (82.5)	25 (83.3)	0.924
BMI	27.5 ± 7.3	27.1 ± 7.2	28.6 ± 7.8	0.522
Diabetes mellitus	30 (32.3)	15 (23.8)	15 (50.0)	0.012
Hypertension*	24 (46.1)	18 (47.4)	6 (42.9)	0.772
CRT*	21 (40.4)	16 (42.1)	5 (35.7)	0.677
Heart rate	98.0 ± 20.6	99.4 ± 19.4	95.1 ± 23.1	0.342
SAP, mmHg	100.2 ± 14.3	101.3 ± 15.4	97.8 ± 11.8	0.261
DAP, mmHg	64 ± 12.4	66.2 ± 12.3	59.4 ± 11.5	0.012
MAP, mmHg	76.1 ± 11.4	77.9 ± 11.8	72.2 ± 9.5	0.022
Wedge pressure, mmHg	30.2 ± 11.4	33.7 ± 10.3	23.9 ± 11.2	0.026
CVP, mmHg	17.2 ± 7.2	16.9 ± 7.2	17.8 ± 7.3	0.587
mPAP, mmHg	38.5 ± 10.6	40.0 ± 9.9	35.4 ± 11.4	0.049
SVcO2	41.3 ± 12.1	40.8 ± 12.6	43.0 ± 10.7	0.557
Arterial lactates, mmol/L	1.6 (1.2–2.5)	1.4 (1.1–2.2)	2.2 (1.4-8)	0.003
Serum creatinine, mg/dl	1.8 (1.4–2.5)	1.7 (1.4–2.6)	1.8 (1.5–2.4)	0.796
CPO	0.54 ± 0.16	0.53 ± 0.17	0.56 ± 0.17	0.417
PAPi	1.5 (1.0-2.4)	1.7 (1.0-2.4)	1.5 (1.0-2.7)	0.884

*Hypertension, CRT: 41 missing values; Wedge pressure: 65 missing

BMI: Body Mass index; CPO: cardiac Power Output; CRF: history of Chronic Renal Failure; CVP: Central Venous Pressure; DAP: Diastolic Arterial Pressure; MAP: Mean Arterial Pressure; mPAP: mean Pulmonary Artery Pressure; PAPi; Pulmonary Arterial Pulsatility index; SAP: Systolic Arterial Pressure.

The ALC-shock score

Estimated ORs for 28-day mortality were 1.06 (95% CI = 1.01–1.108) for year of age, 2.06 (95% CI 1.14–3.72) for 1-point increase in serum creatinine, and 1.18 (95% CI = 1.02–1.36) for 1-point increase in arterial lactates, respectively.

Model calibration

The model showed a good calibration in the internal validation (calibration-in-the-large close to 0 and calibration slope close to 1) while in the validation cohort, calibration was in average slower (calibration-in-the-large=-0.635) and the effect of predictors were on average smaller (calibration slope = 0.486).

Figure 2 shows the median of the predicted probabilities plotted against the proportions of observed 28-day mortality stratified according to terciles of predicted probabilities. The risk prediction was well-calibrated in the derivation cohort (for both the entire cohort and similarly in the subgroup of patients who were treated with IABP), whereas, in the validation cohort, prediction was well calibrated in patients at low and moderate risk but overestimated the mortality rate in the high-risk group.

Score Validation

Results for internal and external validation are summarized in **Appendix** Table 1.

Overall model performance increased at internal and external validation: Brier scores were respectively 16.0%, 17.7% and 22.7%. The c-statistic of the model was 0.82 (95% CI = 0.73–0.91) on the derivation sample as whole and 0.80 (95% CI 0.66–0.92) when only patients receiving IABP were included. At internal validation, the value was comparable (0.80, 95% CI = 0.67–0.88), while in the external validation it decreased to 0.66 (95% CI = 0.54–0.78).

