OBSERVATIONAL STUDY

OPEN

# Clinical Characteristics and In-Hospital Mortality of Cardiac Arrest Survivors in Brazil: A Large Retrospective Multicenter Cohort Study



**Pedro Kurtz, MD**[1,2]
**Christian Storm, MD**[3]
**Marcio Soares, MD**[4]
**Fernando Bozza, MD**[4,5]
**Carolina B. Maciel, MD**[6]
**David M. Greer, MD**[7]
**Leonardo S. L. Bastos, MSc**[8]
**Ulisses Melo, MD**[9]
**Bruno Mazza, MD**[10]
**Marcelo S. Santino, MD**[11]
**Roberto Seabra Lannes, MD**[12]
**Ana Paula Pierre de Moraes, MD**[13]
**Joel Tavares Passos, MD**[14]
**Giulliana Martines Moralez, MD**[15]
**Robson Correa Santos, MD**[16,17]
**Maristela Medeiros Machado, MD**[18]
**Saulo Fernandes Saturnino, MD**[19]
**Ciro Leite Mendes, MD**[20]
**Arthur Oswaldo Vianna, MD**[21]
**Jorge Salluh, MD**[4]
**on behalf of the ORCHESTRA Study Investigators**

**OBJECTIVES:** Data on cardiac arrest survivors from developing countries are scarce. This study investigated clinical characteristics associated with in-hospital mortality in resuscitated patients following cardiac arrest in Brazil.

**DESIGN:** Retrospective analysis of prospectively collected data.

**SETTING:** Ninety-two general ICUs from 55 hospitals in Brazil between 2014 and 2015.

**PATIENTS:** Adult patients with cardiac arrest admitted to the ICU.

**INTERVENTIONS:** None.

**MEASUREMENTS AND MAIN RESULTS:** We analyzed 2,296 patients (53% men; median 67 yr (interquartile range, 54–79 yr]). Eight-hundred patients (35%) had a primary admission diagnosis of cardiac arrest suggesting an out-of-hospital cardiac arrest; the remainder occurred after admission, comprising an in-hospital cardiac arrest cohort. Overall, in-hospital mortality was 83%, with only 6% undergoing withholding/withdrawal-of-life support. Random-effects multivariable Cox regression was used to assess associations with survival. After adjusting for age, sex, and severity scores, mortality was associated with shock (adjusted odds ratio, 1.25 [95% CI, 1.11–1.39]; $p < 0.001$), temperature dysregulation (adjusted odds ratio for normothermia, 0.85 [95% CI, 0.76–0.95]; $p = 0.007$), increased lactate levels above 4 mmol/L (adjusted odds ratio, 1.33 [95% CI, 1.1–1.6; $p = 0.009$), and surgical or cardiac cases (adjusted odds ratio, 0.72 [95% CI, 0.6–0.86]; $p = 0.002$). In addition, survival was better in patients with probable out-of-hospital cardiac arrest, unless ICU admission was delayed (adjusted odds ratio for interaction, 1.63 [95% CI, 1.21–2.21]; $p = 004$).

**CONCLUSIONS:** In a large multicenter cardiac arrest cohort from Brazil, we found a high mortality rate and infrequent withholding/withdrawal of life support. We also identified patient profiles associated with worse survival, such as those with shock/hypoperfusion and arrest secondary to nonsurgical admission diagnoses. Our findings unveil opportunities to improve postarrest care in developing countries, such as prompt ICU admission, expansion of the use of targeted temperature management, and implementation of shock reversal strategies (i.e., early coronary angiography), according to modern guidelines recommendations.

**KEY WORDS:** cardiac arrest; critical care; heart arrest; outcomes assessment; targeted temperature management; therapeutic hypothermia

Data on clinical characteristics and outcomes of cardiac arrest (CA) patients in developing countries are scarce. Clinical outcomes of CA survivors continue to improve in North America and Europe and are affected by premorbid conditions, arrest-specific factors, and postarrest care, such as early coronary angiography and targeted temperature management (TTM) (1). Most recent guidelines—published in 2015 and recently



**DOI: 10.1097/CCE.0000000000000479**

updated—recommend TTM between 32°C and 36°C for at least 24 hours for unconscious CA survivors (2, 3), and further suggest that neuroprognostication should be delayed for at least 3–5 days post CA (4–6). In contrast, the impact of early indicators of systemic severity and organ dysfunction on mortality after return of spontaneous circulation (ROSC) is not completely understood. Furthermore, high heterogeneity of patient populations and care practices (e.g., TTM implementation, palliative care practices) may influence outcome of CA survivors (7).

We hypothesized that a lag exists between modern guidelines recommendations of post-CA care practices and their implementation in developing countries such as Brazil, which may be addressed in future initiatives aiming at improving CA outcomes. The aims of our study were to describe patient profiles and survival rates, as well as identify clinical and process of care-related predictors of in-hospital mortality in a large sample of CA patients admitted to Brazilian ICUs.

## MATERIALS AND METHODS

### Design, Setting, and Patients

We performed a restrospective analysis of prospectively collected data from ORganizational CHaractEeriSTics in cRitcal cAre study—a multicenter cohort study of critical care organization and outcomes in Brazilian ICUs (8). We retrieved deidentified data from the Epimed Monitor System (Epimed Solutions, Rio de Janeiro, Brazil)—a cloud-based registry for ICU quality improvement and benchmarking purposes (9). The local ethics committee at the D'Or Institute for Research and Education (Approval Number 334.835) and Brazilian National Ethics Committee (CAAE 19687113.8.1001.5249) approved the study and waived need for informed consent.

All consecutive patients with a CA diagnosis—either as a primary admission diagnosis or occurring after admission—admitted to 92 ICUs from 55 public and private hospitals in Brazil, from January 2014 to December 2015, were included. Readmissions to ICU and patients less than 16 years old were excluded.

### Patient Level Covariates and Outcomes

Age, gender, comorbidities (individually and the Charlson Comorbidity Index [CCI]), disease severity scores at admission (Simplified Acute Physiology Score [SAPS] III and Sequential Organ Failure Assessment [SOFA]), and arterial lactate (normal < 2, 2–4, and > 4 mmol/L) on the first day of admission were recorded. Additional variables evaluated included source of admission (operating room, emergency department [ED], cardiac catheterization laboratory, outside hospital transfers), organ support requirements (i.e., vasopressors, mechanical ventilation) during the ICU stay, and use of TTM. Additionally, several process of care-related variables were recorded, such as delayed admission to the ICU (defined as remaining in the ED for > 24 hr), the presence of a rapid response team, having a TTM protocol implemented, and being a public or private hospital. CA-specific data, including type of arrest rhythm, time to ROSC, and definite CA location (in-hospital CA [IHCA] vs out-of-hospital CA [OHCA]), were not available. Clinical status and functional outcomes data after hospital discharge were also not available.

