Fatal outcome of isolated patients who suffered an in-hospital cardiac arrest

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Short Report

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Abstract

Background: Isolation of patients in single-patient rooms for infection control precautions is a daily practice to reduce the propagation of various infectious agents. Isolation of patients leads to less contact with medical staff. Our objective was to assess whether isolated patients who suffer an in-hospital cardiac arrest (IHCA) have lower survival to hospital discharge as non-isolated IHCA patients.

Methods: A single-center, observational study was performed including adult patients suffering in-hospital cardiac arrest. We screened for IHCA occurrence and the isolation state in 75,987 patients that had been hospitalized from 2016 to 2019 at the internal medicine or neurology departments at the university hospital. Primary endpoint was survival to discharge. Neurological outcome was assessed at discharge using the cerebral performance category scale.

Results: In five consecutive years, 4,249 out of 75,987 patients (5.6%) had to be isolated for infection control precautions. In-hospital cardiac arrest occurred in 32 (0.8%) of these isolated patients and in 410 out of 71,738 non-isolated patients (0.6%) (p=0.130). Propensity score matching yielded 30 isolated and 30 non-isolated patients who suffered an IHCA, without a difference in baseline characteristics, IHCA etiology, and characteristics of cardiac arrests between the groups. Only one out of 30 isolated patients (3.3%) survived to discharge after IHCA compared to 11 non-isolated patients (36.6%) (risk difference, 33.3% [95% CI, 14.9%–51.7%]. None of the 30 isolated patients were discharged with good neurological outcomes compared to nine out of 30 non-isolated IHCA patients (30%) (risk difference, 30% [95% CI, 13.6%–46.4%]). In the multivariate analysis, patient isolation was an independent predictor of poor survival after IHCA (OR, 18.99; 95% CI, 2.467–133.743).

Conclusions: Isolation of patients for infection control precautions is associated with considerable poorer survival and neurological outcome in case these patients are suffering an IHCA.

Background

Isolation of patients in single-patient rooms for infection control precautions is a daily practice to reduce the propagation of various infectious agents (1). However, isolation of patients is associated with fewer bedside visits from medical staff (2–4). Our objective was to assess whether isolated patients who suffer an in-hospital cardiac arrest (IHCA) have lower survival to hospital discharge as non-isolated IHCA patients.

We screened for IHCA occurrence and the isolation state in 75.987 patients who had been hospitalized from 2015 to 2019 at the internal medicine or neurology departments at the university hospital. The primary endpoint of this study was survival to discharge. Neurological outcomes were assessed using the cerebral performance category (CPC) scale (5). Patients who were isolated in single-patient rooms for infection control precautions at the time point of IHCA were assigned as isolated patients. Propensity score matching was used to compare the groups in terms of survival. We created 1:1 matched groups using the nearest neighbor matching without replacement with a caliper of 0.10. Based on the results of

the logistic regression analysis, we used these variables as potential cofounders that might have impact on the outcome of IHCA: Age, presence of known coronary artery disease, glomerular filtration rate, Charlson Comorbidity Index, level of C-reactive protein, non-elective admission, non-cardiac arrest etiology, and cardiac arrest time off-hours (5 pm – 7 am, week-ends, public holidays).

From 2015 to 2019, 75,987 patients were hospitalized in the internal medicine or neurology departments at the university hospital. Of these, 4,249 (5.6%) had to be isolated during their inpatient stay for infection control precautions. During this period, 442 patients suffered an IHCA in the normal ward, 410 of 71,738 non-isolated patients (0.6%), and 32 of 4,249 isolated patients (0.8%) (p = 0.130) (Supplemental Fig. 1).

Baseline characteristics of the full cohort were described at Supplemental Table 1. Propensity score matching yielded 30 isolated and 30 non-isolated patients who suffered an IHCA. Most of the isolated patients had methicillin-resistant Staphylococcus aureus colonization (10 patients, 33.3%) or a *Clostridium difficile* infection (12 patients, 40%) as the cause of the isolation. Six patients (20%) had a multi-resistant gram-negative bacterial infection. Two patients (6.7%) had to be isolated due to a vancomycin-resistant enterococcus. There was no difference in baseline laboratory values, comorbidities, and etiology of cardiac arrest between the two groups (Table 1). The proportion of patients who achieved ROSC (50% vs. 83%, p = 0.006) was lower in isolated patients than in non-isolated patients (Table 2, Supplemental Table 2). Isolated patients had poorer survival after IHCA compared to non-isolated patients, in the full cohort (Supplemental Fig. 2A), as well as in the propensity score matched cohort: Only one out of 30 isolated patients (3.3%), in contrast to 11 out of 30 non-isolated patients (36.6%) survived to discharge after IHCA (risk difference, 33.3% [95% CI, 14.9–51.7%]) (Fig. 1A).

