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Original Article

Acute Mesenteric Ischemia: Impact of Preexisting Comorbidity on Outcomes

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SUMMARY

Introduction: Acute mesenteric ischemia (AMI) is a critical condition with high mortality rates in intensive care units (ICUs). This study evaluated whether comorbidities, quantified using the Charlson Comorbidity Index (CCI), predict ICU and in-hospital mortality among patients with AMI.
Methods: A retrospective analysis was conducted on 183 AMI patients from the MIMIC-IV database (2008–2019). Comorbidities were assessed using CCI scores, and clinical severity was evaluated using the Sequential Organ Failure Assessment (SOFA), Simplified Acute Physiology Score II, and Logistic Organ Dysfunction Score. Logistic regression analyses identified predictors of mortality, and ROC curves determined optimal CCI cut-off values.
Results: The study included 183 patients (mean age 65.9 years; 50.8% male). A CCI cut-off ≥ 6 independently predicted increased ICU (aOR 3.44, 95% CI: 1.29–9.16; $p = 0.013$) and in-hospital mortality (aOR 3.44, 95% CI: 1.32–8.94; $p = 0.011$). Both CCI (continuous aOR 1.34, $p = 0.005$) and SOFA scores (aOR 1.27, $p = 0.007$) were independent predictors. Kaplan–Meier analyses confirmed significantly lower survival rates with CCI > 6 ($p < 0.001$).
Conclusion: The CCI effectively predicts ICU and in-hospital mortality in AMI patients, with a cut-off value of 6 serving as a practical threshold to guide early prognostication and clinical decision-making.

1. Introduction

Acute mesenteric ischemia (AMI) is a life-threatening condition characterized by a sudden interruption of blood flow to the intestine, leading rapidly to irreversible bowel necrosis, metabolic disturbances, multiple organ dysfunction, and death.[1] Although relatively rare, AMI accounts for approximately 0.09 to 0.2% of all acute surgical admissions.[2–4] Despite advancements in multidisciplinary care, the mortality rate remains alarmingly high, ranging from 40% to 70%.[5,6] Accurately predicting outcomes in intensive care units (ICUs) remains a key challenge in the management of AMI.

Several prognostic factors, including patient age, biochemical markers, and radiological findings, have been identified as relevant predictors of AMI outcomes.[4,7–10] Additionally, comorbidities such as cardiovascular disease, arrhythmias, heart failure, diabetes mellitus, and chronic renal insufficiency significantly influence prognosis.[10–13] However, individual predictors or isolated comorbidities often fail to capture the clinical complexity of AMI, which arises from a heterogeneous etiology encompassing arterial, venous, and nonocclusive cases. This highlights the need for multidimensional prognostic tools to improve risk stratification and clinical decision-making.

The Charlson Comorbidity Index (CCI) is a validated scoring system designed to quantify the cumulative burden of comorbidities using weighted measures.[14] It reflects the overall health status of patients — particularly their mortality risk — and is widely appreciated for its ease of use, not requiring laboratory data, and for its applicability across diverse clinical settings.[14,15] Its effectiveness as a prognostic indicator has been well-documented in critically ill populations.[16,17]

Previous studies have shown that lower CCI scores are associated with improved long-term survival in patients with AMI, whereas higher scores predict increased perioperative and in-hospital mortality.[18,19] Nonetheless, the utility of CCI for early prediction of ICU mortality in patients with AMI remains underexplored. Therefore, this study aimed to determine the prognostic significance of CCI in predicting ICU mortality in patients with AMI.

2. Materials and methods

2.1. Data source

This retrospective cohort study was conducted using data from the Medical Information Mart for Intensive Care IV (MIMIC-IV version 2.2), which includes clinical records collected from 2008 to 2019.[20,21] MIMIC-IV is a publicly accessible, real-world clinical database maintained by the Beth Israel Deaconess Medical Center in Boston, MA, USA. It contains detailed information on over 200,000 emergency department visits and > 60,000 ICU admissions, providing a robust foundation for epidemiological and clinical research.

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The database was granted under credentialed record ID 42188048. The code used for data extraction is available on GitHub and can be accessed at https://github.com/MIT-LCP/mimic-iv, ensuring transparency and reproducibility. The study protocol was approved by the Institutional Review Board of MacKay Memorial Hospital (approval number: 24MMHIS460e).

2.2. Study population

The initial MIMIC-IV v2.2 database included 73,181 patients admitted to ICUs. After identifying cases with AMI using the International Classification of Diseases, Ninth Revision (ICD-9) code 557.0, and Tenth Revision (ICD-10) codes K55.0 and K55.9, yielding 931 patients.

For individuals with multiple ICU admissions, only data from their first ICU stay were included to avoid duplication. Patients were excluded if they were under 18 years of age, had a diagnosis of AIDS or malignant cancer, had an ICU stay less than 6 hours, or survived for less than 24 hours after ICU admission. After applying these criteria, 183 participants were included in the final analysis (Figure 1).

2.3. Outcomes and variables

The primary outcomes of this study were ICU mortality and in-hospital mortality. Variables analyzed included baseline demographic and clinical characteristics. In addition, laboratory parameters previously associated with AMI-related mortality were extracted and are represented in Table 1.

