Supplemental Materials

Table S1. *Study 1 SCAI classification framework according to Naidu et al. (J Am Coll Cardiol., 2022)*

SCAI SHOCK stage	Parameter/ clinical scenario	Criteria
A[1]	Lactate	Baseline lactate < 2 mmol/L [a]
	Blood pressure and heart rate	- Mean SBP ≥ 100 mmHg AND baseline SBP ≥ 90 mmHg AND lowest SBP equal to or < 30mmHg below baseline - Baseline MAP ≥ 60 mmHg - Baseline HR < 100 beats/min
	Kidney function	eGFR > 90mL/min/1.73 m^2 (< 90 mL/min/1.73 m^2 if history of chronic kidney disease is documented)
	Liver function	No LFT elevation (i.e. ALT < 35 U/L, AST < 40 U/L) [b]
	Vasoactive / inotropic drugs used	None
	MCS devices	None
B[1]	Lactate	Baseline lactate < 2 mmol/L [a]
	Blood pressure and heart rate	Baseline SBP < 90 mmHg OR lowest SBP > 30mmHg below baseline OR baseline MAP < 60 mmHg OR baseline HR ≥ 100 beats/min
	Kidney function	eGFR > 60mL/min/1.73 m^2 (< 60 mL/min/1.73 m^2 if history of chronic kidney disease is documented)
	Liver function	No LFT elevation (i.e. ALT < 35 U/L, AST < 40 U/L) [b]
	Vasoactive / inotropic drugs	None
	MCS devices	None
C[2]	Scenario 1	- Baseline lactate ≥ 2 mmol/L[a] AND no further increase - 0 / 1 vasoactive / inotropic drug OR MCS devices
	Scenario 2	- Highest AST > 40 U/L OR highest ALT > 35 U/L OR highest NT-proBNP > 125 ng/L [b] OR baseline SBP < 90 mmHg OR baseline MAP < 60 mmHg OR lowest SBP > 30 mmHg below baseline OR highest lactate within the 24h timeframe > baseline lactate - 1 vasoactive / inotropic drug OR MCS devices
	Scenario 3	- No signs of hypotension: mean SBP > 90 mmHg AND mean MAP > 60 mmHg AND lowest SBP is equal to or < 30 mmHg below baseline - Highest lactate within the 24h timeframe is equal to the baseline lactate [a] - Sum of MCS devices and vasoactive / inotropic drugs ≥ 2 - No increase in absolute number or cumulative dose of vasoactive / inotropic drug / MCS devices within the 24h timeframe [c]
D[2]	Scenario 1	- Baseline lactate ≥ 2 mmol/L AND highest lactate within the 24h timeframe > baseline lactate [a] - 1 vasoactive / inotropic drug OR 1 MCS device OR highest creatinine within the 24h timeframe > baseline creatinine OR highest AST > 40U/L OR highest ALT > 35 U/L OR highest NT-proBNP > 125 ng/L [b]
	Scenario 2	- Baseline lactate ≥ 2 mmol/L [a] and no further increase OR highest creatinine within the 24h timeframe > baseline creatinine OR highest AST > 40U/L OR highest ALT > 35 U/L OR highest NTproBNP > 125 ng/L [b] - Sum of vasoactive / inotropic drugs and MCS devices ≥ 2 with an increase in absolute numbers or applied doses within the 24h timeframe [c] - No sign of hypotension: mean SBP > 90 mmHg AND mean MAP > 60 mmHg AND lowest SBP is equal to or < 30 mmHg below baseline
E[3]		- CPR (duration at least ≥ 2 min) - Baseline lactate ≥ 8 mmol/L [a] - Lowest pH < 7,2 (arterial; if not available venous pH) - Highest Base deficit > 10 mmol/L (arterial; if not available venous base deficit) - Vasopressor bolus applied - Profound hypotension despite maximal hemodynamic support: mean SBP < 90 mmHg OR mean MAP < 60 mmHg OR lowest SBP > 30 mmHg below baseline AND ≥ 3 vasoactive / inotropic drugs used +/- MCS devices

[1] all criteria apply; [2] at least one of the clinical scenarios applies; [3] at least one criterion applies

[a] arterial lactate values; venous lactate values to be used in cases where arterial lactate values are not available;
[b] cutoffs based on local reference values established by the Institute for Clinical Chemistry, University Medical Center Mannheim, Germany.
*[c] cumulative vasoactive/inotropic dosage assessed according to the vasoactive-inotropic score (VIS; defined as Dobutamin + Dopamin + (10*Phenylephrin+milrinone) + (100*(A+NA) + (10.000*U/kg/min Vasopressin)), norepinephrine equivalent dose (NEE; NA 0,1µg/kg/min = 0,1µg/kg/min; A 0,1µg/kg/min = NA 0,1µg/kg/min; V 0,04U/min = NA 0,1µg/kg/min) or cumulative vasopressor index (CVI; no vasopressors used (0 points), Dopamine > 0 but ≤ 5 µg/kg/min (1 point), Norepinephrine > 0 but ≤ 0,05 µg/kg/min, Epinephrine > 0 but ≤ 0,05 µg/kg/min, Dopamine > 5 but ≤ 10 µg/kg/min (2 points), Norepinephrine > 0,05 but ≤ 0,1 µg/kg/min, Epinephrine > 0,05 but ≤ 0,1 µg/kg/min, Dopamine > 10 but ≤ 15 µg/kg/min (3 points), Vasopressin, Norepinephrine > 0,1 µg/kg/min, Epinephrine > > 0,1 µg/kg/min, Dopamine > 15 µg/kg/min (4 points).*
ALT, alanine aminotransferase; AST, aspartate aminotransferase; CPR, cardiopulmonary resuscitation; eGFR, estimated glomerular filtration rate; HR, heart rate; LFT, liver function test; MAP, mean arterial pressure; MCS, mechanical circulatory support; NT-proBNP, N-terminal prohormone of brain natriuretic peptide; SBP, systolic blood pressure.