The primary outcome was in-hospital mortality.

### Statistical Analysis

Descriptive statistics were reported as medians with interquartile ranges (IQRs) for continuous data and counts and percentages for categorical data. To compare patient characteristics between survivors and nonsurvivors, we used chi-square or Fisher exact test and Wilcoxon rank-sum test for categorical and continuous variables, respectively. We performed univariate analyses of in-hospital mortality using Kaplan-Meier survival curves. We considered age, gender, sources of admission, primary diagnoses, and markers of organ dysfunction as the variables of clinical relevance that were available. Differences among survival curves were evaluated with the log-rank test (confidence level: 0.05).

To assess the independent association between each predictor and hospital mortality at the patient level, we used a random-effects multivariable Cox proportional hazards model where the hazard is death. Due to the different case-mix among the hospitals, we considered the hospital variable as a source of random variability (random intercept). We estimated the hazard ratio (HR) and its corresponding 95% CI for each variable. We reported the full final model including all nonredundant variables associated with the primary

outcome. We also reported a sensitivity analysis with a reduced model that included age, gender, and significant nonredundant covariates, in order to assess the robustness of the estimates found in the main model. Some variables such as age and gender were forced into the models based on their clinical relevance (10), and meaningful interactions were tested and reported. Results from the models are presented as the HR for in-hospital mortality with 95% CIs. We used the tolerance statistic and variance inflation factor to assess multicollinearity within the model.

We performed all analyses in R 4.0.2 (R Core Team, Vienna, Austria, 2020).

### Missing Data

There was no missing information regarding admission diagnosis or hospital outcome. For clinical data at admission and ICU resource use, if the number of missing values was less than 1%, we imputed using the most frequent category; otherwise, we used a multiple imputation technique using chained equations (11).

## RESULTS

### Patient Population

The final sample included 2,296 patients from 92 ICUs in 55 hospitals (**Supplementary Fig. 1**, http://links.lww.com/CCX/A706). Median age was 67 years, and 52% were male. Main clinical characteristics are depicted in **Table 1**. Eight-hundred patients (35%) were admitted to the hospital with a primary CA diagnosis, whereas 1,496 (65%) developed CA within the first hour of ICU admission. Overall, 0.9% ($n$ = 21) received TTM, and 6% ($n$ = 132) underwent withholding/withdrawal-of-life support. Among those with registered withholding/withdrawal measures, median age was 68 years (IQR, 54–81 yr), 49% were male, 49% had a primary admission diagnosis of CA, and 30% were considered frail. Late admissions to ICU (> 24 hr) arriving from the ED comprised 16% ($n$ = 372) of the cohort. Median SOFA and SAPS III scores were 10 (IQR, 7–13) and 70 (IQR, 57–83), respectively. Eighty-nine percent ($n$ = 2,042) required invasive mechanical ventilation, and 77% ($n$ = 1,765) required vasopressors within 24 hours of ICU admission, with 51% ($n$ = 775/1,512) having lactate levels greater than 4 mmol/L. Over half (54%, $n$ = 1,101/2,055) had Glasgow Coma Scale score less than 7 upon ICU admission. Overall, in-hospital mortality was 83%, with 888 deaths (47%) occurring within 48 hours of ICU admission and 1,007 (53%) after 48 hours.

### Survivors Versus Nonsurvivors

As shown in Table 1, age was higher and female gender was more frequent among nonsurvivors. The CCI was worse in nonsurvivors, whereas individual premorbid conditions and frailty were not significantly different. In univariate analyses, survival over 90 days was progressively worse for patients with increasing SOFA scores and higher lactate levels (**Fig. 1**, ***B*** and ***D*** (log-rank $p < 0.001$ for both). Also, patients arriving in the ICU transferred from the operating room or catheterization laboratory and those with a primary CA admission diagnosis had higher survival rates (**Fig. 1*A***) (log-rank $p < 0.001$) and (**Fig. 1*C***) (log-rank $p = 0.029$). In addition, survival was higher in patients who did not present with temperature dysregulation or hypotension upon ICU arrival. Stratification by age and sex was not associated with survival in univariate analysis (**Supplementary Fig. 2**, http://links.lww.com/CCX/A706).

### Predictors of In-Hospital Mortality

We performed a multivariate random-effects Cox proportional hazards regression analysis to identify characteristics independently associated with in-hospital mortality (**Fig. 2**). After adjusting for age, gender, and severity, each additional point in SOFA score increased the hazard of death by 6%. Furthermore, markers of shock and hypoperfusion (systolic blood pressure [SBP] < 100 mm Hg and arterial lactate > 4 mmol/L) were associated with higher mortality (odds ratio [OR], 1.25; 95% CI [1.11–1.39]; $p < 0.001$ and OR, 1.33; 95% CI [1.1–1.6]; $p = 0.009$, respectively). Conversely, transfer from the operating room or catheterization laboratory (OR, 0.72; 95% CI [0.6–0.86]; $p = 0.002$) and normothermia (35.5–36.5°C) at admission (OR, 0.85; 95% CI [0.76–0.95]; $p = 0.007$) were independently associated with improved survival. There was a significant interaction between CA as a primary admission diagnosis and delayed admission to the ICU. Therefore, CA as a primary diagnosis was associated with better survival, once ICU admission occurred within up to 24 hours of presentation to the ED (OR, 0.47; 95% CI [0.42–0.54]).