Within the first 24 hours of ICU admission, several scoring systems were evaluated, including the CCI, Glasgow Coma Scale (GCS), Sequential Organ Failure Assessment (SOFA) score, Simplified Acute Physiology Score II (SAPS II), and Logistic Organ Dysfunction Score (LODS). Variables with more than 20% missing data were excluded from the analysis. For variables with less than 20% missing data, multiple imputation techniques were used with the 'mice' package in R software to manage the missing data.[22,23]

2.4. Statistical analysis

Continuous variables were reported as means and standard deviations (mean ± SD), while categorical variables were expressed as frequencies and percentages (%). Between-group comparisons of categorical variables were performed using either the chi-square or Fisher's exact tests, as appropriate. For continuous variables, comparisons were made using t-tests, when appropriate. Logistic regression models were used to examine the association between the CCI score and mortality outcomes, with findings represented as odds ratios (ORs) and corresponding 95% confidence intervals (95% CIs). Additionally, Kaplan–Meier survival curves were constructed to illustrate ICU and in-hospital mortality trends. All statistical analyses were conducted using the R software (version 4.2.3) and SPSS (version 20). A two-tailed p-value < 0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics

A total of 183 patients were included in the study, with a mean age of 65.9 ± 15.0 years; 93 patients (50.8%) were male. The mean

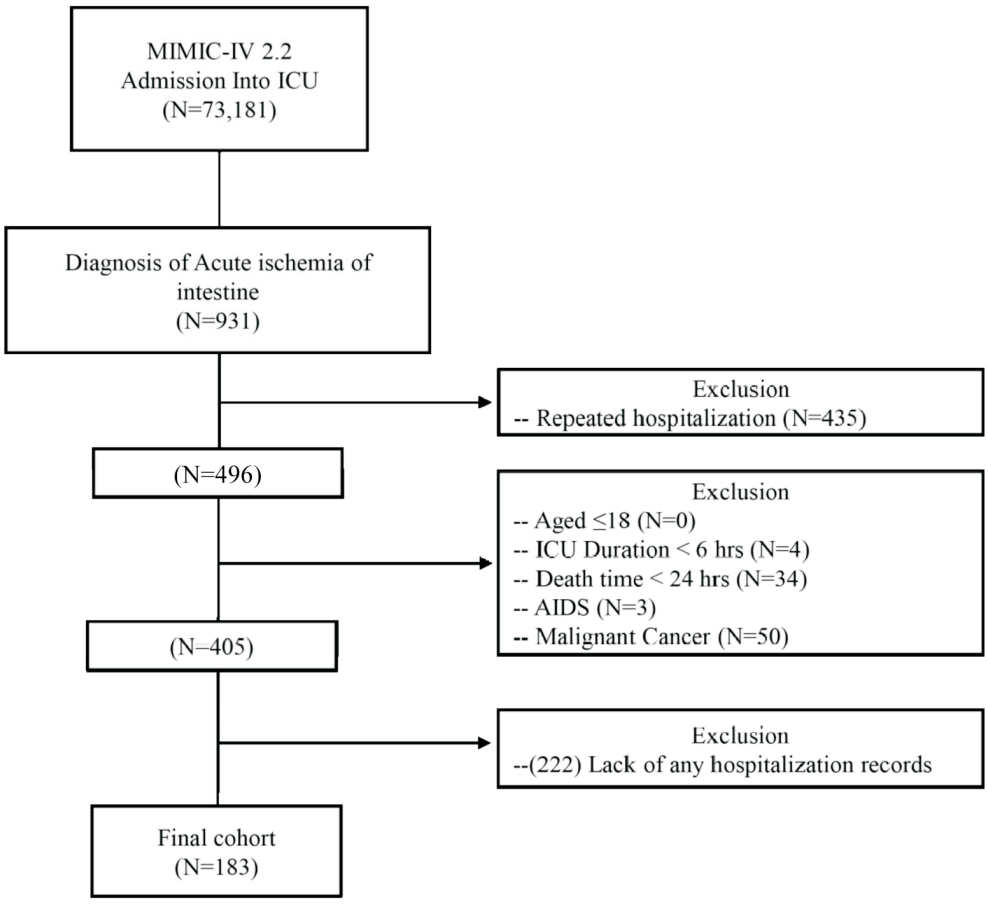

Figure 1. Flowchart for patients' inclusion and exclusion. AIDS, acquired immunodeficiency syndrome; ICU, intensive care unit.

body mass index was 30.1 ± 8.4 kg/m^2. On ICU admission, the mean heart rate was 94.8 ± 20.1 beats/min, mean arterial pressure (MAP) was 83.9 ± 18.5 mmHg, respiratory rate averaged 19.5 ± 6.1 breaths/min, and body temperature was 36.6 ± 1.1 °C. The mean GCS score was 11.4 ± 4.2.