Patients who were isolated and suffered an IHCA had also worse neurological outcomes than those who were not isolated, in the full cohort (Supplemental Fig. 2A), as well as in the propensity score matched cohort: none of the 30 isolated patients with IHCA were discharged with good neurological outcomes (CPC scale 1 + 2) according to the CPC scale (Fig. 1B). In the non-isolated group, nine out of 30 patients (30%) were discharged with good neurological outcomes (CPC scale 1 + 2) (risk difference, 30% [95% CI, 13.6–46.4%]).

To identify predictors (patient characteristics or organization of care) for hospital mortality after IHCA, we performed a regression analysis using the full cohort. In the multivariate analysis, advanced age, worse renal function, non-cardiac arrest etiology, off-hours time point of IHCA, and single room isolation were independent predictors of poor survival to discharge (Supplemental Table 3).

In this study, we demonstrated for the first time that patients who were isolated for infection control precautions and suffered an IHCA had 1.5 times poorer survival and worse neurological outcome than non-isolated patients. It was previously shown that contact isolation has some negative aspects, particularly regarding a reduction in the quality of care (2). Isolated patients were less likely than other patients to be examined by physicians during rounds, and have less documented care (incomplete vital signs recording) (2–4). It has been previously demonstrated that patients who are witnessed or monitored at the time of cardiac arrest demonstrate a significantly higher survival rate to hospital

discharge than those who are neither witnessed nor monitored (6). Isolation of patients might affect the ability of hospital staff to detect cardiac arrest early. This might be associated with later initiation of cardiopulmonary resuscitation, which determines the poor outcome after IHCA. In our study, isolated patients had less shockable rhythm compared to non-isolated patients, which could be an indication of a longer no-flow time due to a later discovery of the patient. This could explain the lower likelihood of achieving ROSC in isolated IHCA patients.

Management of antibiotic-resistant bacteria remains challenging. Patient isolation is a powerful tool to reduce the nosocomial transmission of multidrug-resistant organisms. The present study demonstrates that the decision to prescribe patient isolation implies a potential added risk associated with the isolation process itself. Therefore, continuous professional training in the use of isolation precautions is mandatory, including awareness of the potential risk that is related to limited contact between patients and health professionals. Additionally, the use of telemetry in this single isolated room might provide earlier detection of the physiological decline in isolated patients; therefore, the deterioration of IHCA could be prevented or immediately detected.

The main limitations are the retrospective design and single-centre recruitment of patients. The study included patients in an internal medicine or neurology non-intensive care unit ward; therefore, the interpretation of the results may not be generalized and transferred to other medical disciplines. Although the results in terms of 30-day survival and neurological outcome were highly significant randomized controlled studies investigating the effect of closer monitoring of isolated patients on outcome after IHCA are required.

In conclusion, we demonstrate that the isolation of patients is an independent predictor of poorer outcomes after IHCA. Strategies to enhance early detection of IHCA in isolated patients may have the potential to increase outcomes.

Abbreviations

IHCA: In-hospital cardiac arrest, MRGN: multidrug-resistant gram-negative bacilli, ROSC: Return of spontaneous circulation, CPC: Cerebral performance category, IQR: Interquartile range.

Declarations

Ethics approval and consent to participate

This study was conducted as per the guidelines of the Declaration of Helsinki and was approved by the University of Düsseldorf Committee on Human Research (Study number 2018-112-RetroDEuA). All participants who survived gave written informed consent for the use of their anonymous medical data relating to the defined hospitalization.

Consent for publication

Not applicable

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JH and PH contributed to the to the conception and design of the study, JH, JMH, DO contributed to the acquisition of data, JH, JMH, DO, RW, MK, PH contributed to the analysis and interpretation of the data. All the authors drafted or provided critical revision of the article. All authors read and approved the final manuscript.

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Tables

Table 1. Baseline characteristics of the propensity score matched study population.

Categorical variables are reported as absolute values and percentages, whereas continuous data are expressed as medians with interquartile ranges. * indicates $p \leq 0.05$, between isolated and non-isolated patients.

