Impact of early readmission to the cardiac ICUon in-hospital mortality and hospital length of stay in 30,942 cardiac patients

T. Thevathasan[1], F.J. Krause[1], J. Paul[1], S.D. Boie[2], J. Friebel[1], W. Knie[1], G. Girke[1], U. Landmesser[1], F. Balzer[2], C. Skurk[1]

[1]*Charite University Hospital, Department of Cardiology, Berlin, Germany;* [2]*Charite University Hospital, Institute of Medical Informatics, Berlin, Germany*

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Background: The need for cardiac intensive care unit (ICU) beds remains high in order to monitor and treat emergency patients with severe cardiovascular diseases, particularly during the COVID-19 pandemic. Therefore, timely discharge strategies from the cardiac ICU to peripheral wards are crucial to meet the increasing demand for cardiac ICU beds. Early patient transfer from ICU to the peripheral ward may result in worsening of the patient's clinical condition and outcome with readmission to the ICU, while late transfer may require prolonged expert care and generate unwanted costs.

Purpose: To investigate whether unplanned readmission of cardiac patients to the cardiac ICU within 72 hours after the index ICU stay is associated with increased mortality risk (primary outcome) and prolonged total hospital length of stay (LOS) (secondary outcome), as well as to identify predictors of ICU readmission in cardiac patients.

Methods: Adult patients who were admitted to the cardiac ICU due to a primary cardiac admission diagnosis at a tertiary care center between 2003 and 2021 were included. Outcomes were analysed with multivariable regression models adjusted for 26 a priori defined variables on patient demographics, underlying comorbidity levels, ICU procedures and administered ICU drugs.

Results: 30,942 cardiac patients were included, out of whom 1,499 patients (4.84%) were readmitted to the cardiac ICU within 72 hours. 1,023 (68.2%) of readmitted patients were male. Compared to non-readmitted patients, readmitted patients were older, had more underlying comorbidities (Charlson Index), had more severe disease courses (SOFA score, TISS, APACHE II score and SAPS), as well as required more frequently vasopressor therapy, renal replacement therapy and coronary angiographies (Table 1). Readmission to the cardiac ICU was associated with higher in-hospital mortality risk (Odds Ratio 7.52, 95% Confidence Interval (CI) 4.15–12.27, $P<0.001$) and prolonged hospital LOS (Incidence Rate Ratio 1.56, 95% CI 1.15–1.58, $P<0.001$). Patients who were readmitted to the ICU had been discharged 18% earlier during the index ICU stay compared to non-readmitted patients ($P<0.001$). Of note, readmitted and non-readmitted patients had similar vital parameters at time of ICU discharge after their index ICU stay. During the index ICU stay, non-readmitted patients were prescribed more beta blockers (65.3% vs. 45.8%), ACE inhibitors (37.0% vs. 27.2%) and blood transfusions (10.7% vs. 7.7%).

Conclusion: Early readmission to the cardiac ICU was associated with increased in-hospital mortality and prolonged hospitalisation. Readmitted patients had been discharged earlier from their index ICU stay and required more comprehensive critical care. ICU discharge strategies should optimally be based on objective patient assessments to facilitate patient safety and shorten hospital length of stay. Artificial intelligence-based algorithms may support clinicians with safe ICU discharge.

	Patients not readmitted to the ICU (N = 29,443)	Patients readmitted to the ICU (N = 1,499)	Total (N = 30,942)
Demographic data			
Sex (male)	19,873 (67.5%)	1,023 (68.2%)	20,896 (67.5%)
Age (years)	66.7 (13.5)	68.3 (13.0)	66.8 (13.4)
Charlson Comorbidity Index	2.52 (1.93)	3.24 (2.03)	2.55 (1.94)
Study outcomes			
In-hospital mortality rate (percent)	19 (0.1%)	128 (8.5%)	147 (0.5%)
Index ICU length of stay (days)	3.61 (7.27)	2.94 (5.30)	3.58 (7.19)
Total hospital length of stay (days)	11.5 (13.1)	19.9 (21.4)	11.9 (13.7)
Scores at ICU admission			
Sequential Organ Failure Assessment (SOFA) Score	1.63 (2.75)	2.33 (3.15)	1.67 (2.78)
Therapeutic Intervention Scoring System (TISS) 28	19.4 (7.13)	21.5 (8.93)	19.4 (7.13)
Acute Physiology And Chronic Health Evaluation (APACHE II) Score	10.9 (7.14)	12.8 (7.72)	11.0 (7.19)
Simplified Acute Physiology Score (SAPS)	28.5 (12.6)	31.5 (13.2)	28.7 (12.7)
Frequency of prescribed drugs during index ICU stay			
Beta blocker	15,984 (54.3%)	687 (45.8%)	16,671 (53.9%)
Angiotensin converting enzyme inhibitor	10,904 (37.0%)	408 (27.2%)	11,312 (36.6%)
Vasopressors	4,909 (16.7%)	359 (23.9%)	5,268 (17.0%)
Packed red blood cell transfusion	3,138 (10.7%)	115 (7.67%)	3,253 (10.5%)
Procedures during index ICU stay			
Coronary angiography	17,151 (58.3%)	976 (65.1%)	18,127 (58.6%)
Renal replacement therapy	2,172 (7.38%)	273 (18.2%)	2,445 (7.90%)

Numbers are displayed as frequency (percent) or mean (standard deviation).

Table 1. Patient characteristics