Laboratory findings revealed a mean serum sodium level of 137.7 ± 6.3 mEq/L, creatinine of 1.9 ± 1.9 mg/dL, chloride of 102.9 ± 8.1 mEq/L, potassium of 4.4 ± 1.1 mEq/L, and hemoglobin of 11.9 ± 2.8 g/dL. The mean platelet count was 238.2 ± 141.6 × 10^3/μL, white blood cell count, 14.2 ± 8.6 × 10^3/μL, red blood cell count, 4.0 ± 0.9 × 10^6/μL, and international normalized ratio, 1.8 ± 1.4.

The mean CCI score was 5.3 ± 2.6. Common comorbidities included peripheral vascular disease (21.9%), cerebrovascular disease (4.9%), diabetes mellitus (27.9%), atrial fibrillation (38.3%), and hypertension (68.3%). Illness severity at admission was reflected by a mean SOFA score of 8.6 ± 4.7, SAPS II score of 45.0 ± 16.6, and LODS score of 7.8 ± 3.9.

Regarding clinical outcomes, the mean ICU stay was 8.3 ± 9.6 days, and the mean hospital stay was 19.0 ± 18.8 days. ICU mortality occurred in 50 patients (27.3%), and in-hospital mortality in 65 patients (35.5%) (Table 1).

3.2. Cut-off value of CCI to predict ICU and in-hospital mortality

The primary aim of this study was to assess whether the CCI, a weighted point-based mortality estimator, could independently predict ICU and in-hospital mortality. Receiver operating characteristic (ROC) curve analysis identified a CCI cut-off value of 6.5 for ICU mortality, yielding a sensitivity of 48.0% and a specificity of 74.4% (area under the curve [AUC] = 0.642, p = 0.003; Figure 2A). For in-hospital mortality, a CCI cut-off value of 5.5 demonstrated a sensitivity of 63.1% and specificity of 69.5% (AUC = 0.703, p < 0.001; Figure 2B). These results suggest that the CCI provides moderate discriminatory power in predicting ICU and in-hospital mortality.

Based on these findings, patients were stratified into two groups according to a CCI threshold 6 (Table 2). Patients with CCI ≤ 6 were significantly younger (mean age 63.7 ± 15.8 vs. 70.8 ± 11.8 years, p = 0.001) and exhibited higher baseline heart rates (97.6 ± 20.1 vs. 88.9 ± 18.8 beats/min, p = 0.006), GCS scores (12.0 ± 3.7 vs. 10.1 ± 4.7, p = 0.008), hemoglobin levels (12.3 ± 2.9 vs. 11.0 ± 2.4 g/dL, p = 0.004), RBC 4.09 ± 0.94 vs. 3.69 ± 0.79 × 10^6/μL, p = 0.006), while lower

Table 1
Baseline characteristics.

	N/mean
Gender, male	93 (50.82%)
Age	65.94 (± 15.01)
BMI, kg/m²	30.13 (± 8.38)
Heart rate, beats/min	94.83 (± 20.08)
MBP, mmHg	83.85 (± 18.48)
Respiratory rate, breaths/min	19.45 (± 6.12)
Temperature, °C	36.58 (± 1.06)
GCS	11.42 (± 4.15)
Sodium, mEq/L	137.66 (± 6.32)
Creatinine, mg/dL	1.85 (± 1.94)
Chloride, mEq/L	102.90 (± 8.05)
Potassium, mEq/L	4.44 (± 1.09)
Hemoglobin, g/dl	11.87 (± 2.78)
Platelet, ×10^3/μL	238.17 (± 141.63)
WBC, ×10^3/μL	14.21 (± 8.63)
RBC, ×10^6/μL	3.97 (± 0.92)
INR	1.80 (± 1.41)
CCI score	5.33 (± 2.63)
Peripheral vascular disease	40 (21.86%)
Cerebrovascular disease	9 (4.92%)
Diabetes mellitus	51 (27.87%)
Atrial fibrillation	70 (38.25%)
Hypertension	125 (68.31%)
SOFA score	8.56 (± 4.74)
SAPS II score	45.00 (± 16.56)
LODS score	7.79 (± 3.89)
ICU length of stay, days	8.30 (± 9.56)
Length of stay, days	18.98 (± 18.84)
ICU mortality	50 (27.32%)
In-hospital mortality	65 (35.52%)

Abbreviation: BMI, body mass index; CCI, Charlson comorbidity index; GCS, Glasgow coma scale; ICU, intensive care unit; INR, international normalized ratio, LODS, logistic organ dysfunction score; MBP, mean blood pressure; RBC, red blood cell; SAPS II, simplified acute physiology score II; SOFA, sequential organ failure assessment; WBC, white blood cell.