Patient characteristics	PS-matched study population n=60	Isolated patients n=30	Non-isolated patients n=30	p-value
Age, median, years	73 (IQR 61–79)	70 (IQR 62–79)	74 (IQR 59–79)	0.703
Women/ male, n/n (%/%)	17/43 (28/72)	6/ 24 (20/80)	11/ 19 (37/63)	0.152
CAD, n (%)	30 (50)	13 (43)	17 (57)	0.302
PAD, n (%)	9 (30)	4 (13)	5 (17)	0.718
Arterial hypertension, n (%)	43 (72)	22 (73)	21 (70)	0.774
Diabetes mellitus, n (%)	14 (23)	8 (27)	6 (20)	0.542
Chronic obstructive disease, n (%)	2 (3)	2 (7)	0 (0)	0.492
End stage chronic kidney disease, n (%)	7 (12)	5 (17)	2 (7)	0.228
Malignancy, n (%)	6 (10)	4 (13)	2 (7)	0.671
GFR, median, mL/min	45 (IQR 23–75)	40 (IQR 18–85)	49 (IQR 28–74)	0.939
Hemoglobin, median, g/dL	9.7 (IQR 8.2–10.9)	9.4 (IQR 8.1–10.7)	9.7 (IQR 8.1–11.4)	0.858
C-reactive protein, median, mg/dL	4.8 (IQR 1.9–9.3)	6.4 (IQR 2.6–14.1)	3.4 (IQR 1.1–8.3)	0.747
Charlson Comorbidity Index	6 (IQR 4–7)	5 (IQR 4–6)	6 (IQR 5–8)	0.209
Non-elective admission, n (%)	52 (87)	25 (83)	27 (90)	0.448
Admission diagnosis				0.855
Pneumonia, n (%)	8 (13)	5 (17)	3 (10)	
Acute heart failure, n (%)	2 (3)	1 (3)	1 (3)	
Acute coronary syndrome, n (%)	6 (10)	2 (7)	4 (14)	
Urosepsis, n (%)	4 (7)	3 (10)	1 (3)	
Acute kidney failure, n (%)	4 (7)	2 (7)	2 (7)	
Gastrointestinal, n (%)	6 (10)	3 (10)	3 (10)	
Other, n (%)	30 (50)	14 (46)	16 (53)	

Cardiac arrest characteristics				
Non-cardiac arrest etiology, n (%)	38 (63)	19 (63)	19 (63)	1
Arrest time off-hours, n (%)	31 (52)	17 (57)	14 (47)	0.438

CAD: Coronary artery disease, PAD: Peripheral arterial disease, CKD: Chronic kidney disease, GFR: glomerular fraction rate

Table 2. Intra-hospital outcome after IHCA

Categorical variables are reported as absolute values and percentages, whereas continuous data are expressed as medians with interquartile ranges. * indicates $p \leq 0.05$, between isolated and non-isolated patients.

	PS-matched study population n=60	Isolated patients n=30	Non-isolated patients n=30	p
Primary shockable rhythm, n (%)	12 (20)	4 (13)	8 (27)	0.197
Patients with ROSC, n (%)	40 (66)	15 (50)	25 (83)	**0.006***
Time to ROSC, min	15 (IQR 11–30)	20 (IQR 14–26)	15 (IQR 8–30)	0.351
Phosphat, mmol/L	1.8 (IQR 1.2–2.5)	1.8 (IQR 1.3–2.9)	1.9 (IQR 1.1–2.3)	0.518
TroponinT, ng/L	111 (IQR 56–288)	109 (IQR 61–175)	138 (IQR 48–307)	0.306
Lactate, mg/L	10.7 (IQR 7.6–13.4)	11.6 (IQR 8.4–13.9)	10.5 (IQR 5.8–12.8)	0.729
NSE peak, µg/L	51 (IQR 34–166)	133 (IQR 42–253)	62 (IQR 37–112)	0.099
pH-value after ROSC	7.14 (IQR 6.91–7.31)	7.18 (IQR 6.99–7.32)	7.13 (IQR 6.90–7.30)	0.344

IHCA: In-hospital cardiac arrest, ROSC: Return of spontaneous circulation, NSE: Neuron-specific enolase