Table S2. *Study 2 SCAI classification framework according to to Lawler et al. (Crit Care Med., 2021)*

SCAI SHOCK stage	Parameter/ clinical scenario	Criteria
A[1]	Lactate	Highest lactate < 2 mmol/L [a]
	Blood pressure and heart rate	No signs of hypotension: mean SBP ≥ 90 mmHg AND baseline SBP ≥ 90 mmHg AND no phase of SBP < 90 mmHg for more than 30 min
	Kidney function	eGFR > 90mL/min/1.73 m^2 (< 90 mL/min/1.73 m^2 if history of chronic kidney disease is documented)
	Liver function	No additional signs of hypoperfusion: highest ALT / AST values < 3 times ULN [b]
	Vasoactive / inotropic drugs used	None
	MCS devices	None
B[1]	Lactate	Baseline lactate < 2 mmol/L [a]
	Blood pressure and heart rate	Signs of hypotension: SBP < 90 mmHg for more than 30 min OR hemodynamic support necessary to maintain mean SBP ≥ 90 mmHg (1 vasoactive / inotropic drug used)
	Kidney function	eGFR > 60mL/min/1.73 m^2 (< 60 mL/min/1.73 m^2 if history of chronic kidney disease is documented)
	Liver function	No further signs of hypoperfusion: highest ALT / AST values < 3 times ULN [b]
	Vasoactive / inotropic drugs	None
	MCS devices	None
C[2]	Scenario 1	- 1 vasoactive / inotropic drug OR MCS device - Highest lactate ≥ 2 mmol/L [a] OR eGFR < 45mL/min/1.73 m2 OR highest ALT / AST value > 3 times ULN - Highest lactate within the 24h timeframe equals the baseline value or is < 50% higher [a]
	Scenario 2	- 0 vasoactive / inotropic drugs OR mechanical devices - Baseline SBP < 90 mmHg OR SBP < 90 mmHg for more than 30 min - Highest lactate ≥ 2 mmol/L (highest lactate within the 24h timeframe equals the baseline value or is < 50% higher)[a] OR eGFR < 45mL/min/1.73 m2 OR highest ALT / AST value > 3 x ULN [b]
	Scenario 3	- Baseline and maximum lactate ≥ 2 mmol/L within 24h timeframe - 0 vasoactive / inotropic drugs OR MCS - Baseline SBP ≥ 90mmHg AND no phase of SBP < 90 mmHg for more than 30 min
D[2]	Scenario 1	- 1 vasoactive / inotropic drug OR MCS device - Highest lactate ≥ 2 mmol/L [a] OR eGFR < 45mL/min/1.73 m^2 OR highest ALT / AST value > 3 times ULN - Highest lactate within the 24h timeframe > 50% higher than the baseline value
	Scenario 2	Multiple vasoactive / inotropic drugs (≥2)
	Scenario 3	Multiple MCS device (simultaneously ECMO and Impella) (≥2)
E[3]		- Highest lactate ≥ 5 mmol/L [a] - Lowest pH ≤ 7,2 (arterial; if not available venous pH)

[1] all criteria apply; [2] at least one of the clinical scenarios applies; [3] at least one criterion applies
[a] arterial lactate values; venous lactate values to be used in cases where arterial lactate values are not available;
[b] cutoffs based on local reference values established by the Institute for Clinical Chemistry, University Medical Center Mannheim, Germany. [c]
ALT, alanine aminotransferase; ASAT, aspartate aminotransferase; eGFR, estimated glomerular filtration rate; LFT, liver function test; MCS, mechanical circulatory support; SBP, systolic blood pressure; ULN, upper limit of normal.

Table S3. *Study 3 SCAI classification framework according to Jentzer et al. (J Am Heart Assoc., 2023)*

SCAI SHOCK stage	Parameter/ clinical scenario	Criteria
A[1]	Lactate	Not included
	Blood pressure and heart rate	- Lowest SBP ≥ 90 mmHg - Highest HR ≤ 100 beats/min - Lowest MAP ≥ 65 mmHg - Highest SI < 1 (for any 60 min block within the 24h timeframe) [a] - Mean SI < 1 (within the 24h timeframe) [b]
	Kidney function	Not included
	Liver function	Not included
	Vasoactive / inotropic drugs used	None
	MCS devices	None
B[2]	Lactate	Not included
	Blood pressure and heart rate	- Lowest SBP < 90 mmHg - Highest HR > 100 beats/min - Lowest MAP < 65 mmHg - Highest SI ≥ 1 (for any 60 min block within the 24h timeframe) [a] - Mean SI ≥ 1(within the 24h timeframe) [b]
	Kidney function	Not included
	Liver function	Not included
	Vasoactive / inotropic drugs	Use of inotropic drugs (i.e. Dobutamin), but no vasopressors
	MCS devices	None
C[2]	Lactate	Highest lactate ≥ 2 mmol/L [c]
	Blood pressure and heart rate	Not included
	Kidney function	- Reduced urine output: < 400ml within an ICU stay ≥ 24h, < 200ml within an ICU stay ≥ 12h but < 24h - Highest plasma/serum creatinine value ≥ 0.3mg/dl higher than the baseline plasma/serum creatinine value
	Liver function	Highest ALT value > 200 U/L
	Vasoactive / inotropic drugs	At least 1 vasoactive drug OR vasopressor boluses
	MCS devices	Use of 1 MCS device
D[2]	Lactate	Highest lactate within 24h timeframe higher than the baseline lactate and at least ≥ 2 mmol/L [c]
	Blood pressure and heart rate	Not included
	Kidney function	Not included
	Liver function	Not included
	Vasoactive / inotropic drugs	- Rising number of vasoactive drugs (absolute number ≥ 2h after admission higher than within hour 0-2) - Rising VIS (Score ≥ 2h after admission; higher than within the first 2h after admission) [d] - Rising NEE (Score ≥ 2h after admission; higher than within the first 2h after admission) [e]
	MCS devices	Not included
E[2]		- Cardiopulmonary resuscitation (duration at least ≥ 2 min) - Highest lactate within the 24h timeframe ≥ 10 mmol/L [c] - Absolute numbers of vasoactive drugs ≥ 3 - Absolute numbers of vasoactive drugs ≥ 2 AND 1 MCS device - ≥ 2 MCS devices - Highest VIS Score within the 24h timeframe > 50 - Highest NEE Score within the 24h timeframe > 0,5 - Highest CVI Score within the 24h timeframe > 8 [f] - Severe hypotension: SBP for ≥ 2h continuously < 80 mmHg OR MAP for ≥ 2h continuously < 50 mmHg