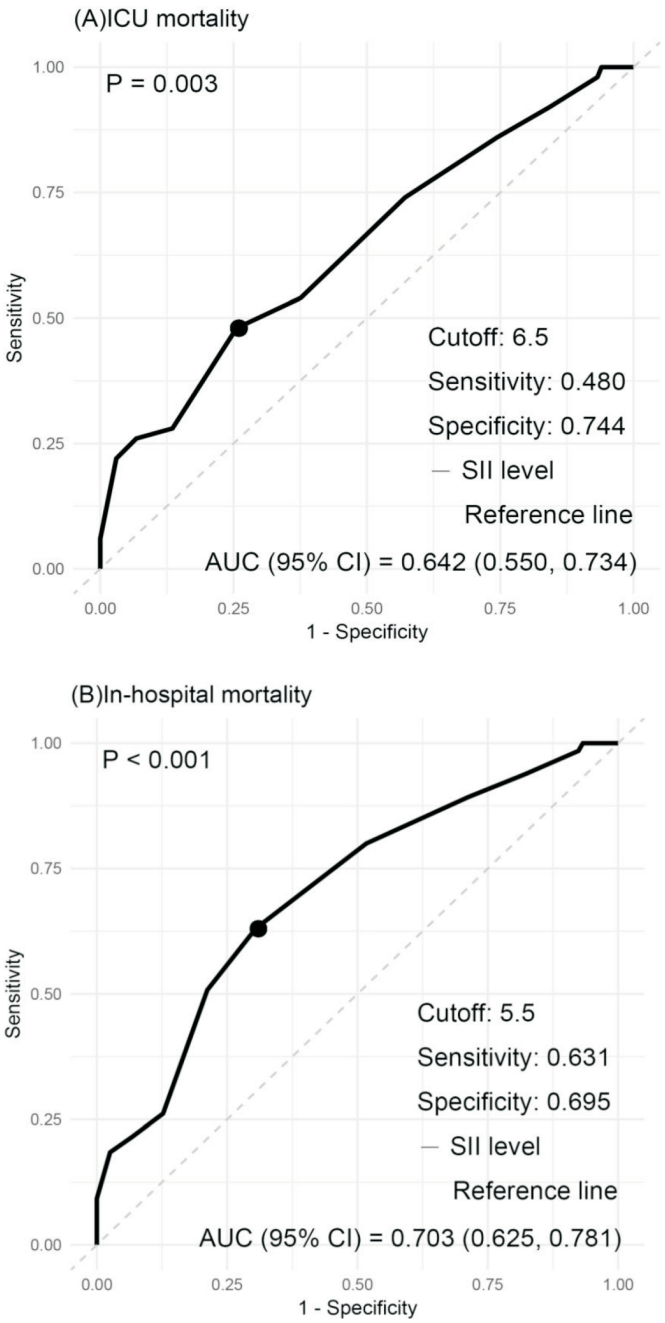

Figure 2. (A) ROC curve for ICU mortality according to CCI score. (B) ROC curve for in-hospital mortality according to CCI score. AUC, area under the curve.

Table 2
The demographics and baseline characteristics for ICU patients grouped by CCI score ≤ 6 and CCI > 6.

	CCI Group		*p* value
	≤ 6	> 6	
Number of patients	125 (68.30%)	58 (31.69%)	
CCI, mean	3.92 (± 1.64)	8.36 (± 1.60)	
Gender, male	63 (50.4%)	30 (51.72%)	0.497
Age	63.67 (± 15.84)	70.82 (± 11.77)	0.001
BMI, kg/m^2	30.01 (± 7.85)	30.38 (± 9.49)	0.782
Heart rate, beats/min	97.58 (± 20.13)	88.9 (± 18.79)	0.006
MBP, mmHg	84.76 (± 17.65)	81.91 (± 20.17)	0.333
Respiratory rate, breaths/min	19.32 (± 5.95)	19.73 (± 6.53)	0.673
Temperature, °C	36.63 (± 1.06)	36.48 (± 1.05)	0.378
Sodium, mEq/L	137.74 (± 5.94)	137.47 (± 7.11)	0.782
Creatinine, mg/dL	1.54 (± 1.28)	2.51 (± 2.78)	0.013
Chloride, mEq/L	103.05 (± 7.35)	102.57 (± 9.46)	0.734
Potassium, mEq/L	4.36 (± 1.09)	4.6 (± 1.08)	0.180
Hemoglobin, g/dl	12.27 (± 2.86)	11.01 (± 2.41)	0.004
Platelet, $\times 10^3/\mu L$	231.38 (± 127.77)	252.79 (± 167.97)	0.343
WBC, $\times 10^3/\mu L$	14.07 (± 8.73)	14.51 (± 8.49)	0.751
RBC, $\times 10^6/\mu L$	4.09 (± 0.94)	3.69 (± 0.79)	0.006
INR	1.72 (± 1.31)	1.96 (± 1.62)	0.294
Peripheral vascular disease	20 (16%)	20 (34.48%)	0.007
Cerebrovascular disease	3 (2.4%)	6 (10.34%)	0.030
Diabetes mellitus	18 (14.4%)	33 (56.9%)	< 0.001
Atrial fibrillation	36 (28.8%)	34 (58.62%)	0.007
Hypertension	73 (58.4%)	52 (89.66%)	< 0.001
GCS	12.02 (± 3.74)	10.12 (± 4.7)	0.008
SOFA score	8.31 (± 4.86)	9.09 (± 4.47)	0.306
SAPS II score	43.62 (± 16.36)	47.97 (± 16.73)	0.099
LODS score	7.38 (± 3.93)	8.69 (± 3.69)	0.033
ICU length of stay, days	8.14 (± 9.40)	8.65 (± 9.98)	0.737
Length of stay, days	19.09 (± 19.21)	18.75 (± 18.19)	0.909