# TABLE 1.
## Characteristics of Survivors and Nonsurvivors

| Variables | Full Cohort *N* = 2,296 | Survivors *N* = 400 | Nonsurvivors *N* = 1,896 | *p* |
|---|---|---|---|---|
| | *n* (%) or Median (IQR) | | | |
| Age | 67 (54–79) | 62 (49–73) | 68 (55–80) | < 0.001 |
| Male | 1,205 (52) | 229 (57) | 976 (51) | 0.041 |
| Cancer | 406 (18) | 58 (14) | 348 (18) | 0.078 |
| Chronic obstructive pulmonary disease | 183 (8.0) | 29 (7.3) | 154 (8.2) | 0.6 |
| Hypertension | 1,219 (55) | 202 (52) | 1,017 (55) | 0.2 |
| Diabetes | 310 (14) | 44 (11) | 266 (15) | 0.12 |
| Dementia | 149 (6.7) | 18 (4.6) | 131 (7.1) | 0.091 |
| Stroke with deficit | 142 (6.4) | 26 (6.7) | 116 (6.3) | 0.9 |
| Charlson Comorbidity Index | 1.00 (0.00–3.00) | 1.00 (0.00–3.00) | 1.00 (0.00–3.00) | 0.008 |
| Frailty | 622 (28) | 93 (24) | 529 (29) | 0.14 |
| Admission characteristics | | | | |
| Delayed admission to ICU (> 24 hr in ED) | 372 (16) | 34 (8.5) | 338 (18) | < 0.001 |
| Source of admission: ED | 1,179 (51) | 160 (40) | 1,019 (54) | < 0.001 |
| Source of admission: operating room or catheterization laboratory | 305 (13) | 91 (23) | 214 (11) | < 0.001 |
| Primary admission diagnosis: cardiac arrest | 800 (35) | 254 (64) | 546 (29) | < 0.001 |
| Simplified Acute Physiology Score 3 | 70 (57–83) | 57 (45–68) | 72 (60–85) | < 0.001 |
| Sequential Organ Failure Assessment first day | 10.0 (7.0–13.0) | 8.0 (5.0–10.0) | 11.0 (8.0–13.0) | < 0.001 |
| Lowest systolic blood pressure < 100 mm Hg first day (*N* = 2,181) | 1,066 (49) | 134 (34) | 932 (52) | < 0.001 |
| Normothermia at admission (temperatures between 35.5°C and 36.5°C in first hour of ICU admission) (*N* = 2,143) | 1,210 (56) | 233 (61) | 977 (55) | 0.035 |
| Lactate (*N* = 1,512), mmol/L | | | | < 0.001 |
| < 2 | 400 (26) | 99 (40) | 301 (24) | |
| 2–4 | 337 (22) | 52 (21) | 285 (23) | |
| > 4 | 775 (51) | 95 (39) | 680 (54) | |
| Mechanical ventilation at admission | 2,042 (89) | 322 (80) | 1,720 (91) | < 0.001 |
| TTM | 21 (0.9) | 4 (1.0) | 17 (0.9) | 0.8 |
| Hospital level variables | | | | |
| Public hospital | 929 (40) | 102 (26) | 827 (44) | < 0.001 |
| Rapid response team | 1,071 (47) | 228 (57) | 843 (44) | < 0.001 |
| TTM protocol implemented | 246 (11) | 68 (17) | 178 (9.4) | < 0.001 |
| Hospital length of stay (d) | 5 (1–18) | 22 (9–42) | 3 (1–12) | |

ED = emergency department, IQR = interquartile range, TTM = target temperature management.

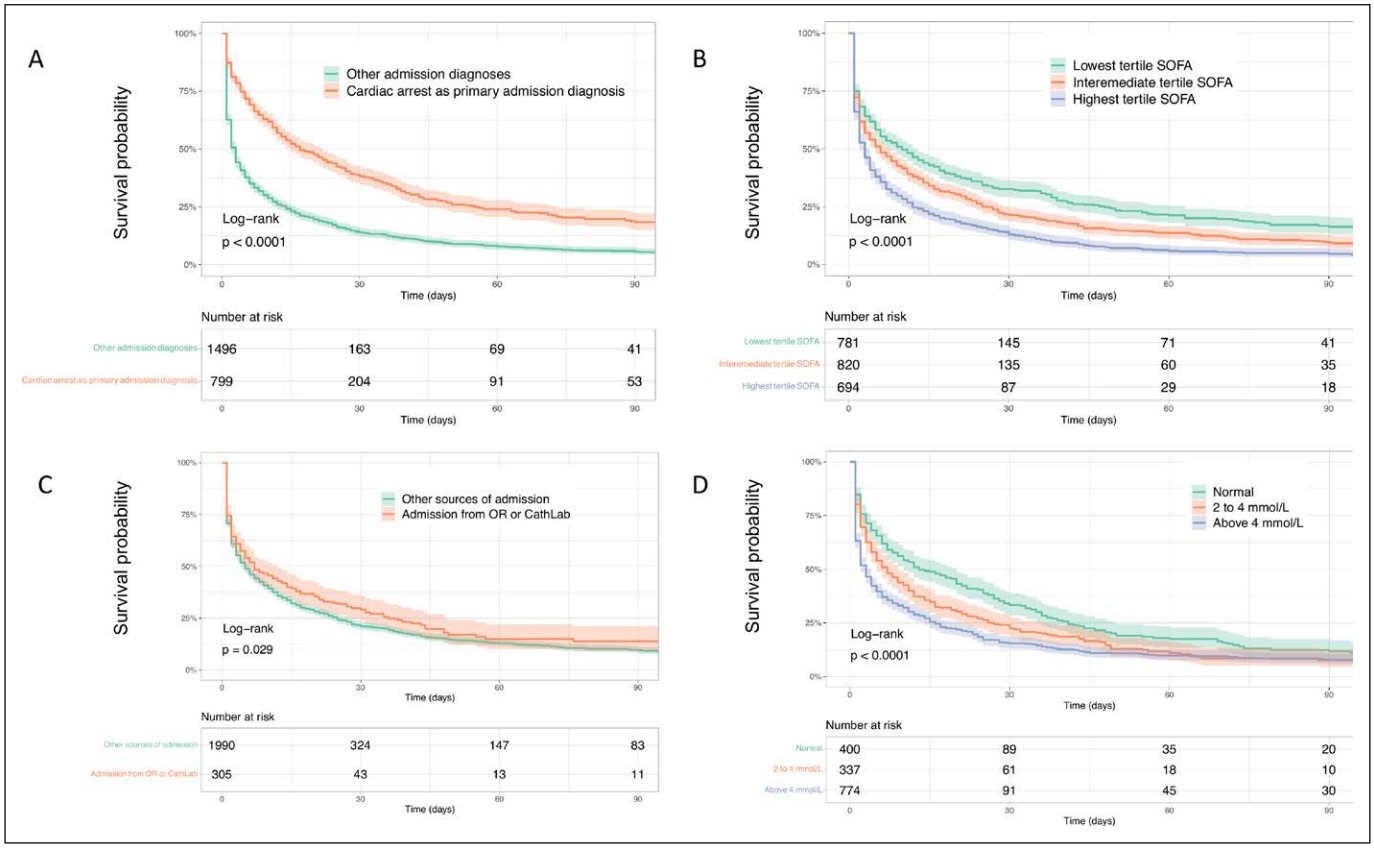


**Figure 1.** Univariable survival curves (Kaplan-Meier) of factors related to outcome in cardiac arrest patients. **A**, Cardiac arrest as the primary admission diagnosis versus other primary causes for admission, (**B**) tertiles of Sequential Organ Failure Assessment (SOFA) scores, (**C**) sources of admission: operating room (OR) or catheterization laboratory (CathLab) versus other sources, (**D**) lactate levels on the first day: normal, 2–4 mmol/L and above 4 mmol/L. Differences among curves were assessed using the log-rank test with a confidence level of 0.05.