The prediction model was further evaluated by incorporating clinical consequences throughout the graphical display of the net effect of submitting 100 patients to the risk prediction. For a decision threshold of 40% of 28-day mortality, the ALC shock score would identify, in a population of 100 patients with a 34% incidence of 28-day mortality the following number of patients: 21 events, i.e. identified correctly with prediction exceeding the threshold, and 12 non-events, i.e. incorrectly identified with prediction exceeding the threshold. Since the choice of a threshold equal to 40% translates into a cost of declaring a patient at high risk (i.e. with a prediction greater than 40%) equal to 40%/(100%-40%) = 0.67, the net gain is 21-0.66*12 = 13 patients. (**Appendix, Fig. 1**)

Nomogram

Figure 3 presents a nomogram that predicts 28-day mortality. Points assigned to the patient's variables are added and allow estimation of the probability of 28-day mortality.

Comparison between the ALC-shock score and the Cardshock score

Compared to the ALC-shock score, the Cardshock score showed a poorer discrimination (AUC 0.67; 95% CI 0.55–0.79; p = 0.009) (Fig. 4) and calibration (Fig. 5) on the derivation sample.

Discussion

Herein we report the outcomes of CS in a patient population limited exclusively to ADHF in 2 tertiary care centers capable of providing heart replacement therapy. The main finding of this study is that a simple risk score which includes age, serum creatinine and arterial lactates may adequately predict 28-day survival in ADHF-CS patients. In this specific population, this score performed better than a previously validated stratification tool which was derived from a heterogenous population of cardiogenic shock patients.[13]

Clinical decision-making is challenging in CS patients due to the complexity of the metabolic, hemodynamic and inflammatory pathways which occur once a low output state develops[3]. Moreover, the epidemiologic changes that occurred in the last decades further require attention[6] : data from the collaborative research network of American Heart Association showed a shift from AMI-CS to CS occurring as a consequence of ADHF.[3] These two scenarios differ from a pathophysiological and hemodynamic standpoint,[28] and this may explain why treatments that are ineffective in the setting of AMI (e.g. IABP) might be beneficial in patients with CS-ADHF.[7–24,28]

In particular, a favorable profile may emerge from IABP, since the risks of the procedure are low, the limited increase of cardiac output that it provides may be sufficient for improving tissue perfusion in patients with chronic advanced HF, in whom some adaptation to reduced cardiac output exists, and these effects are not blurred or confounded by the effect of an etiology-directed treatment such as reperfusion in CS associated with acute MI.

In an examination of multiple prognostication tools recently published in CS patients, three variables were consistently included[10,13,25,27,29] (age, renal function, and lactates,). Ageing and renal failure are associated with worst outcomes in several cardiac and non-cardiac disease states. [30,31,32] Although these characteristics may contribute to contraindications for HT/LVAD, they could be regarded as hallmarks for early decision in favor of surgery (mainly LVAD) as long-term therapy, before deterioration that would reduce the probability of survival, either with or without heart replacement therapy. Elevated arterial lactate is an early marker of the metabolic dysregulation and microcirculatory dysfunction that leads to multiorgan failure.[3] Therefore, in patients with acutely decompensated chronic heart failure, these three variables reflect constitutive and contingent factors strongly related to prognosis.

It is important to note that the performance of our score was somewhat reduced when applied to an external validation cohort. However, the derivation and validation population differed in age and risk profile. Furthermore, every patient in the validation cohort was treated with IABP, suggesting a potential impact of this therapy on outcomes. Importantly, when we compared the actual and predicted rates of mortality, the ALC-shock score was well-calibrated for all patients at low and intermediate risk including

those in the external validation cohort. The overestimation of mortality rates in the high-risk group could be explained by the early timing of IABP therapy in this latter cohort.

Recent data have focused on the prognostic role of hemodynamic indexes [cardiac power output/index (CPO/CPI) and pulmonary artery pulsatility index (PAPi)] in patients with ADHF-CS.[25,28] However, the insertion of a pulmonary artery catheter, though often performed in some centers, is not routinely pursued, involves some risks to the patient, and data are not readily available upon admission. Moreover, patients with chronic AHF may adapt to highly abnormal hemodynamic profile with normal or near normal end-organ function, lactate and minimal symptoms - thus models based on purely hemodynamic parameters may be limited in both prognostic ability and broad application. Indeed, the major strength of this data is the description of a simple and reliable prediction model for ADHF-CS patients, who represent a growing percentage of the overall cohort of CS patients. This tool can be used at bedside upon admission to the ICU to prognosticate and plan the next management strategies in order to identify the right patient to get access to durable surgical solutions such as HT or LVAD.