The abbreviations are the same as in Table 1.

creatinine levels (1.5 ± 1.3 vs. 2.5 ± 2.8 mg/dL, $p = 0.013$) and LODS scores (7.4 ± 4.0 vs. 8.7 ± 4.7, $p = 0.033$). Besides, patients with a CCI ≤ 6 exhibited a significantly lower incidence of peripheral vascular disease, cerebrovascular disease, diabetes mellitus, atrial fibrillation, and hypertension compared to those with a CCI > 6 (all $p < 0.05$). Furthermore, they had similar ICU stays (12.3 ± 2.9 vs. 11.0 ± 2.4 days, $p = 0.737$) and hospital stays (12.3 ± 2.9 vs. 11.0 ± 2.4 days, $p = 0.909$). Overall, patients with CCI ≤ 6 displayed more favorable physiological profiles and a lower comorbidity burden than those with CCI > 6.

3.3. CCI cut-off above 6 significantly predicted ICU and in-hospital mortality in both univariate and multivariate analyses

A CCI cut-off value greater than 6 was significantly associated with ICU and in-hospital mortality in univariate and multivariate analyses. ICU mortality was analyzed with the CCI modeled as a continuous and a binary variable (≤ 6 vs. > 6; Table 3). In univariate analysis, each one-point increase in CCI was associated with a 26% higher risk of ICU death (OR 1.26, 95% CI 1.11–1.45, $p = 0.001$). Patients with CCI > 6 had a 2.69-fold increased risk of ICU mortality (95% CI 1.37–5.32, $p = 0.004$). Other variables positively associated with ICU mortality in univariate analysis included male sex, higher body temperature, atrial fibrillation, hypertension, serum creatinine, and elevated SOFA, SAPS II, and LODS scores, while higher GCS scores were inversely associated with mortality.

Two multivariate logistic regression models were constructed. In Model 1 (CCI as a continuous variable), both CCI (adjusted odds ratio [aOR] 1.34, 95% CI 1.09–1.65, $p = 0.005$) and SOFA (aOR 1.27, 95% CI 1.07–1.51, $p = 0.007$) independently predicted ICU mortality. In Model 2 (CCI binary), CCI > 6 remained significant (aOR 3.44, 95% CI 1.29–9.16, $p = 0.013$), while the SOFA effect persisted with slight attenuation (aOR 1.25, 95% CI 1.06–1.48, $p = 0.010$). Kaplan–Meier curves corroborated poorer ICU survival in the CCI > 6 group (log-rank $p = 0.005$; Figure 3).

A similar pattern was observed for in-hospital mortality (Table 4). Each additional point in the CCI increased the odds of death by 36% (OR 1.36, 95% CI 1.20–1.58, $p < 0.001$), while a CCI > 6 was associated with a 3.84-fold higher risk (95% CI 2.00–7.48, $p < 0.001$). Univariate predictors of in-hospital mortality included older age; lower body temperature; hyponatremia; elevated creatinine; diabetes mellitus; atrial fibrillation; hypertension; lower GCS score; and higher SOFA, SAPS II, and LODS scores.

In the multivariate models, only CCI (continuous aOR 1.31, $p = 0.014$; binary aOR 3.44, $p = 0.011$) and SOFA score (aOR 1.26, $p = 0.006$; aOR 1.27, $p = 0.005$) remained independent predictors of in-hospital mortality. Kaplan–Meier survival analysis demonstrated significantly lower survival rates in patients with CCI > 6 (log-rank $p < 0.001$; Figure 4). These findings underscore the complementary prognostic value of CCI and SOFA scores in identifying chronic comorbidity burden and acute physiological stress, respectively, among critically ill patients with AMI.

4. Discussion

This study demonstrated that the CCI independently predicted ICU and in-hospital mortality in patients with AMI. A higher CCI was significantly associated with increased mortality, as shown by the survival divergence at a cut-off value of 6. Patients with AMI and a

Table 3
Association of ICU mortality with the CCI analyzed both as a continuous score and dichotomized at six points (CCI ≤ 6 vs. CCI > 6).