Figures

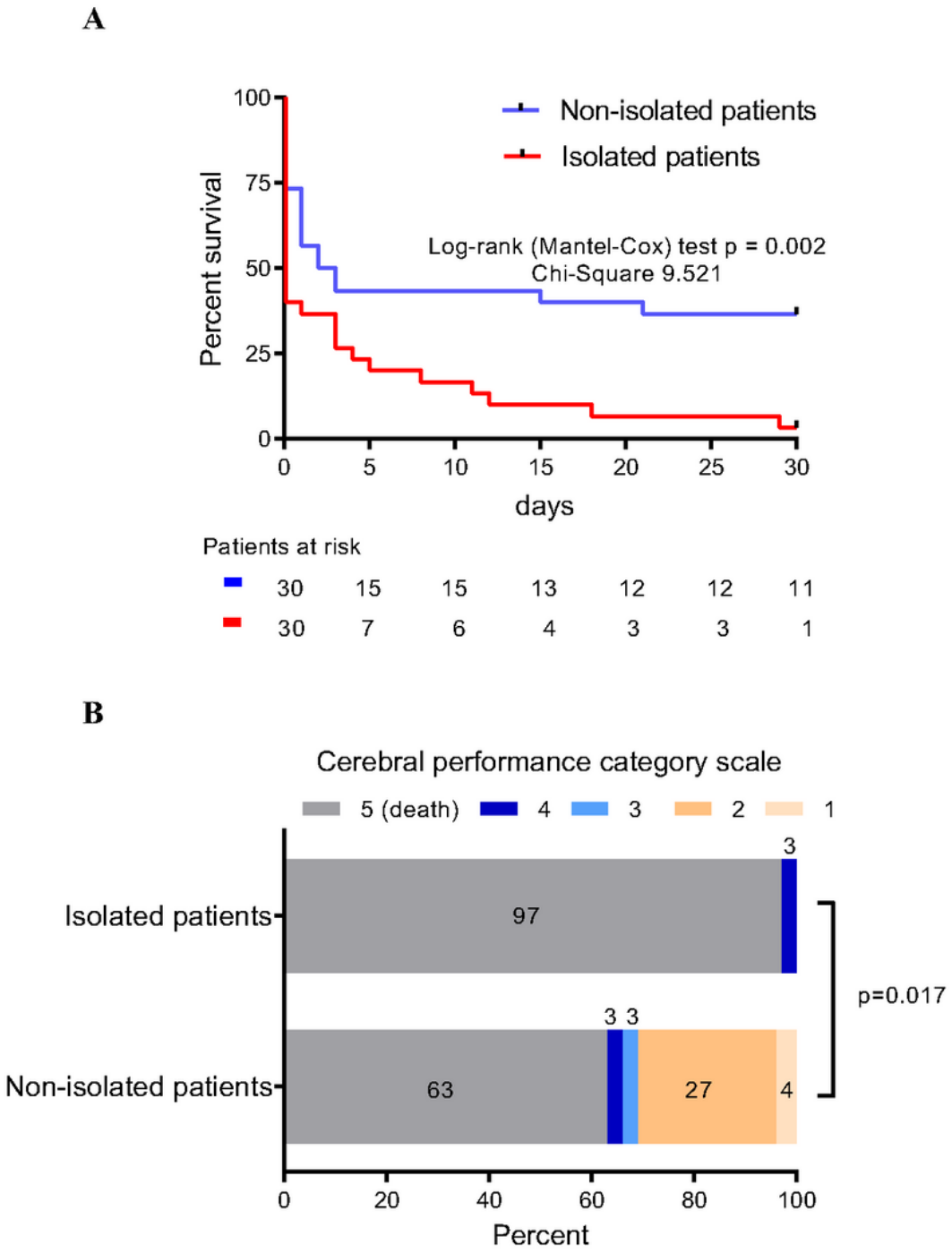

Figure 1

Figure 1

Outcome after IHCA was worse in isolated patients when compared to non-isolated patients.

Comparison of propensity score matched groups (each n=30). **(A)** Kaplan–Meier survival curves for survival to discharge stratified by isolation or non-isolation at the time point IHCA occurred. Survival to discharge in isolated patients is lower than that in non-isolated patients. **(B)** Neurological outcome

according to the CPC scale after IHCA. CPC scale of 1 and 2 indicates good neurological outcome. Patients who are isolated at the timepoint IHCA occurs have worse neurological outcomes than non-isolated patients.

IHCA: In-hospital cardiac arrest; CPC: Cerebral Performance Category

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementalFigure1.pdf
- SupplementalFigure2.pdf
- SupplementalTablesBriefReport.docx