Our study has several limitations. First, we did not compare our score to others that included hemodynamic data.[25] However, as previously discussed, hemodynamic assessment with pulmonary artery catheters is not routinely performed, limiting the widespread applicability of such scores. Second, as noted above, the model had diminished performance in the validation cohort, particularly among the highest risk profile. Third, it is important to note that intermediate and long-term survival often depends on the patient's candidacy for heart replacement therapies and the criteria for such therapies often differ somewhat between different centers such as the two contributing cohorts for the analysis.

Conclusions

CS remains a deadly scenario; little is known about the management of patients with ADHF complicated by CS, for which dedicated stratification tools are lacking. Indeed, this subgroup is epidemiologically relevant in the current era and requires specific focus. According to our results, short-term survival of patients with ADHF-CS may be adequately predicted upon admission based on patient's age, serum lactate and serum creatinine (ALC-shock score). This stratification tool is easy to use and may help clinicians with early prognostication in their daily practice particularly in identifying a high-risk cohort that might eventually benefit from early aggressive therapies.

Abbreviations

ACS
acute coronary syndrome
ALC
age, serum lactates and creatinine
AMI
acute myocardial infarction

ADHF
acute decompensated heart failure
CI
confidence interval
CS
cardiogenic shock
HR
hazard ratio
IABP
intra-aortic balloon pump
ICCU
intensive coronary care unit
ICU
intensive care unit

Declarations

Authors' contributions

NM, MB, PC and ARG were involved in conceptualization. GV, LV and LDP helped in data curation. LA, MDM and CLV contributed to formal analysis. MF, FO, AS contributed to methodology. PC, JF, FP and ARG contributed to supervision. ARG was involved in validation. NM, FP, PC, ARG were involved in writing—review and editing. All authors read and approved the final manuscript.

Funding Sources

None

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

This study was approved by the Local Ethics Committee of Milano Area 3 of the ASST Grande Ospedale Metropolitano Niguarda (Piazza Ospedale Maggiore 3, 20162 Milano) and by the Ethics Committee Institutional Review Board of the Columbia University Medical Center**.** Since not all patients were able to give their informed consent, the Ethics Committee waived this requirement. Informed consent was sought from all surviving patients as soon as they regained their mental competence.

Consent for publication

Not applicable.