[1] all criteria apply; [2] at least one of the criteria applies.
[a] shock index defined as heart rate (beats/min) divided by systolic blood pressure (mmHg); [b] mean shock index defined by average heart rate (beats/min) divided by average systolic blood pressure (mmHg); [c] arterial lactate values; venous lactate values to be used in cases where arterial lactate values are not available; [d] VIS,

*vasoactive-inotropic score defined as Dobutamin + Dopamin + (10*Phenylephrin+milrinone) + (100*(A+NA) + (10.000*U/kg/min Vasopressin);* [e] *NEE, norepinephrine equivalent dose; NA 0,1µg/kg/min = 0,1µg/kg/min; A 0,1µg/kg/min = NA 0,1µg/kg/min; V 0,04U/min = NA 0,1µg/kg/min;* [f] *CVI, cumulative vasopressor index; No vasopressors used (0 points), Dopamine > 0 but ≤ 5 µg/kg/min (1 point), Norepinephrine > 0 but ≤ 0,05 µg/kg/min, Epinephrine > 0 but ≤ 0,05 µg/kg/min, Dopamine > 5 but ≤ 10 µg/kg/min (2 points), Norepinephrine > 0,05 but ≤ 0,1 µg/kg/min, Epinephrine > 0,05 but ≤ 0,1 µg/kg/min, Dopamine > 10 but ≤ 15 µg/kg/min (3 points), Vasopressin, Norepinephrine > 0,1 µg/kg/min, Epinephrine > > 0,1 µg/kg/min, Dopamine > 15 µg/kg/min (4 points).*
ALT, alanine aminotransferase; MAP, mean arterial pressure; MCS, mechanical circulatory support. SBP, systolic blood pressure; SI, shock index.

Table S4. *Study 4 SCAI classification framework according to Thayer et al. (Circ Heart Fail., 2020)*

SCAI SHOCK stage	Parameter/ clinical scenario	Criteria
AB[1]	Lactate	Baseline lactate < 2 mmol/L [a]
	Blood pressure and heart rate	Not included
	Kidney function	Not included
	Liver function	Not included
	Vasoactive / inotropic drugs	None
	MCS devices	None
C[2]	Scenario 1	- Baseline lactate < 5 mmol/L - 1 vasoactive / inotropic drug OR 1 MCS device
	Scenario 2	- Baseline lactate ≥ 2 mmol/L - 0 vasoactive / inotropic drugs OR MCS devices
D[2]	Scenario 1	- Baseline lactate < 5 mmol/L [a] - ≥ 2 vasoactive / inotropic drugs AND 0/1 mechanical devices
	Scenario 2	- Baseline lactate < 5 mmol/L [a] - ≥ 2 mechanical devices AND 0/1 vasoactive / inotropic drug
	Scenario 3	- Baseline lactate < 5 mmol/L [a] - Sum of drugs and mechanical devices = 2
E[2]	Scenario 1	Baseline lactate ≥ 5 mmol/L [a]
	Scenario 2	≥ 2 vasoactive / inotropic drugs AND ≥ 2 mechanical devices

[1] SCAI SHOCK stages A and B combined in one stage AB; all criteria apply; [2] at least one of the clinical scenarios applies.

[a] arterial lactate values; venous lactate values to be used in cases where arterial lactate values are not available; MCS, mechanical circulatory support.

Table S5. *Adaptions and Interpretations of SCAI classification frameworks*

SCAI classification framework	Adaptions	Rationale
Study 1 SCAI classification framework	**A1** Symptoms and physical examination findings not included in the adapted Study 1 SCAI classification framework	Symptoms and physical examination not available in retrospective dataset
	A2 Blood pressure and heart rate on admission applied for SCAI SHOCK stage assignment	Time points for blood pressure and heart rate measurement not specified in initial Study 1 SCAI classification framework
	A3 Invasive hemodynamics including cardiac index, pulmonary capillary wedge pressure, pulmonary artery oxygen saturation or central venous pressure not included in the adapted Study 1 SCAI classification framework	Invasive hemodynamics not available in retrospective dataset
	A4 Cutoffs for laboratory parameters selected based on local reference values established by the Institute for Clinical Chemistry, University Medical Center Mannheim, Germany	Cutoff definitions and assay characteristics not specified in initial Study 1 SCAI classification framework
	A5 Longitudinal changes in laboratory values not included as deterioration criterion for SCAI SHOCK stage D	Multiple laboratory values within 24h time frame not available for most patients in retrospective dataset
	A6 *Profound hypotension despite maximal hemodynamic support* defined as average SBP < 90 mmHg or mean MAP < 60 mmHg or > 30mmHg below baseline despite the usage of at least 3 vasoactive / inotropic drugs, with or without MCS.	*profound hypotension despite maximal hemodynamic support* not specified in initial Study 1 SCAI classification framework
	A7 CPR used as criterion without the "A"-modifier and only considered if at least 2 min in duration	"A" modifier not available in retrospective dataset
	B1 SCAI SHOCK stage C definition expanded to include - patients with signs of systemic hypoperfusion reflected by elevated arterial or venous lactate (≥ 2 mmol/L), but without the need for hemodynamic support (vasoactive / inotropic drugs or MCS) - patients with signs of hypotension (as defined according to SCAI SHOCK stage B) with the need for hemodynamic support (vasoactive / inotropic drugs or MCS)	SCAI SHOCK stage classification details not provided in initial Study 1 SCAI classification framework
	B2 SCAI SHOCK stage C definition expanded to include patients with the initial need for more than one hemodynamic support measure, but without deterioration (no SCAI stage D criteria applicable).	SCAI SHOCK stage classification details not provided in initial Study 1 SCAI classification framework
	B3 Patients without documented chronic kidney disease and impaired renal function were categorized accordingly to the defined criteria (SCAI stage A: eGFR > 90mL/min/1.73 m^2 or SCAI stage B: eGFR 60–90mL/min/1.73 m^2). In case of documented chronic kidney disease, renal function was not considered as classification criterion.	Cutoff definitions not sufficiently specified in initial Study 1 SCAI classification framework
Study 2 SCAI classification framework	**A1** Symptoms and physical examination findings not included in the adapted Study 2 SCAI classification framework	Symptoms and physical examination not available in retrospective dataset
	A2 Cutoffs for laboratory parameters based on local reference values established by the Institute for Clinical Chemistry, University Medical Center Mannheim, Germany	Cutoff definitions and assay characteristics not specified in initial Study 2 SCAI classification framework