	Univariate analysis				Multivariate analysis				Multivariate analysis			
	OR	95% CI		*p* value	aOR	95% CI		*p* value	aOR	95% CI		*p* value
		Lower	Upper			Lower	Upper			Lower	Upper	
ICU mortality												
CCI as a continuous variable	1.264	1.110	1.453	0.001	1.343	1.094	1.648	0.005				
CCI > 6 vs. CCI ≤ 6	2.688	1.365	5.321	0.004					3.439	1.292	9.158	0.013
Gender (Male)	0.489	0.248	0.944	0.035	0.345	0.132	0.900	0.030	0.346	0.134	0.891	0.028
Age	1.021	0.998	1.046	0.075	0.995	0.951	1.040	0.813	1.008	0.967	1.050	0.717
BMI	1.019	0.981	1.058	0.324	1.019	0.968	1.071	0.476	1.020	0.971	1.072	0.425
Heart rate	1.008	0.992	1.025	0.308	1.006	0.981	1.030	0.659	1.005	0.981	1.030	0.669
MBP	0.993	0.975	1.010	0.416	1.015	0.990	1.040	0.252	1.015	0.991	1.040	0.211
Respiratory rate	1.018	0.965	1.073	0.499	1.007	0.935	1.084	0.855	1.000	0.929	1.077	0.994
Temperature	0.619	0.435	0.854	0.005	0.792	0.534	1.175	0.247	0.802	0.542	1.185	0.268
Sodium	1.034	0.981	1.092	0.216								
Creatinine	1.314	1.103	1.634	0.006	1.031	0.829	1.281	0.786	1.058	0.852	1.313	0.609
Chloride	1.010	0.970	1.053	0.632								
Potassium	1.231	0.919	1.650	0.159								
Hemoglobin	0.918	0.812	1.033	0.160								
Platelet	0.998	0.996	1.001	0.246								
WBC	1.009	0.972	1.047	0.626								
RBC	0.729	0.502	1.045	0.089								
INR	1.002	0.766	1.246	0.989								
Peripheral vascular disease	1.184	0.533	2.521	0.667								
Cerebrovascular disease	3.583	0.911	15.034	0.065								
Diabetes mellitus	1.934	0.958	3.873	0.063								
Atrial fibrillation	1.956	1.010	3.802	0.047	0.727	0.264	1.999	0.537	0.764	0.280	2.087	0.600
Hypertension	2.657	1.235	6.252	0.017	1.436	0.473	4.358	0.523	1.507	0.499	4.549	0.467
GCS	0.884	0.819	0.954	0.002	1.106	0.963	1.270	0.153	1.090	0.952	1.247	0.211
SOFA score	1.312	1.200	1.454	0.000	1.268	1.067	1.506	0.007	1.250	1.056	1.480	0.010
SAPS II score	1.073	1.046	1.104	0.000	1.016	0.971	1.063	0.504	1.014	0.970	1.061	0.529
LODS score	1.354	1.219	1.524	0.000	1.181	0.939	1.486	0.155	1.183	0.943	1.484	0.147

The abbreviations are the same as in Table 1. aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

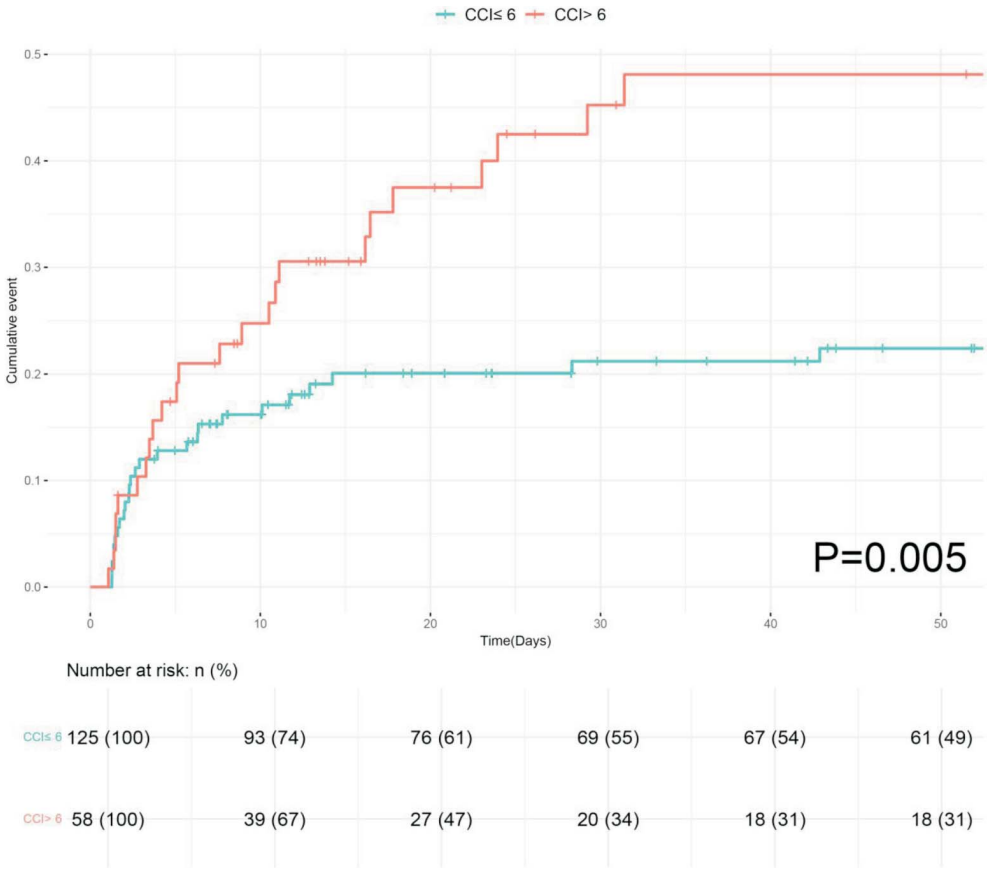

Figure 3. Kaplan–Meier survival curves illustrating ICU mortality stratified by a CCI threshold of six. CCI, Charlson Comorbidity Index; ICU, intensive care unit.