Competing interests

None

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Figures

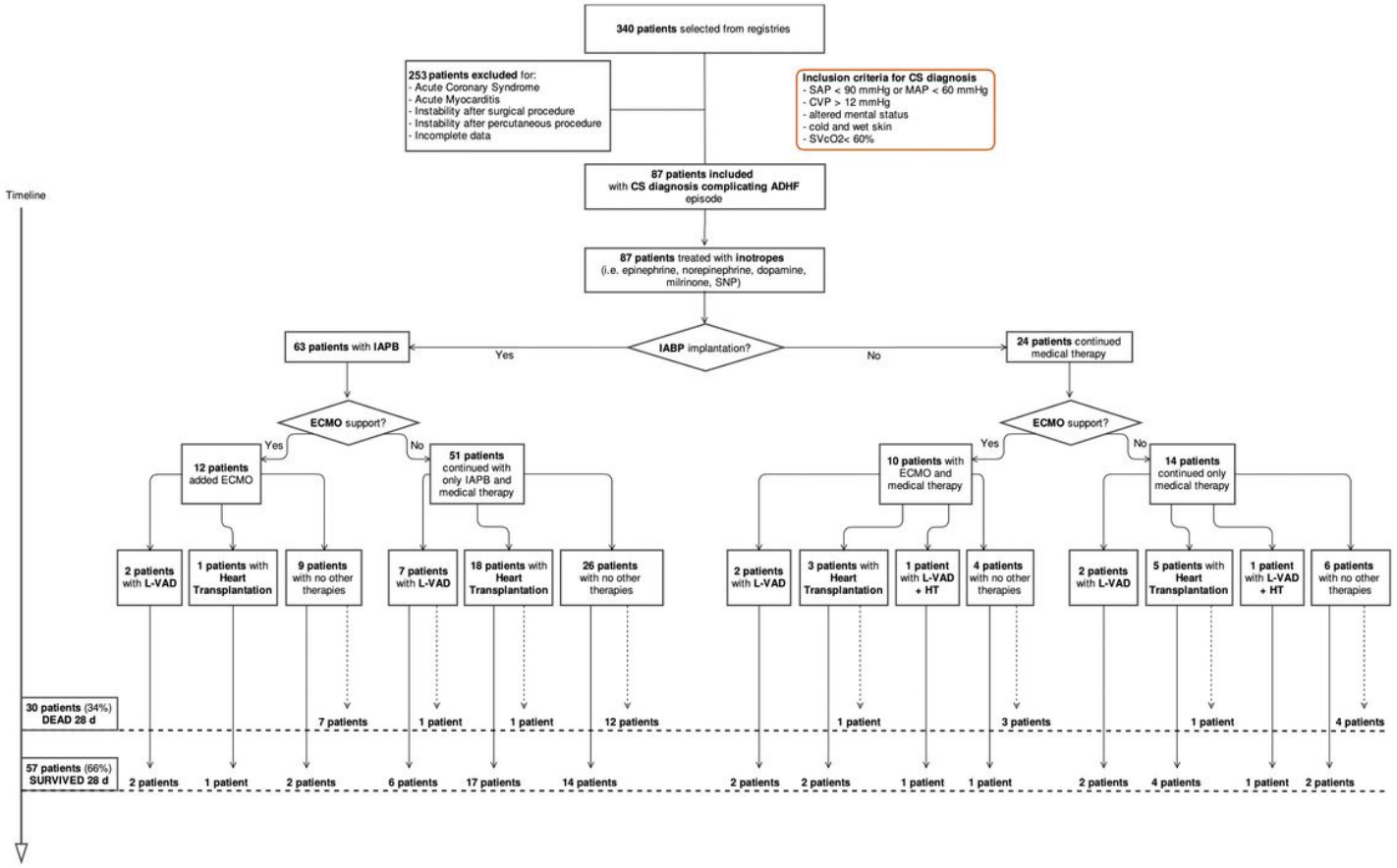
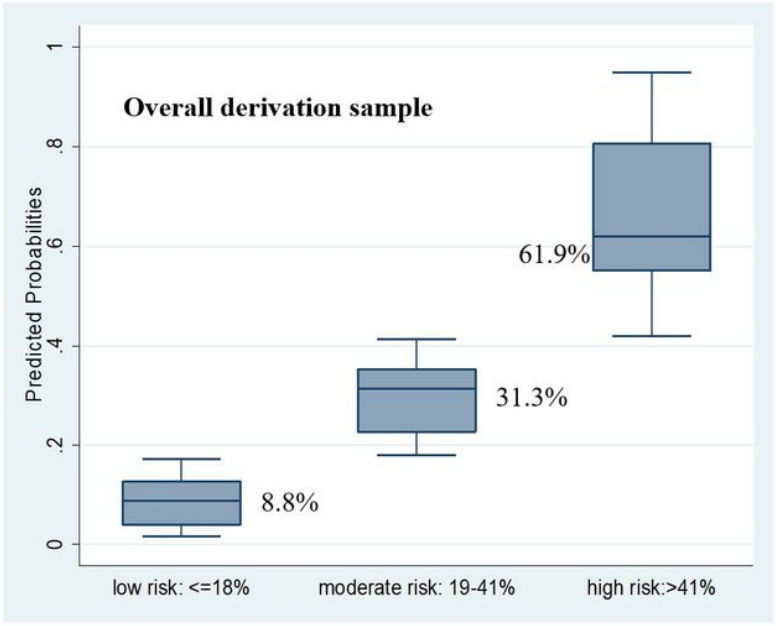


Figure 1

The most reported etiology was non-ischemic dilated cardiomyopathy, followed by ischemic dilated cardiomyopathy. In this derivation cohort, 30 patients (34%) had expired at 28-days and 57 (66%) were alive; among them, 19 (33%) experienced improvement that allowed discharged on medical therapy and 38 (67%) were bridged to heart replacement therapy [12 patients to left ventricle assist device (LVAD), 24 patients to heart transplantation (HT) and 2 patients to HT after LVAD]. Patients' flow is detailed in Figure 1.