	A3 Late onset of additional or new MCS more than 24h after admission as a criterion for SCAI stage D was not considered	Only first 24h after ICU admission considered for adapted Study 2 SCAI classification framework
	B1 SCAI SHOCK stage C definition expanded to include patients with one or more signs of systemic hypoperfusion in form of elevated lactate (≥ 2 mmol/L), elevated LFTs or abnormal renal function (in the absence of a documented chronic kidney disease) and hypotension, but without the need for hemodynamic support (vasoactive / inotropic drugs or MCS devices),	SCAI SHOCK stage classification details not provided in initial Study 2 SCAI classification framework
	Patients without documented chronic kidney disease and impaired renal function were categorized accordingly to the defined criteria (SCAI stage A: eGFR > 90mL/min/1.73 m^2 or SCAI stage B: eGFR 60–90mL/min/1.73 m^2). In case of documented chronic kidney disease, renal function was not considered as classification criterion.	Cutoff definitions not specified in initial Study 2 SCAI classification framework
Study 3 SCAI classification framework	**A1** Reduced urine-output was defined as less than 400ml in a 24h-period or less than 200ml in a 12h-period	Initial Study 3 SCAI classification framework applying 4-hour time windows adapted to the 24-hour window used in this study
	A2 The longitudinal comparison of lactate and creatinine levels in between 4h-blocks was adjusted to comparisons between baseline- (first measurement after admission) and highest level within the 24h timeframe	Initial Study 3 SCAI classification framework applying 4-hour time windows adapted to the 24-hour window used in this study
	A3 To reflect increasing doses of vasoactive/inotropic drugs, comparisons in 2h-blocks (first and second 2h in one 4h block) were adapted to comparisons between the first 2h after admission and the following 2h of the 24h timeframe	Initial Study 3 SCAI classification framework applying 4-hour time windows adapted to the 24-hour window used in this study
	A4 Severe hypotension as criterion for SCAI SHOCK stage E was defined as mean MAP < 50 mmHg for at least 2h or mean SBP < 80 mmHg for at least 2h within the 24h timeframe	Initial Study 3 SCAI classification framework applying 4-hour time windows adapted to the 24-hour window used in this study
	A5 “Vasopressor boluses” removed as a single criterion for SCAI SHOCK stage E, due to an given overlap with SCAI SHOCK stage C defining criteria	SCAI SHOCK stage classification details not provided in initial Study 3 SCAI classification framework
Study 4 SCAI classification framework	**B1** SCAI SHOCK stage C definition expanded to include patients with an elevated arterial or venous lactate (≥ 2 mmol/L), as a sign of systemic hypoperfusion, but without the need for hemodynamic support (vasoactive / inotropic drugs or mechanical devices)	SCAI SHOCK stage classification details not provided in initial Study 4 SCAI classification framework

A= Indispensable modifications and interpretation of the original published SCAI classification frameworks to adjust to the framework of this study; B= Further adaptions applied on the original published SCAI shock classification frameworks; CPR, cardiopulmonary resuscitation; ICU, intensive care unit; MAP, mean arterial pressure; MCS, mechanical circulatory support; SBP, systolic blood pressure.

Table S6. *Comparison of all SCAI classification frameworks*

SCAI SHOCK stage	Study 1 SCAI classification framework	Study 2 SCAI classification framework	Study 3 SCAI classification framework	Study 4 SCAI classification framework
A	- Lactate - Blood pressure and heart rate - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Lactate - Blood pressure - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Blood pressure and heart rate - Vasoactive / inotropic drugs - MCS devices	- Lactate - Vasoactive / inotropic drugs - MCS devices
B	- Lactate - Blood pressure and heart rate - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Lactate - Blood pressure - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Blood pressure and heart rate - Vasoactive / inotropic drugs - MCS devices	
C	- Lactate - Blood pressure - Liver function - NT-proBNP - Vasoactive / inotropic drugs - MCS devices	- Lactate - Blood pressure - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Lactate - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Lactate - Vasoactive / inotropic drugs - MCS devices
D	- Lactate - Blood pressure - Liver function - NT-proBNP - Vasoactive / inotropic drugs - MCS devices	- Lactate - Kidney function - Liver function - Vasoactive / inotropic drugs - MCS devices	- Lactate - Vasoactive / inotropic drugs	- Lactate - Vasoactive / inotropic drugs - MCS devices
E	- Lactate - Blood pressure - Vasoactive / inotropic drugs - MCS devices - CPR - pH - Base deficit	- Lactate - pH	- Lactate - Blood pressure - Vasoactive / inotropic drugs - MCS devices - CPR	- Lactate - Vasoactive / inotropic drugs - MCS devices