Table 4
Association of in-hospital mortality with the CCI, analyzed both as a continuous score and dichotomized at six points (CCI ≤ 6 vs. CCI > 6).

	Univariate analysis				Multivariate analysis				Multivariate analysis			
	OR	95% CI		*p* value	aOR	95% CI		*p* value	aOR	95% CI		*p* value
		Lower	Upper			Lower	Upper			Lower	Upper	
In-hospital mortality												
CCI as a continuous variable	1.364	1.197	1.577	0.000	1.312	1.057	1.629	0.014				
CCI > 6 vs. CCI ≤ 6	3.836	2.003	7.478	0.000					3.437	1.320	8.948	0.011
Gender (Male)	0.560	0.301	1.029	0.063	0.451	0.190	1.068	0.070	0.422	0.177	1.006	0.052
Age	1.030	1.008	1.054	0.009	1.000	0.959	1.042	0.994	1.011	0.972	1.051	0.599
BMI	1.018	0.982	1.056	0.334	1.006	0.959	1.054	0.820	1.005	0.959	1.053	0.835
Heart rate	1.005	0.989	1.020	0.553	1.002	0.980	1.024	0.887	1.003	0.981	1.026	0.788
MBP	0.995	0.978	1.011	0.520	1.017	0.994	1.040	0.150	1.016	0.994	1.039	0.153
Respiratory rate	1.021	0.971	1.072	0.416	1.020	0.951	1.094	0.583	1.013	0.945	1.086	0.713
Temperature	0.695	0.502	0.937	0.021	0.875	0.584	1.313	0.520	0.869	0.582	1.295	0.490
Sodium	1.057	1.005	1.114	0.035	1.049	0.985	1.117	0.136	1.054	0.989	1.124	0.106
Creatinine	1.280	1.075	1.596	0.013	1.002	0.806	1.246	0.984	1.019	0.822	1.262	0.867
Chloride	1.006	0.969	1.045	0.762								
Potassium	1.117	0.845	1.474	0.431								
Hemoglobin	0.929	0.830	1.037	0.192								
Platelet	0.999	0.997	1.002	0.625								
WBC	1.030	0.995	1.067	0.096								
RBC	0.729	0.515	1.020	0.069								
INR	0.938	0.714	1.165	0.593								
Peripheral vascular disease	0.971	0.457	2.002	0.938								
Cerebrovascular disease	3.898	0.992	18.990	0.061								
Diabetes mellitus	2.212	1.140	4.309	0.019	1.759	0.625	4.950	0.284	2.127	0.792	5.710	0.134
Atrial Fibrillation	2.767	1.484	5.221	0.001	1.818	0.669	4.936	0.241	1.884	0.692	5.128	0.215
Hypertension	3.250	1.586	7.132	0.002	1.217	0.494	3.000	0.669	1.293	0.526	3.174	0.575
GCS	0.900	0.836	0.968	0.005	1.101	0.965	1.257	0.153	1.094	0.959	1.247	0.179
SOFA score	1.243	1.151	1.353	0.000	1.260	1.067	1.487	0.006	1.269	1.074	1.499	0.005
SAPS II score	1.062	1.039	1.089	0.000	1.009	0.966	1.055	0.674	1.008	0.965	1.053	0.717
LODS score	1.265	1.156	1.396	0.000	1.069	0.864	1.323	0.539	1.064	0.858	1.319	0.575

The abbreviations are the same as in Table 1. aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio.