	Low risk	Moderate risk	High risk
IABP cohort of the derivation sample			
sample	n=25	n=21	n=16
Observed	8.0%	28.6%	56.3%
Predicted	9.1%	31.4%	56.7%
Validation cohort			
sample	n=21	n=28	n=44
Observed	14%	32%	41%
Predicted	11%	30%	60%

Sample	n=29	n=29	n=29
Observed mortality	10%	27%	65%

proportions of observed 28-day mortality and median of predicted probabilities

Figure 2

Figure 2 shows the median of the predicted probabilities plotted against the proportions of observed 28-day mortality stratified according to terciles of predicted probabilities

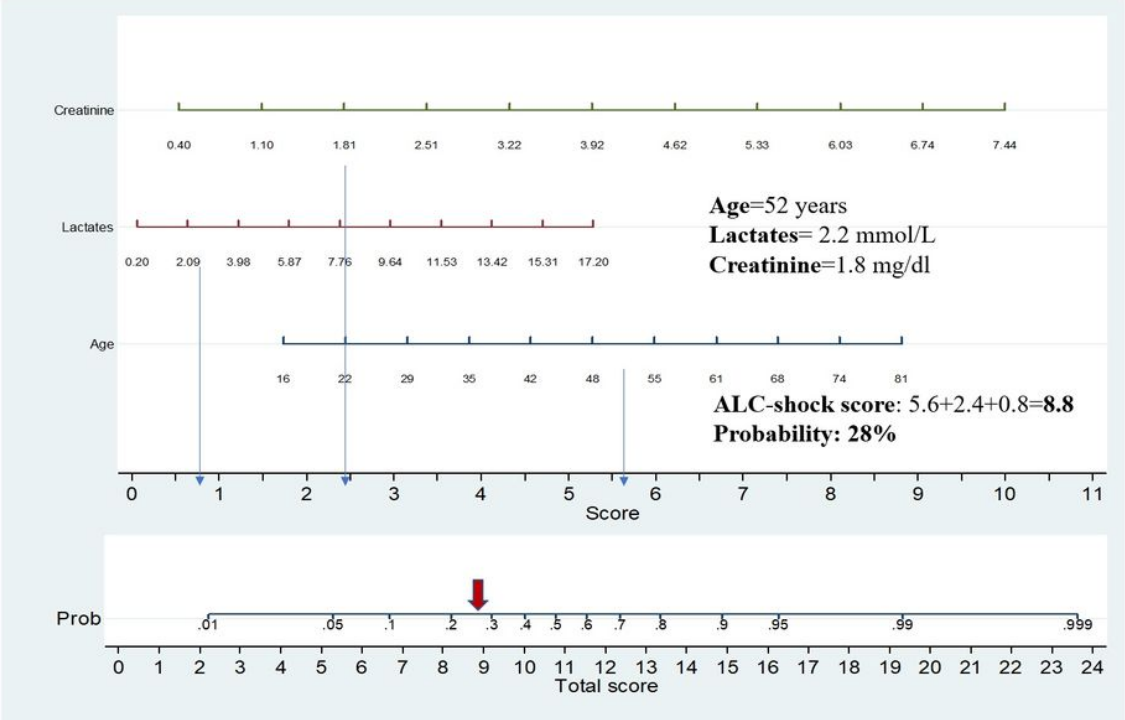


Figure 3

Figure 3 presents a nomogram that predicts 28-day mortality. Points assigned to the patient's variables are added and allow estimation of the probability of 28-day mortality.