CPR, cardiopulmonary resuscitation; MCS, mechanical circulatory support; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

Table S7. *Retrospective classification of SCAI SHOCK stages in the entire study population based on the SCAI classification frameworks.*

SCAI SHOCK stage	Study 1 SCAI classification framework No. (%)	Study 2 SCAI classification framework No. (%)	Study 3 SCAI classification framework No. (%)	Study 4 SCAI classification framework No. (%)
A	272 (20.8)	718 (55.1)	269 (20.6)	DNA
B	593 (45.5)	113 (8.6)	541 (41.5)	DNA
AB	DNA	DNA	DNA	909 (69.8)
C	122 (9.7)	195 (15.0)	238 (18.3)	234 (18.0)
D	50 (3.8)	53 (4.1)	97 (7.4)	67 (5.1)
E	249 (19.1)	206 (15.8)	141 (10.8)	93 (7.1)
NA	17 (1.3)	18 (1.4)	17 (1.3)	0 (0.0)

DNA; does not apply. NA, not available.

Table S8. *Retrospective classification of SCAI SHOCK stages in the final study cohort based on original SCAI SHOCK classification framework with minor adaptions as outlined in Supplemental Table 5 AND final adjudication by a physician based on available data.*

	Study 1 SCAI classification framework No. (%)	**Study 2 SCAI classification framework** No. (%)	**Study 3 SCAI classification framework** No. (%)	**Study 4 SCAI classification framework** No. (%)
Patients identified based on ICD codes and included into the 'initial study cohort'	1,303 (100.0)			
Patients **remaining unclassified** due to missing data	16 (1.2)[1]	18 (1.4)[1]	17 (1.3)[1]	0 (0.0)[1]
All patients classified into SCAI SHOCK stages according to the **respective classification framework**	1,287 (100.0)	1,285 (100.0)	1,286 (100.0)	1,303 (100.0)
Patients assigned based on **original SCAI SHOCK classification framework with minor adaptions** as outlined in **Supplemental Table 5**	845 (65.7)[2]	901 (70.1)[2]	1,286 (100.0)[2]	1,303 (100.0)[2]
Patients assigned by final adjudication by a physician based on available data and the respective SCAI SHOCK classification framework	442 (34.3)[2]	384 (29.9)[2]	0 (0.0)[2]	0 (0.0)[2]
All patients classifiable into SCAI SHOCK stages according to **all four** classification frameworks	1,281 (98.3)[1]			

[1] Percentages calculated based patients identified based on ICD codes and included into the 'initial study cohort (n=1,303).

[2] Percentages calculated based on all patients classified into SCAI SHOCK stages according to the respective classification framework (n differs across individual SCAI SHOCK classification frameworks).

Table S9. *Overlap of SCAI shock stage C–E and ICD-10-coded cardiogenic shock (primary diagnosis, n = 80, final study cohort) across the four classification frameworks.*

SCAI SHOCK stage	Study 1 SCAI classification framework No. (%)	Study 2 SCAI classification framework No. (%)	Study 3 SCAI classification framework No. (%)	Study 4 SCAI classification framework No. (%)
CS in SCAI Shock Classification + ICD-10 Code[1]	70 (87.5)	65 (81.3)	72 (90.0)	70 (87.5)
CS **NOT** in SCAI Shock Classification + **CS** in ICD-10 Code[1]	10 (12.5)	15 (18.7)	8 (10.0)	10 (12.5)
CS in SCAI Shock Classification + **NOT** in ICD-10 Code[2]	351 (83.4)	387 (85.6)	403 (84.8)	323 (82.2)
CS in SCAI Shock Classification + **NOT** in ICD-10 Code[3]	351 (27.4)	387 (30.2)	403 (31.5)	323 (25.2)
CS **NOT** in SCAI Shock Classification + **NOT** in ICD-10 Code[3]	850 (66.4)	814 (63.5)	798 (62.3)	878 (68.5)

CS, Cardiogenic Shock. Percentages refer to: (1) 80 patients with ICD-10-coded cardiogenic shock as primary diagnosis; (2) number of SCAI C–E patients per framework; (3) total cohort size (n = 1281), as indicated.

Table S10. *Overlap of SCAI shock stage C–E and ICD-10-coded cardiogenic shock (primary or secondary diagnosis, n = 309, final study cohort) across the four classification frameworks.*

SCAI SHOCK stage	**Study 1 SCAI classification framework** No. (%)	**Study 2 SCAI classification framework** No. (%)	**Study 3 SCAI classification framework** No. (%)	**Study 4 SCAI classification framework** No. (%)
CS in SCAI Shock Classification + ICD-10 Code[1]	258 (83.5)	250 (80.9)	270 (87.4)	257 (83.2)
CS NOT in SCAI Shock Classification + **CS** in ICD-10 Code[1]	50 (16.2)	58 (18.8)	38 (12.3)	51 (16.5)
CS in SCAI Shock Classification + **NOT** in ICD-10 Code[2]	163 (38.7)	202 (44.7)	205 (43.2)	136 (34.6)
CS in SCAI Shock Classification + **NOT** in ICD-10 Code[3]	163 (12.7)	202 (15.8)	205 (16.0)	136 (10.6)
CS NOT in SCAI Shock Classification + **NOT** in ICD-10 Code[3]	810 (63.2)	771 (60.2)	768 (59.9)	837 (65.3)

CS, Cardiogenic Shock. Percentages refer to: (1) 309 patients with ICD-10-coded cardiogenic shock as primary or secondary diagnosis; (2) number of SCAI C–E patients per framework; (3) total cohort size (n = 1281), as indicated.