In cases where ICU admission was delayed for more than 24 hours, no independent association was found (OR, 0.77; 95% CI [0.51–1.19]). Sensitivity analysis showed similar results in comparison with our main model (**Supplementary Table 1**, http://links.lww.com/CCX/A706).

## DISCUSSION

To our knowledge, this is the largest cohort of CA survivors from South America. We found an exceedingly high in-hospital mortality rate in post-CA patients admitted to medical-surgical ICUs in Brazil and negligible rates of TTM in postarrest care. Almost half of patients died within 48 hours of admission, and death was associated with organ dysfunction, temperature dysregulation, source of admission other than the operating room or catheterization laboratory, and CA secondary to other primary admission diagnoses.

Reported mortality rates of CA survivors vary significantly depending on the location and etiology of arrest, type of arrest rhythm, and specific measures of post-CA care (1, 12–18). Even in the setting of clinical trials of OHCA with cardiac etiology undergoing TTM, survival rates ranged from 27% to 48% (19, 20). In a randomized trial of TTM following OHCA and IHCA with nonshockable rhythm, overall reported mortality reached 82% (21).

A recent analysis of OHCA patients from the International CA Registry treated with TTM showed profound differences in the rates of good functional outcomes, which persisted after adjustment for patient-specific factors, with risk-adjusted good outcomes ranging from 20% to 50% (22). High-performing centers reported greater use of temperature targets 33°C, faster TTM implementation, and higher rates of early cardiac revascularization. In a large mixed IHCA and OHCA population from an observational multicenter

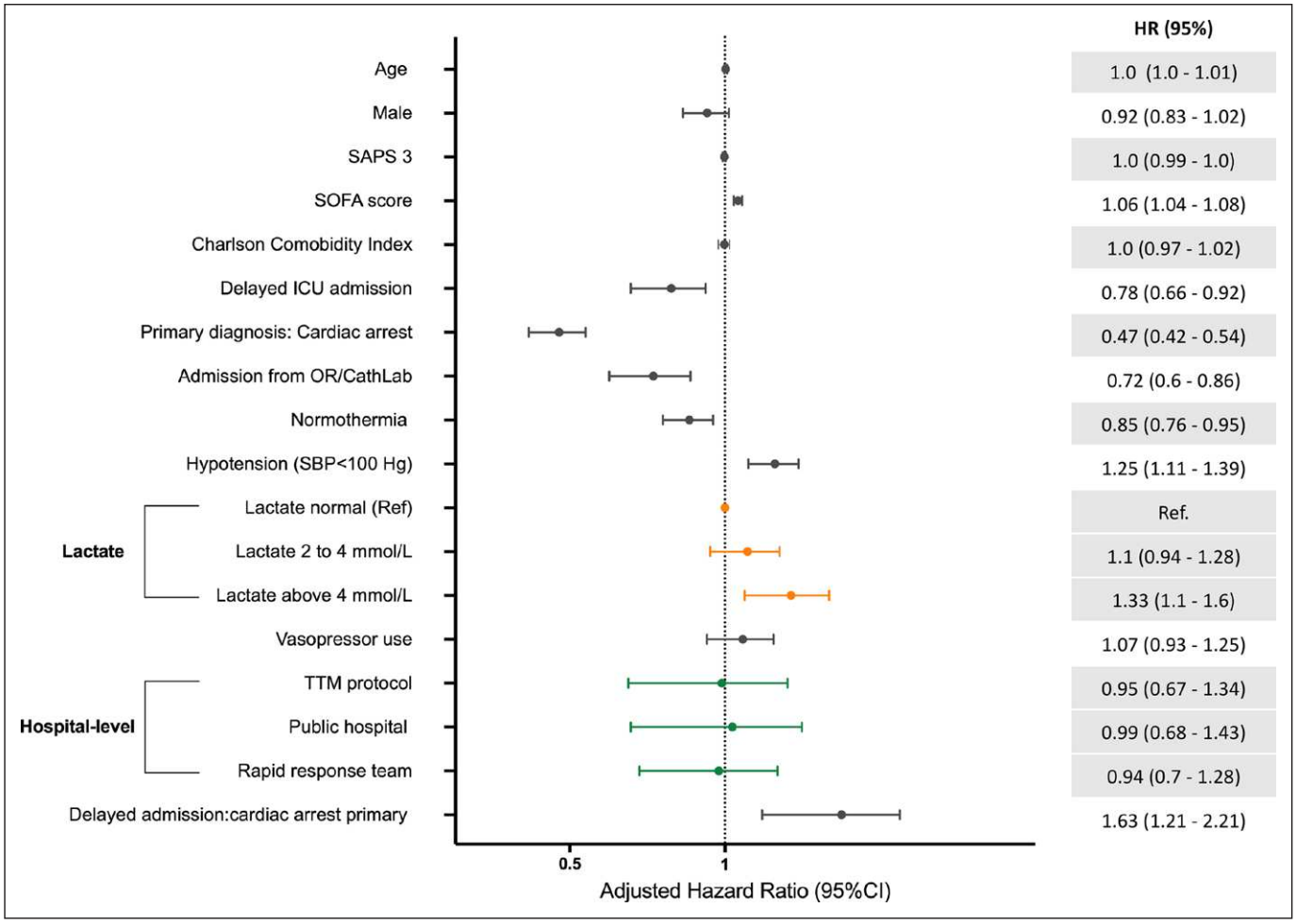


**Figure 2.** Random-effects multivariable Cox proportional hazards model to assess the association of clinical characteristics with in-hospital mortality in patients who survived a cardiac arrest. Shown are results of the full model, including one interaction term. The hospital was considered as the random intercept. We provide the hazard ratio (HR) for in-hospital mortality and its respective 95% CIs for each variable. CathLab = catheterization laboratory, OR = operating room, Ref. = reference, SAPS = Simplified Acute Physiology Score, SBP = systolic blood pressure, SOFA = Sequential Organ Failure Assessment, TTM = target temperature management.

European study, in-hospital mortality reached 53% (23).