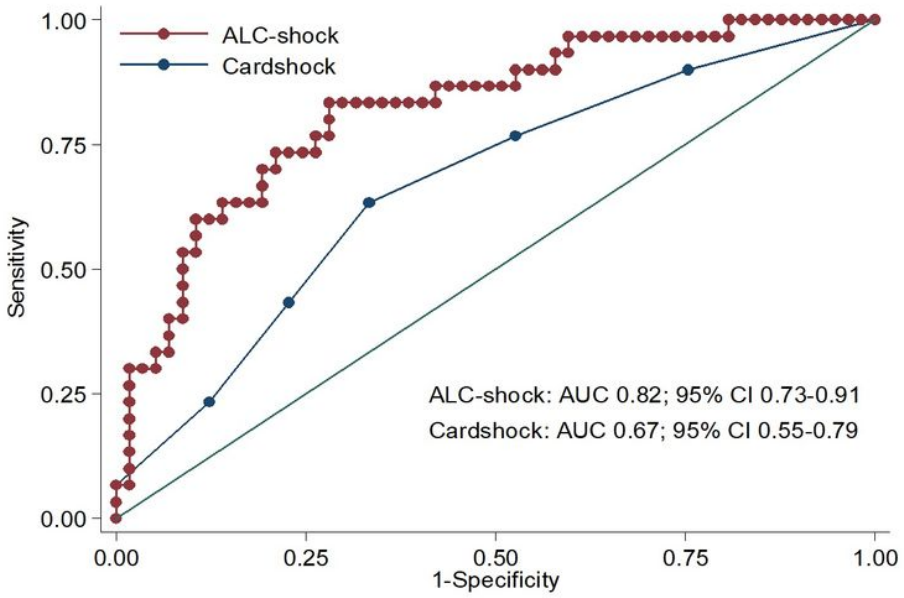
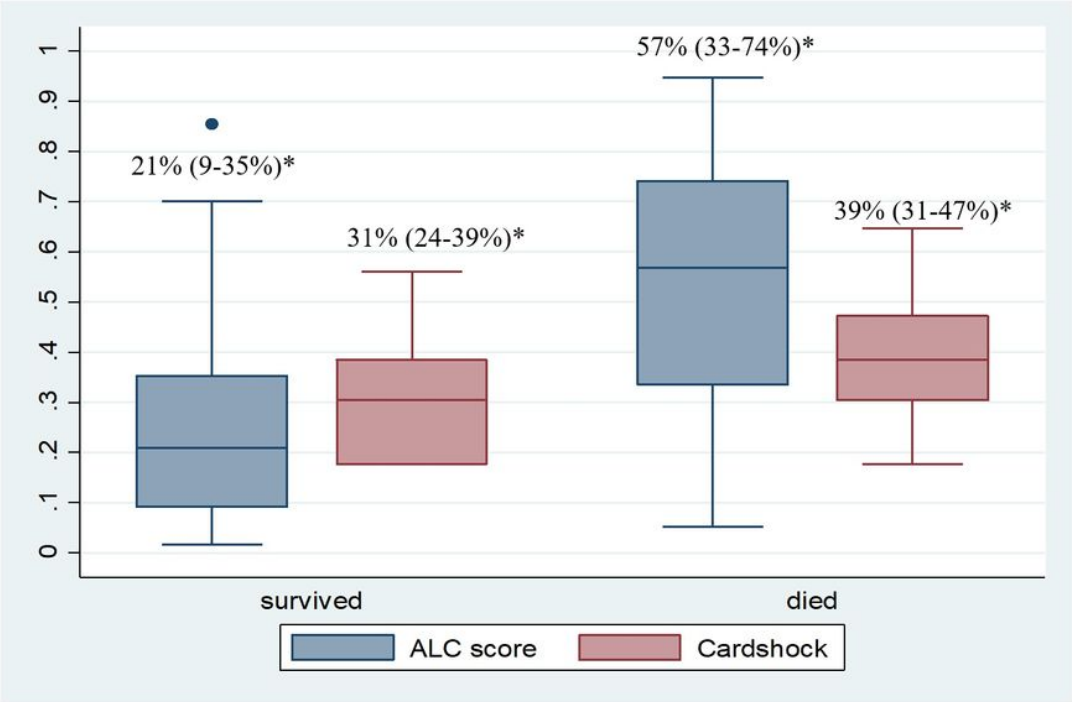


Figure 4

Compared to the ALC-shock score, the Cardshock score showed a poorer discrimination (AUC 0.67; 95% CI 0.55-0.79; p=0.009) (Figure 4)



*median and interquartile range of the predicted probabilities

Figure 5

Compared to the ALC-shock score, the Cardshock score showed a poorer discrimination (AUC 0.67; 95% CI 0.55-0.79; p=0.009) (Figure 4) and calibration (Figure 5) on the derivation sample.

Supplementary Files

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- Supplementarymaterial.docx