Table S11. *Retrospective classification of SCAI SHOCK stages in the final study cohort based on the SCAI classification frameworks.*

SCAI SHOCK stage	Study 1 SCAI classification framework No. (%)	Study 2 SCAI classification framework No. (%)	Study 3 SCAI classification framework No. (%)	Study 4 SCAI classification framework No. (%)
A	268 (20.9)	716 (55.9)	267 (20.8)	DNA
B	592 (46.2)	113 (8.8)	539 (42.1)	DNA
AB	DNA	DNA	DNA	888 (69.3)
C	122 (9.5)	194 (15.1)	238 (18.6)	234 (18.3)
D	50 (3.9)	53 (4.5)	97 (7.6)	66 (5.5)
E	249 (19.4)	205 (16.0)	140 (11.0)	93 (7.3)

DNA; does not apply.

Table S12. *In-hospital mortality rates of all patients in the final study cohort based on the SCAI classification frameworks.*

	Study 1 SCAI classification framework No. (%)	**Study 2 SCAI classification framework** No. (%)	**Study 3 SCAI classification framework** No. (%)	**Study 4 SCAI classification framework** No. (%)
SCAI Classification				
A	9 (3.4)	28 (3.9)	6 (2.5)	53 (6.0)
B	38 (6.4)	21 (18.9)	37 (6.9)	
C	28 (22.9)	35 (18.0)	57 (23.9)	74 (31.6)
D	22 (37.8)	24 (45.3)	32 (33.0)	40 (60.6)
E	141 (56.6)	130 (63.4)	106 (75.7)	71 (76.3)

Table S13. *Retrospective classification of SCAI SHOCK stages in Acute myocardial ischemia (AMI) patients based on the SCAI classification frameworks.*

SCAI SHOCK stage in Acute myocardial ischemia (AMI) patients	**Study 1 SCAI classification framework** No. (%)	**Study 2 SCAI classification framework** No. (%)	**Study 3 SCAI classification framework** No. (%)	**Study 4 SCAI classification framework** No. (%)
A	232 (24.9)	617 (66.27)	247 (26.5)	DNA
B	484 (52.0)	65 (7.0)	425 (45.6)	DNA
AB	DNA	DNA	DNA	723 (77.6)
C	71 (7.6)	127 (13.6)	135 (14.5)	128 (13.7)
D	27 (2.9)	29 (3.1)	51 (5.5)	37 (4.0)
E	117 (12.6)	93 (10.0)	73 (7.8)	43 (4.6)
No cardiogenic shock (A, B)*	716 (76.9)	682 (73.3)	672 (72.2)	723 (77.7)
Cardiogenic shock (C, D, E)*	215 (23.1)	249 (26.7)	259 (27.8)	208 (22.3)

*DNA; does not apply. *Distribution of SCAI shock stages (AB vs. CDE) across classification frameworks. Chi-squared test indicates a statistically significant difference between groups (p = 0.004).*

Table S14. *Retrospective classification of SCAI SHOCK stages in Acute heart failure (AHF) patients based on the SCAI classification frameworks.*

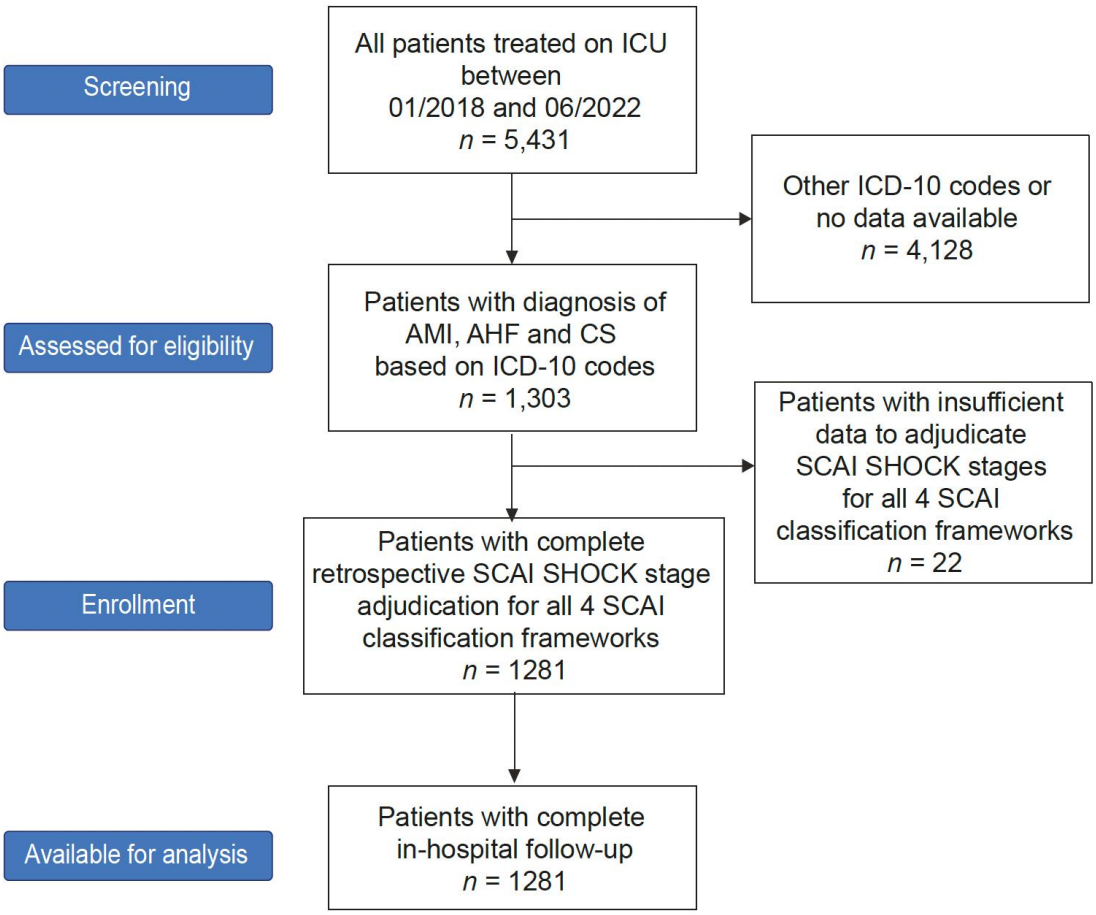
SCAI SHOCK stage in Acute heart failure (AHF)	**Study 1 SCAI classification framework** No. (%)	**Study 2 SCAI classification framework** No. (%)	**Study 3 SCAI classification framework** No. (%)	**Study 4 SCAI classification framework** No. (%)
A	36 (13.3)	95 (35.2)	20 (7.4)	DNA
B	98 (36.3)	37 (13.7)	106 (39.3)	DNA
AB	DNA	DNA	DNA	155 (57.4)
C	44 (16.3)	59 (21.8)	88 (32.6)	81 (30.0)
D	17 (6.3)	19 (7.0)	34 (12.6)	18 (6.7)
E	75 (27.8)	60 (22.2)	22 (8.1)	16 (5.9)
No cardiogenic shock (A, B)*	134 (43.7)	132 (48.9)	126 (49.6)	155 (57.4)
Cardiogenic shock (C, D, E)*	144 (53.3)	138 (51.1)	136 (50.4)	115 (42.6)