Although data suggest temporal trends toward improved survival for IHCA (24), outcomes remain worse than OHCA in most cohorts. Analyses of large registry data showed highly variable mortality rates across centers, with unadjusted mortality of 82% in the United Kingdom and adjusted mortality rates ranging from 77% to 88% in the United States (13, 25). A recent systematic review including 40 studies found an overall 1-year survival rate of 13%, with large between-study variability, and increased survival trends over time (18).

In comparison with previous studies, ours had higher in-hospital mortality than most cohorts (83%), but similar to large registries of real life IHCA and to a pragmatic TTM clinical trial in nonshockable rhythm. This finding may be partially explained by the characteristics of the population studied. Although data specifically related to CA location were not prospectively collected, our cohort comprised IHCA in its majority, as at least 65% suffered CA while in the ICU. Furthermore, of the 35% who were admitted in the ICU with CA diagnosis, some may have also experienced the CA in the hospital (ward or ED). Furthermore, our study included only medical-surgical ICUs, excluding dedicated coronary care units. Although cardiac patients from general ICUs were analyzed in our study, this may have introduced a selection bias reducing the prevalence of cardiac etiologies, which are known to have better outcomes.

Multivariate analyses showed that the presence of spontaneous normothermia at admission and transfer from the operating room or the catheterization laboratory were associated with better survival. In addition, clinical markers of shock (elevated arterial lactate and hypotension with SBP < 100 mm Hg) were independently associated with increased mortality. Since almost all patients did not receive TTM, we hypothesize that temperatures between 35.5°C and 36.5°C in the first hour of ICU were probably related to less severely ill patients and may have been protective in comparison with those presenting with hyperthermia. Transfer from the catheterization laboratory suggest a cardiac-related etiology (18, 26). Mortality rates of patients with a cardiac-related cause (i.e., ST-elevation myocardial infarction [STEMI]) are lower than of those with other etiologies such as acute respiratory failure (27). A recent analysis of the International Cardiac Arrest Registry showed that overall survival was greater in those with STEMI compared with those without (28), whereas a systematic review found that patients with a likely cardiac cause had better survival compared with noncardiac etiology patients (18). Our findings that patients with presumed cardiac etiology (i.e., transfer from catheterization laboratory, CA as primary admission) had better survival reinforce this. Among patients who died, these variables were independently associated with better survival. Additionally, early hypotension and markers of hypoperfusion (i.e., elevated lactate) have previously been associated with worse mortality (29, 30). In our cohort, mortality was more likely if each of these factors were present. Thus, correct identification of these characteristics may identify patients who would benefit from a more aggressive and structured care pathway of management. In a systematic review, the implementation of structured care pathways that included early coronary intervention, TTM, and standardized post-CA care was associated with a higher likelihood of favorable functional outcome compared with standard care (1).

Finally, we found that delayed admission to the ICU modified the association of probable OHCA and better survival. Patients admitted with a primary diagnosis of CA and who remained in the ED for greater than 24 hours had similar mortality to those admitted with another primary diagnosis and arrested in the ICU (all IHCA). Time from CA to ICU admission has been linked to worse survival after CA (12, 31). However, these studies revealed differences of a few hours when comparing patients with favorable and unfavorable outcomes. In our cohort, 16% of patients remained in ED for at least 1 day despite having survived a CA. This may be due to reduced availability of ICU beds and/or underestimation of patients' severity. Our results underline the absolute necessity of access to an ICU bed for these patients, better screening, and streamlined ICU transfer. Additionally, unlike the majority of published CA cohorts, only 6% of patients in our study underwent limitation or withdrawal-of-life support. This finding is probably related to cultural and legal issues in Brazil and raises concerns and opportunities. With such an elevated overall mortality, we hypothesize that many patients may have received futile treatment with prolonged length of stay and very little chance of functional recovery (32). In contrast, observational studies from developed countries showed that early withdrawal-of-life support is common and associated with excess mortality (33, 34). As early withdrawal-of-life support is not part of standard of care in Brazil (35), studies evaluating late prognostication in developing countries become feasible and could improve our understanding of the natural history of recovery after CA.

Our study has significant limitations. First, the database analyzed lacked specific arrest-related data (e.g., arrest location, initial rhythm [shockable vs nonshockable], time to ROSC and bystander cardiopulmonary resuscitation), which precluded a more granular analysis. Data collection was not diagnosis specific; however, we could identify patients with ventricular fibrillation and estimate IHCA using surrogates such as admission diagnosis and time of CA during hospitalization. Second, our database did not provide data on percutaneous coronary intervention, which has been associated with better outcomes. However, we were able to show that patients coming from the catheterization laboratory had lower mortality than those who did not. Third, long-term functional outcomes were not available. In-hospital mortality, although, is an important clinical outcome after CA and may be used as a target measure of improved management and processes of care. Fourth, we used routinely collected data to conduct this analysis at scale, and thus some degree of information was unavailable or missing. However, we used robust imputation techniques to account for the missing data. Finally, data on TTM and palliative care implementation were not mandatory in the

registry. This may have underestimated the actual use of both measures. However, due to the limited availability of TTM devices and implemented TTM protocols in Brazil, we hypothesize the data reflected the reality of postarrest care (7).

## CONCLUSIONS

We demonstrated in a large cohort of CA survivors that in-hospital mortality is elevated and that TTM implementation is negligible in Brazilian ICUs. Furthermore, nearly half of nonsurvivors died within 48 hours of ICU admission with severe hemodynamic compromise and organ dysfunction. These findings unveil great opportunities to improve post-CA care in developing countries. Future studies should focus on the implementation of structured pathways including prompt ICU transfer and TTM in comatose patients. Implementing a combination of these evidence-based measures may positively impact CA outcomes in low- and middle-income countries.