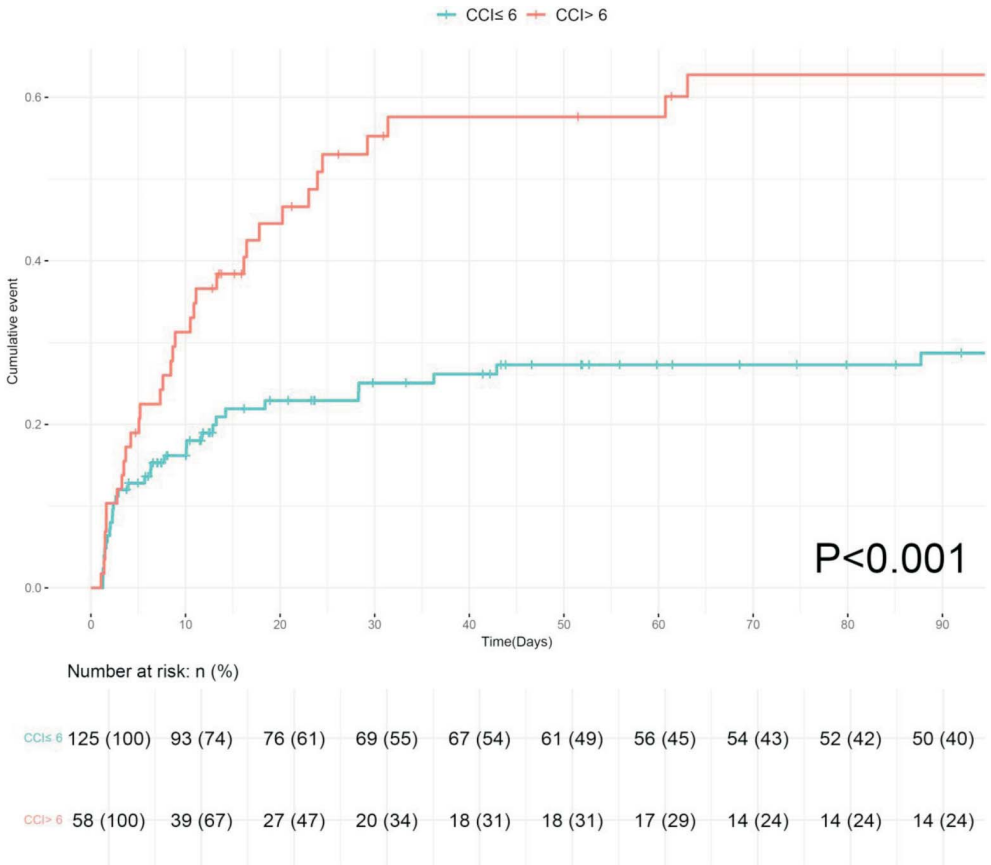

Figure 4. Kaplan–Meier survival curves illustrating in-hospital mortality stratified by a CCI threshold of six. CCI, Charlson Comorbidity Index

CCI below 6 exhibited substantially better outcomes, while those with scores ≥ 6 experienced markedly lower survival in both ICU and hospital settings. To our knowledge, this is the first study to report the prognostic utility of the CCI within an ICU context for patients with AMI, addressing a key gap in the existing literature.

Several prognostic factors have been reported for AMI in ICU settings. Caluwaerts et al. identified associations between higher maximal vasopressor doses, arterial lactate fluctuations, and anticoagulation use with increased risk of multi-organ failure.[24] In a multicenter study, Leone et al. reported that advanced age, elevated SOFA scores, and higher serum lactate levels were predictors of ICU mortality, while a history of peripheral vascular disease was inversely associated.[25] Other studies, such as those by Marchena-Gomez et al., identified the CCI as a predictor of outcomes in patients with AMI.[18] Similarly, Parys et al. and Witte et al. reported that elevated CCI scores were associated with an increase in-inhospital mortality.[19,26] In the current study, the CCI and SOFA scores were identified as independent predictors of ICU mortality. When modeled as a continuous variable, the CCI showed an OR of 1.264 (95% CI 1.110–1.453; $p = 0.001$) in univariate analysis and 1.343 (95% CI 1.094–1.648; $p = 0.005$) in multivariate analysis. As a categorical variable (cut-off ≥ 6), the CCI yielded an OR of 2.688 (95% CI 1.365–5.321; $p = 0.004$) in the univariate analysis and 3.439 (95% CI 1.292–9.158; $p = 0.013$) in the multivariate analysis. The SOFA score exhibited an OR of 1.312 (95% CI 1.200–1.454; $p < 0.001$) in the univariate analysis, which decreased to 1.268 (95% CI 1.067–1.506; $p = 0.007$) and 1.250 (95% CI 1.056–1.480; $p = 0.010$) after multivariate adjustment. These findings suggest that CCI, whether analyzed as a continuous variable or using the established cut-off of 6, may offer a superior predictive value compared to the SOFA score for ICU mortality in patients with AMI. Future multicenter trials across diverse international settings are warranted to validate the association between the CCI and ICU mortality in patients with AMI.

The prognostic gradient of the CCI has been supported in other critical care populations. A meta-analysis of 20 Coronavirus Disease 2019 (COVID-19) studies reported that each additional CCI point increased hospital mortality by 16%, with mortality risk doubling when scores exceeded 3.[27] Threshold effects have been observed in cardiogenic shock (CCI > 4.5),[28] septic shock in mobile ICUs (modified CCI ≥ 5),[29] and COVID-19 cohorts (CCI cut-off of 5.5).[30] Additionally, a multicenter study on colorectal surgery reported that a CCI ≥ 6 was significantly associated with postoperative complications.[31] Mechanistically, a higher CCI reflects a cumulative burden of irreversible organ damage and diminished physiological reserve, thus compounding vulnerability to acute stressors captured by scores such as SOFA. Our findings support this model, showing that a CCI > 6 is associated with both ICU and in-hospital mortality in AMI, reinforcing the value of CCI as an independent prognostic marker in critically ill patients.

This study has certain limitations. First, the MIMIC-IV database lacks sufficient detail to determine the exact cause of death in patients with AMI. Second, potential miscoding may have resulted in inadvertent exclusions. Third, the use of ICD-9 and ICD-10 codes precluded differentiation among AMI subtypes, which may affect interpretation. Finally, detailed data on treatment approaches — including medication regimens, intervention timing, surgical procedures, vasopressor use, and nutritional support — were unavailable and may have influenced the observed outcomes.

In conclusion, the CCI demonstrated a strong positive association with both ICU and in-hospital mortality among patients with AMI. A CCI cut-off of 6 represents a practical and reliable threshold for identifying high-risk individuals. Its accessibility and predictive value support its use in early clinical decision-making and patient triage, enabling rapid assessment of comorbidity burden and guiding intensive care management strategies.

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Declarations of interest

None.

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