*DNA; does not apply. *Distribution of SCAI shock stages (AB vs. CDE) across classification frameworks. Chi-squared test indicates a statistically significant difference between groups (p = 0.004).*

Table S15. *Comparison of AUC values for in-hospital mortality prediction across SCAI classification frameworks.*

SCAI SHOCK stage	**Study 1 SCAI classification framework** AUC (95% CI)	**Study 2 SCAI classification framework** AUC (95% CI)	**Study 3 SCAI classification framework** AUC (95% CI)	**Study 4 SCAI classification framework** AUC (95% CI)
Final study cohort (N = 1281)	0.83 (0.80-0.86)	0.84 (0.81-0.86)	0.84 (0.81-0.87)	0.82 (0.79-0.85)
Acute myocardial ischemia (AMI) (N = 931)	0.84 (0.79-0.88)	0.84 (0.80-0.88)	0.84 (0.80-0.88)	0.81 (0.77-0.86)
Acute heart failure (AHF) (N = 270)	0.71 (0.64-0.79)	0.76 (0.69-0.83)	0.74 (0.66-0.81)	0.75 (0.68-0.82)

Figure S1. *Patient flow chart*



AMI, acute myocardial infarction; CS, cardiogenic shock; HF, heart failure; ICU, intensive care unit. ICD-10, German modification of the International Classification of Diseases codes, 10th revision.

Figure S2. *Comparison of shock and no-shock group distribution across different SCAI classification frameworks*

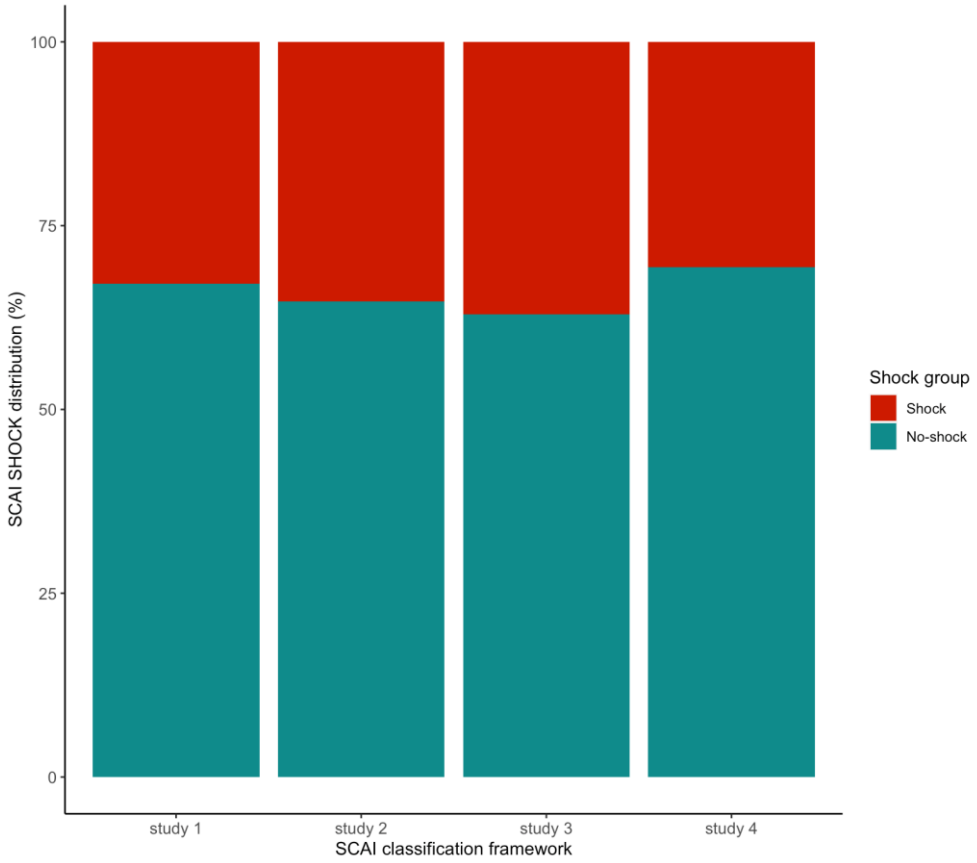
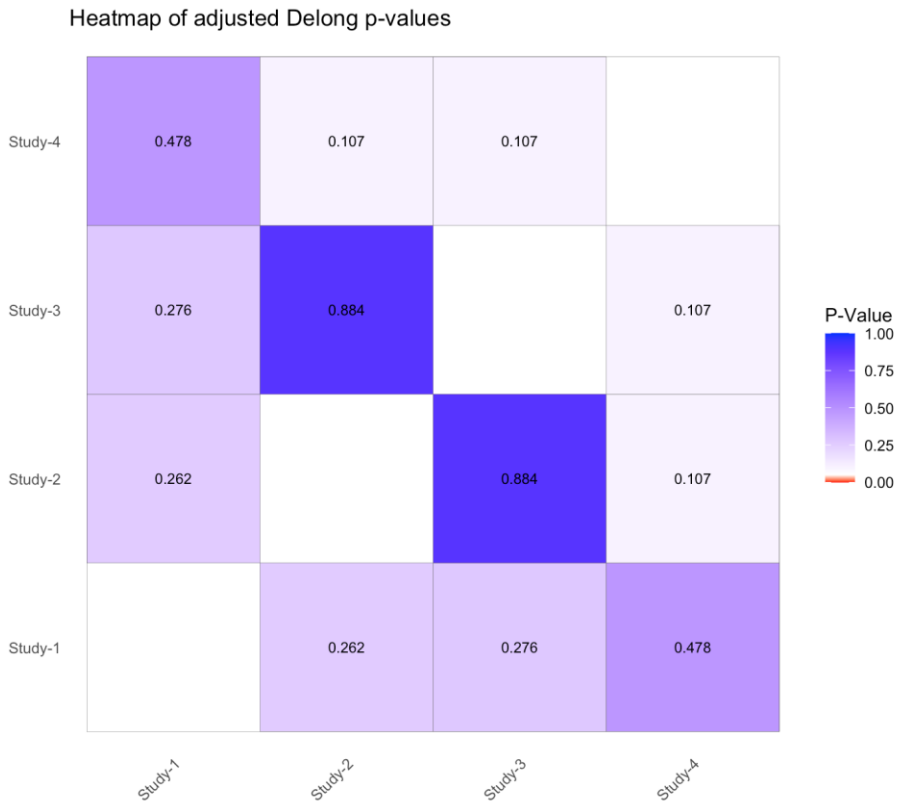