1 *Department of Neurointensive Care, Paulo Niemeyer State Brain Institute, Rio de Janeiro, Brazil.*

2 *Department of Neurointensive Care, Hospital Copa Star, Rio de Janeiro, Brazil.*

3 *Department of Nephrology and Intensive Care, Charité-Universitätsmedizin Berlin, Berlin, Germany.*

4 *Department of Intensive Care Medicine, D´Or Institute for Research and Education, Rio de Janeiro, Brazil.*

5 *Department of Intensive Care Medicine, National Institute of Infection, Fundação Oswaldo Cruz, Rio de Janeiro, Brazil.*

6 *Department of Neurology, University of Florida College of Medicine, Gainesville, FL.*

7 *Department of Neurology, Boston University School of Medicine, Boston, MA.*

8 *Department of Industrial Engineering, Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brazil.*

9 *ICU, Hospital Estadual Alberto Torres, São Gonçalo, Brazil.*

10 *ICU, Hospital Samaritano, São Paulo, Brazil.*

11 *ICU, Hospital Barra D'Or, Rio de Janeiro, Brazil.*

12 *ICU, Hospital Municipal Souza Aguiar, Rio de Janeiro, Brazil.*

13 *ICU, Hospital de Câncer do Maranhão Tarquínio Lopes Filho, São Luís, Brazil.*

14 *ICU, Hospital Unimed Costa do Sol, Macaé, Brazil.*

15 *ICU, Hospital Estadual Getúlio Vargas, Rio de Janeiro, Brazil.*

16 *ICU, Hospital Estadual Adão Pereira Nunes, Duque de Caxias, Brazil.*

17 *ICU, Hospital Estadual Carlos Chagas, Rio de Janeiro, Brazil.*

18 *ICU, Hospital Agenor Paiva, Salvador, Brazil.*

19 *ICU, Department of Emergency, Hospital das Clínicas da Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.*

20 *ICU, Hospital Universitário Lauro Wanderley, João Pessoa, Brazil.*

21 *ICU, Clínica São Vicente, Rio de Janeiro, Brazil.*

*The ORganizational CHaractEeriSTics in cRitical cAre (ORCHESTRA) Study Investigators and participating centers are listed in Appendix 1.*


*Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's website (http://journals.lww.com/ccejournal).*

*Supported, in part, by institutional departmental funds (D´Or Institute for Research and Education).*

*Drs. Soares and Salluh are shareholders of Epimed Solutions®. They are partially supported by research grants from National and State funding agencies (Conselho Nacional de Desenvolvimento Científico e Tecnológico and Fundação de Amparo à Pesquisa do Estado do Rio de Janeiro). The remaining authors have disclosed that they do not have any conflicts of interest.*

*For information regarding this article, E-mail: kurtzpedro@mac.com; jorgesalluh@gmail.com*

## REFERENCES

1. Storm C, Leithner C, Krannich A, et al: Impact of structured pathways for postcardiac arrest care: A systematic review and meta-analysis. *Crit Care Med* 2019; 47:e710–e716
2. Panchal AR, Bartos JA, Cabañas JG, et al; Adult Basic and Advanced Life Support Writing Group: Part 3: Adult basic and advanced life support: 2020 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2020; 142:S366–S468
3. Nolan JP, Sandroni C, Böttiger BW, et al: European Resuscitation Council and European Society of Intensive Care Medicine guidelines 2021: Post-resuscitation care. *Intensive Care Med* 2021; 47:369–421
4. Ponz I, Lopez-de-Sa E, Armada E, et al: Influence of the temperature on the moment of awakening in patients treated with therapeutic hypothermia after cardiac arrest. *Resuscitation* 2016; 103:32–36
5. Sandroni C, Cariou A, Cavallaro F, et al: Prognostication in comatose survivors of cardiac arrest: An advisory statement from the European Resuscitation Council and the European Society of Intensive Care Medicine. *Intensive Care Med* 2014; 40:1816–1831
6. Geocadin RG, Callaway CW, Fink EL, et al; American Heart Association Emergency Cardiovascular Care Committee: Standards for studies of neurological prognostication in comatose survivors of cardiac arrest: A scientific statement from the American Heart Association. *Circulation* 2019; 140:e517–e542

7. Pitrowsky MT, Storm C, Salluh JI: Target temperature management after cardiac arrest in comatose survivors in Brazil - A survey of the current clinical practice. *Resuscitation* 2017; 117:e15–e16
8. Soares M, Bozza FA, Angus DC, et al: Organizational characteristics, outcomes, and resource use in 78 Brazilian intensive care units: The ORCHESTRA study. *Intensive Care Med* 2015; 41:2149–2160
9. Zampieri FG, Soares M, Borges LP, et al: The epimed monitor ICU database®: A cloud-based national registry for adult intensive care unit patients in Brazil. *Rev Bras Ter Intensiva* 2017; 29:418–426
10. Kim LK, Looser P, Swaminathan RV, et al: Sex-based disparities in incidence, treatment, and outcomes of cardiac arrest in the United States, 2003-2012. *J Am Heart Assoc* 2016; 5:e003704
11. van Buuren S, Groothuis-Oudshoorn K: mice: Multivariate imputation by chained equations in R. *J Stat Softw* 2011; 45:67
12. Perman SM, Stanton E, Soar J, et al; American Heart Association's Get With the Guidelines®—Resuscitation (formerly the National Registry of Cardiopulmonary Resuscitation) Investigators: Location of in-hospital cardiac arrest in the United States-variability in event rate and outcomes. *J Am Heart Assoc* 2016; 5:e003638
13. Nolan JP, Soar J, Smith GB, et al; National Cardiac Arrest Audit: Incidence and outcome of in-hospital cardiac arrest in the United Kingdom national cardiac arrest audit. *Resuscitation* 2014; 85:987–992
14. Andersen LW, Østergaard JN, Antonsen S, et al: The Danish in-hospital cardiac arrest registry (DANARREST). *Clin Epidemiol* 2019; 11:397–402
15. Andersen LW, Holmberg MJ, Løfgren B, et al: Adult in-hospital cardiac arrest in Denmark. *Resuscitation* 2019; 140:31–36
16. Andersen LW, Holmberg MJ, Berg KM, et al: In-hospital cardiac arrest: A review. *JAMA* 2019; 321:1200–1210
17. Zhang XW, Xie JF, Chen JX, et al: The effect of mild induced hypothermia on outcomes of patients after cardiac arrest: A systematic review and meta-analysis of randomised controlled trials. *Crit Care* 2015; 19:417
18. Schluep M, Gravesteijn BY, Stolker RJ, et al: One-year survival after in-hospital cardiac arrest: A systematic review and meta-analysis. *Resuscitation* 2018; 132:90–100
19. Kirkegaard H, Søreide E, de Haas I, et al: Targeted temperature management for 48 vs 24 hours and neurologic outcome after out-of-hospital cardiac arrest: A randomized clinical trial. *JAMA* 2017; 318:341–350
20. Nielsen N, Wetterslev J, Cronberg T, et al; TTM Trial Investigators: Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med* 2013; 369:2197–2206
21. Lascarrou JB, Merdji H, Le Gouge A, et al; CRICS-TRIGGERSEP Group: Targeted temperature management for cardiac arrest with nonshockable rhythm. *N Engl J Med* 2019; 381:2327–2337
22. May TL, Lary CW, Riker RR, et al: Variability in functional outcome and treatment practices by treatment center after out-of-hospital cardiac arrest: Analysis of international cardiac arrest registry. *Intensive Care Med* 2019; 45:637–646
23. Taccone FS, Horn J, Storm C, et al: Death after awakening from post-anoxic coma: The "Best CPC" project. *Crit Care* 2019; 23:107
24. Ofoma UR, Basnet S, Berger A, et al; American Heart Association Get With the Guidelines – Resuscitation Investigators: Trends in survival after in-hospital cardiac arrest during nights and weekends. *J Am Coll Cardiol* 2018; 71:402–411
25. Merchant RM, Berg RA, Yang L, et al; American Heart Association's Get With the Guidelines-Resuscitation Investigators: Hospital variation in survival after in-hospital cardiac arrest. *J Am Heart Assoc* 2014; 3:e000400
26. Bascom KE, Dziodzio J, Vasaiwala S, et al; International Cardiac Arrest Registry (INTCAR): Derivation and validation of the CREST model for very early prediction of circulatory etiology death in patients without ST-segment-elevation myocardial infarction after cardiac arrest. *Circulation* 2018; 137:273–282
27. Tran S, Deacon N, Minokadeh A, et al: Frequency and survival pattern of in-hospital cardiac arrests: The impacts of etiology and timing. *Resuscitation* 2016; 107:13–18
28. Kern KB, Lotun K, Patel N, et al; INTCAR-Cardiology Registry: Outcomes of comatose cardiac arrest survivors with and without ST-segment elevation myocardial infarction: Importance of coronary angiography. *JACC Cardiovasc Interv* 2015; 8:1031–1040
29. Dell'Anna AM, Sandroni C, Lamanna I, et al: Prognostic implications of blood lactate concentrations after cardiac arrest: A retrospective study. *Ann Intensive Care* 2017; 7:101
30. Orban JC, Novain M, Cattet F, et al: Association of serum lactate with outcome after out-of-hospital cardiac arrest treated with therapeutic hypothermia. *PLoS One* 2017; 12:e0173239
31. Churpek MM, Wendlandt B, Zadravecz FJ, et al: Association between intensive care unit transfer delay and hospital mortality: A multicenter investigation. *J Hosp Med* 2016; 11:757–762
32. Petzinka VN, Endisch C, Streitberger KJ, et al: Unresponsive wakefulness or coma after cardiac arrest-A long-term follow-up study. *Resuscitation* 2018; 131:121–127
33. May TL, Ruthazer R, Riker RR, et al: Early withdrawal of life support after resuscitation from cardiac arrest is common and may result in additional deaths. *Resuscitation* 2019; 139:308–313
34. Elmer J, Torres C, Aufderheide TP, et al; Resuscitation Outcomes Consortium: Association of early withdrawal of life-sustaining therapy for perceived neurological prognosis with mortality after cardiac arrest. *Resuscitation* 2016; 102:127–135
35. Soares M: End of life care in Brazil: The long and winding road. *Crit Care* 2011; 15:110