Figure S3. *Pairwise comparison of the predictive performance for in-hospital mortality for all four SCAI classification frameworks*



Pairwise comparison were performed for each SCAI classification framework combination by comparing areas under the receiver operating characteristics curve (AUROCs) using the method published by DeLong et al and adjusted by using the Benjamini-Hochberg procedure to control the false discovery rate (FDR). The indicated p-values represent adjusted p-values.

Figure S4. *Retrospective classification of SCAI SHOCK stages in Acute myocardial ischemia (AMI) patients based on the SCAI classification frameworks (barplot).*

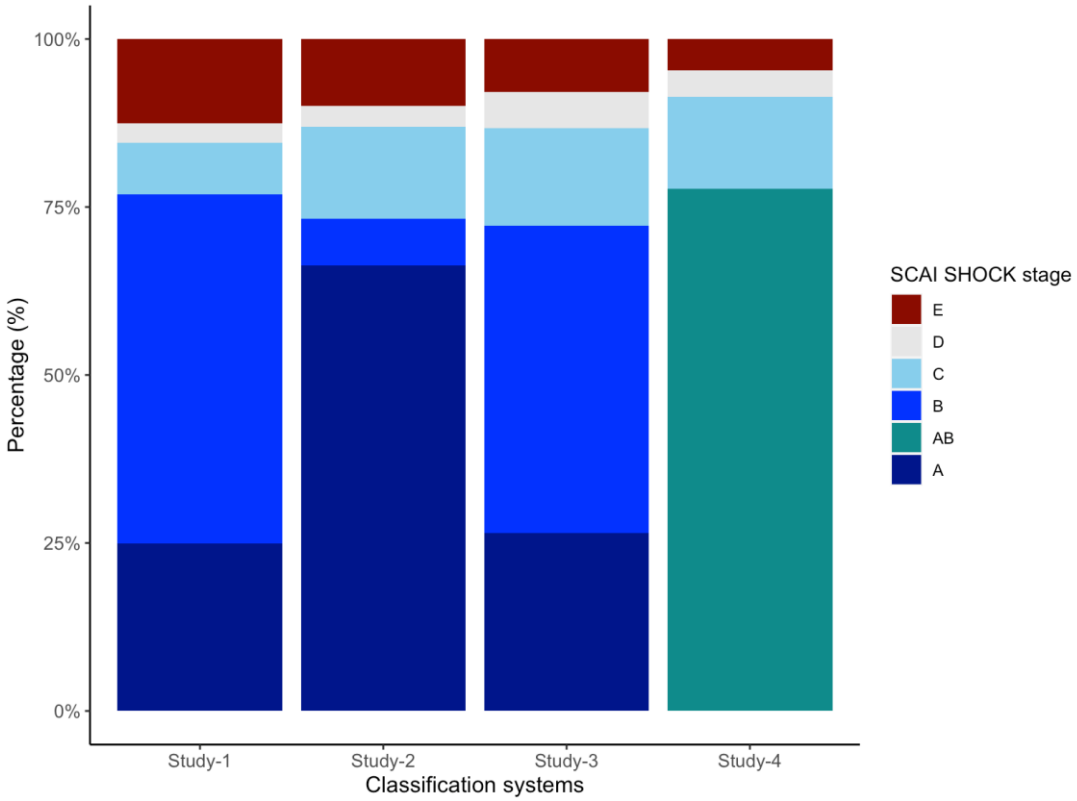


Figure S5. *Retrospective classification of SCAI SHOCK stages in Acute heart failure (AHF) patients based on the SCAI classification frameworks (barplot).*