## APPENDIX 1

The ORganizational CHaractEeriSTics in cRitical cAre (ORCHESTRA) Study: ORCHESTRA Investigators and participating centers: Bahia: Hospital Agenor Paiva, Salvador (UTI: Maristela Medeiros Machado); Hospital Santa Helena, Camaçari (UTI Geral: Luciano Ferreira de Souza, Maristela Medeiros Machado); Distrito Federal: Hospital Anchieta Distrito Federal, Taguatinga (UTI A: Rubens Antônio Bento Ribeiro, Eduardo Cesar Guimarães Lessa); Hospital Brasília, Brasília (UTIs 1 and 2: Clayton Barbieri de Carvalho, Tullio Xavier Leirias); Hospital Santa Luzia Rede D'Or São Luiz DF, Brasília (UTIs 1, 2, T and C: Marcelo de Oliveira Maia, Edmilson Leal Bastos, Rebeca Martins da Silva Barros, Cintya M. V. Oliveira, Jose Aires A Neto); Espírito Santo: Hospital Unimed Vitória, Vitória (UTI Adulto Geral: Eliana Bernadete Caser, Silvane Damasceno); Goiás: Hospital Geral de Goiânia, Goiânia (UTIs Alas A, B, and C: Marcelo Rabahi Fouad, Marco Antônio Mendes Castilho, Durval Ferreira Fonseca Pedroso, Humberto Borges Barbosa); Maranhão: Hospital de Câncer do Maranhão Tarquínio Lopes Filho, São Luís (UTI Geral: Ana Paula Pierre de Moraes); UDI Hospital, São Luís (UTI: Ana Cláudia Pinho de Carvalho, Alexandre Guilherme Ribeiro de Carvalho, Akemy Carvalho do Rosário); Minas Gerais: Santa Casa de Caridade de Diamantina, Diamantina (UTI Dr. Jose Aristeu de Andrade: Marcelo Ferreira Sousa, Marcia Maria Ferreira de Souza); Hospital das Clínicas da Universidade Federal de Minas Gerais, Belo Horizonte (UTI PS: Saulo Fernandes Saturnino); Paraíba: Hospital Universitário Lauro Wanderley, João Pessoa (UTI Adulto: Ciro Leite Mendes, Paulo César Gottardo, Igor Mendonça do Nascimento); Pernambuco: Hospital Esperança, Recife (UTI Geral: Mariza da Fonte Andrade Lima, Marçal Paiva); Hospital Esperança Olinda, Olinda (UTIs 1, 2, 3, and 4: Carlos Eduardo Ferraz Freitas, Lanecley Gouveia Neves Fulco); Hospital São Marcos, Recife (UTI Geral: Maurício Magalhães Cabral, Luciane Ishiy, Renato Fábio Alberto Della Santa Neto); Rio de Janeiro: Hospital Estadual Getúlio Vargas, Rio de Janeiro (Giulliana Martines Moralez; UTI 1: Giulliana Martines Moralez, Flavio Callil; UTI 2: Claudio Eduardo Calife Chagas, Eliane Casanova; UPO: Antonio Carlos Babo Rodrigues, Bruno Vidal); Clínica São Vicente, Rio de Janeiro (CTI 1: Arthur O. A. Vianna, Patrícia Soares D'Alessandro); Hospital Estadual Adão Pereira Nunes, Duque de Caxias (UTI Geral and UPO: Robson Correa Santos, Ricardo Pessoa Martelo); Hospital Estadual Carlos Chagas, Rio de Janeiro (UTI Geral: Rodrigo Barros, Luisa Chuairi); Hospital Quinta D'Or, Rio de Janeiro (Roberto Costa; UTI A: Cristiane Belo, Giulia P. C. Lima; UTI C: Cristiane Cariús, Eduardo Xavier; UCV-1: Claudia Lourenço de Almeida, Rafael Sibanto; UHB: Alessandra Longo, Joyce Roma; UHO: Juliana Gurgel da Silveira, Laura Brasil Herranz; UNI: Gustavo Vaz, Bruno Cartelo Branco; UPO: Leonardo Campioni, Alexandre Coscia); Hospital Barra D'Or, Rio de Janeiro (UPO: Walter Homena; CTI 1, CTI 2 and UTI Neurointensiva: Marcelo de Sousa Santino, Juan Carlos Verdeal); Hospital Copa D'Or, Rio de Janeiro (William Nascimento Viana e Lígia Sarmet Farah Cunha Rabello; UTI Neurointensiva: Janaína Oliveira; UTIs Amarela and Azul: Cecília Magno; UTI Lilás: Alex Gaspar; UTI Verde: Guilherme Feres; UPO: Maria Teresa Saint-Martin); Hospital Caxias D'Or, Duque de Caxias (UTI Sarapuí: Eric Perecmanis); Hospital Norte D'Or, Rio de Janeiro (UTI Geral: Jorge Eduardo da Silva Soares Pinto, Sergio Teixeira Sant'Anna Junior); Hospital Oeste D'Or, Rio de Janeiro (UTI 2º ANDAR: Guilherme Brenande Alves Faria, Alcino Márcio Toledo de Medeiros; UTI 5º ANDAR: Márcia Adélia de Magalhães Menezes, Rosa Imaculada Stancato, Joyce Andrade); Hospital Rios D'Or, Rio de Janeiro (UTI 1: Alessandra Alves); Hospital Badim, Rio de Janeiro (CTIs A and B: Alexandre Vaz Scotti); Hospital Municipal Souza Aguiar, Rio de Janeiro (CTIs ADULTO 1 and 2: Roberto Seabra Lannes, Sion Divan Filho, Andrea Ludovico); Hospital São Lucas, Rio de Janeiro (Marcos Knibel; UTI 1º Andar: Emir Oliveira; UTI 2º Andar: Pedro Azambuja; UTI 4º Andar: Aline Affonso); Hospital Unimed Costa do Sol, Campos dos Goytacazes (UTIs Adulto I and II: Joel Tavares Passos); Hospital Niterói D'Or, Niterói (UTI Geral: Carlos Cesar Hortala Junior); Hospital Israelita Albert Sabin, Rio de Janeiro (UTI: Edmundo de Oliveira Tommasi, Patricia Frascari Litrento, Alexandra Gonçalves da Silva); SAMER Hospital, Resende (UTI 1: Henrique Miller Balieiro, Fellipe de Freitas Pereira); Hospital Estadual Alberto Torres, São Gonçalo (Ulisses de Oliveira Melo; UTI Trauma: Edson Tristão, Kelsey Sampaio, Rogerio Silveira; UTI Adulto: Antonio Carlos, Felipe Mafort, Jose Hipólito, Valquíria Queiroz); Instituto Nacional de Câncer – HC II, Rio de Janeiro (CTI: Bruno

Azevedo da Cruz, Karla Biancha Silva de Andrade); Rio Grande do Sul: Hospital Santa Rita, Santa Casa de Misericórdia de Porto Alegre, Porto Alegre (UTI: Thiago Lisboa, André P. Torelly); Pavilhão Pereira Filho, Santa Casa de Misericórdia de Porto Alegre, Porto Alegre (UTI: Daniella Birriel); Hospital Dom Vicente Scherer, Santa Casa de Misericórdia de Porto Alegre, Porto Alegre (UTI de Transplantes: Edison Moraes Rodrigues Filho); Hospital Montenegro, Montenegro (UTI: José Pettine, Moreno Calcagnotto dos Santos, Tiago Almeida Ramos, Fernando Bourscheit, Ana Flávia Gallas Leivas); São Paulo: Hospital São Francisco, Ribeirão Preto (UTI Geral: Marcus Antonio Ferez, Edson Antonio Nicolini); Hospital Vivalle, São José dos Campos (UTI Geral: Fernando Vinicius Cesar De Marco, Guilherme Paro de Toledo); Fundação Pio XII - Hospital de Câncer de Barretos, Barretos (UTI: Ulysses V. Andrade e Silva, Cristina Prata Amendola); Hospital Alemão Oswaldo Cruz, São Paulo (UTI Adulto: Fernando Colombari); Hospital Israelita Albert Einstein, São Paulo (UTI Adulto: Thiago Domingos Corrêa, Eliézer Silva); Hospital Sírio-Libanês, São Paulo (UTI Geral: José Mauro Vieira Jr, Luciano Azevedo, Fernando Ramos); Hospital São Luiz - Unidade Assunção, São Bernardo do Campo (UTI: Silvia Regina Ramos, Lilian Mara Perroud Miilher); Hospital Sepaco, São Paulo (UTI Adulto: Flávio Geraldo Rezende de Freitas, Antônio Tonete Bafi, Eduardo Souza Pacheco); Hospital Santa Paula, São Paulo (UTIs A, B and Neuro: Dieter Eduardo Siefeld Araya, Ronaldo Escudeiro Borba, Moacyr Fogolin Junior, Pedro Ivo Buainain, Mariza Luciana Pregun); Hospital do Rim, São Paulo (UTI: Flávio Geraldo Rezende de Freitas, Antônio Tonete Bafi); Rede Dor São Luiz – Unidade Morumbi, São Paulo (UTI 2º Andar: José Albani Carvalho Jr); Rede Dor São Luiz – Unidade Itaim, São Paulo (UTI: José Albani Carvalho Jr, Mariza Silva Ramos Loesch, Kassia Pinho); Hospital Samaritano, São Paulo (Bruno Franco Mazza; UTIs Oeste e Neuro: Samantha Longhi de Almeida; UTI Geral: Rosa Goldstein Alheira Rocha); Hospital do Coração – HCor, São Paulo (UTI Geral: Edson Romano, Fernando Zampieri); Hospital Nove de Julho, São Paulo (UTIs 2C, 3C, 4D and D: Carlos Eduardo Nassif Moreira); Hospital da Luz - Vila Mariana, São Paulo (UTI Adulto: Bruno Adler Maccagnan Pinheiro Besen, Carlos Eduardo Brandão).