

RAPID RESPONSE TEAM AND OUT-OF-HOSPITAL CARDIAC ARREST

TIME DE RESPOSTA RÁPIDA E ATENDIMENTO DE PARADAS CARDÍACAS EXTRA-HOSPITALARES

ABSTRACT

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Introduction: Rapid Response Teams (RRT) are multidisciplinary groups trained to treat individuals with severe and acute events, including sudden cardiac arrest (CA), in in-patient units. The aim of this report is to discuss the singularities of deploying a hospital RRT for out-of-hospital CA assistance, using the experience of the team at the Instituto Central of Hospital das Clínicas of the University of São Paulo School of Medicine (IHC-FMUSP) as illustration. **Methodology:** A retrospective, descriptive analysis was conducted, using the RRT database of the IHC-FMUSP. All cases classified as sudden CA treated outside of the hospital between 2014 and 2016 were surveyed. Global data for five patients who progressed to discharge from hospital free of neurological impairment were described and analyzed in detail. **Results:** Of the 11 cases, 8 had return of spontaneous circulation (ROSC) at the scene (72.2%), and 3 died on site. Of the 8 patients admitted to the Emergency Department, 5 were discharged from the hospital after the event (45.5%). The average response time was 3 ± 1.2 minutes, and the call-to-shock time interval was 7.25 ± 3.2 minutes. The cardiac arrest rhythms were ventricular fibrillation (80%) and pulseless electrical activity (20%). Two patients were diagnosed with severe coronary disease and four received an implantable cardioverter-defibrillator (ICD) for secondary prophylaxis of sudden death. One patient, of the 5 discharged, died in another unit. **Conclusion:** Although unusual, the use of a hospital RRT for out-of-hospital CA assistance can be beneficial. The favorable outcomes likely resulted from the team's training and the speed with which the treatment was given. Cardiovascular evaluation of the survivors identified patients with severe diseases, which would, therefore, most benefit from the care of a specialized team.

Keywords: Hospital Rapid Response Team; Heart Arrest; Death, Sudden, Cardiac; Out-of-Hospital Cardiac Arrest

RESUMO

Introdução: Times de Resposta Rápida (TRR) são equipes multidisciplinares treinadas para atender indivíduos com intercorrências agudas e graves, incluindo parada cardiorrespiratória (PCR) súbita, nas unidades de internação. O objetivo deste trabalho é discutir as particularidades do emprego de um TRR hospitalar no atendimento de PCRs extra-hospitalares, utilizando a experiência do time do Instituto Central do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (IHC-FMUSP) para elucidação. **Metodologia:** Estudo retrospectivo, descritivo, utilizando o banco de dados do TRR do IHC-FMUSP. Foram levantados todos os casos classificados como PCR súbita atendidos em ambiente extra-hospitalar, nos anos de 2014 a 2016. Dados globais de cinco pacientes que evoluíram com alta hospitalar e nível neurológico preservado foram descritos e analisados em detalhes. **Resultados:** Entre 11 atendimentos, oito tiveram retorno da circulação espontânea (RCE) na cena (72,2%) e três morreram no local. Dos oito pacientes admitidos com vida no Departamento de Emergência, cinco tiveram alta hospitalar após o evento (45,5%). A média de tempo de resposta foi $3 \pm 1,2$ minutos e o intervalo chamada-choque foi de $7,25 \pm 3,2$ minutos. Os ritmos de parada foram fibrilação ventricular (80%) e atividade elétrica sem pulso (20%). Dois pacientes foram diagnosticados com doença coronariana grave e quatro receberam um cardiodesfibrilador implantável (CDI) para profilaxia secundária de morte súbita. Um paciente, entre os cinco que tiveram alta, faleceu em outro serviço. **Conclusão:** Apesar de pouco usual, o emprego de um TRR hospitalar no atendimento de PCRs extra-hospitalares pode ser benéfico. Os desfechos favoráveis provavelmente decorreram do treinamento da equipe e da rapidez na realização do atendimento. A investigação cardiológica dos sobreviventes identificou pacientes com doenças graves, que, portanto, mais se beneficiariam da assistência de um time especializado.

Descritores: Equipe de Respostas Rápidas de Hospitais; Parada Cardíaca; Morte Súbita Cardíaca; Parada Cardíaca Extra-Hospitalar

INTRODUCTION

Rapid response teams (RRTs) are multidisciplinary teams trained to assist patients with acute and severe complications in inpatient units.¹ The RRT at the Instituto Central of Hospital das Clínicas of the University of São Paulo School of Medicine (ICHC-FMUSP), in addition to performing the traditional functions of an emergency hospital team, particularly assists patients and companions in the outpatient clinics and the external area of the eight institutions that constitute the complex, which has a built-up area of 600,000 m² and daily admission of 18,000 individuals.² The RRT of the ICHC-FMUSP is composed of assistant physicians, with several specialties such as cardiology, intensive care, and pulmonology; a resident physician; nurse; and physiotherapist who are available 24 h/7 days a week. It can be activated through buttons installed in the wards and outpatient clinics or through a specific landline. The team began its activities in 2014 and, in almost 3 years, attended >400 calls for cardiac arrest (CA), some of which occurred in the outpatient/external area setting.

It is estimated that there are between 166,000 and 300,000 cases of out-of-hospital CA annually in the United States.^{3,4} Survival of these patients is variable, but it generally does not exceed 10%.⁴⁻⁷ The meta-analysis by Sasson et al., which included 79 studies and >140,000 patients, showed a mean survival rate of 7.6% at hospital discharge. The study also revealed that patients undergoing cardiopulmonary resuscitation (CPR) maneuvers, both by laypersons and an emergency team, with arrest rhythm had greater chances of survival, especially in places with a defibrillator.⁸ The benefits of early defibrillation and its positive impact on the neurological level of patients with out-of-hospital CA were also observed.⁹

This study aimed to discuss the characteristics of out-of-hospital CA care by a hospital RRT, early defibrillation, neurological prognosis, and relevant post-CPR cardiac management using the experience of the ICHC-FMUSP in cases with favorable outcomes (hospital discharge with preserved neurological level).

METHODOLOGY

All cases classified as sudden CA treated in the outpatient setting/external area from 2014 to 2016 were retrospectively searched in the ICHC-FMUSP RRT database. Data from the medical records, post-CA imaging examinations (echocardiography, coronary cineangiography, and magnetic resonance imaging), and cardiac management of 5 patients who were discharged from hospital were analyzed. Patients were reevaluated 1 month and 6 months after the event.

RESULTS

Of a total of 13 patients with out-of-hospital CA, 2 were excluded because return of spontaneous circulation (ROSC) was noted before the arrival of the team. Of the remaining 11 patients, 8 had ROSC at the scene (72.2%), and 3 died at the scene. Of the 8 patients admitted alive in the emergency department, 5 (45.5%) were discharged from hospital after the event with preserved neurological level. Their mean age was 65.2 ± 4.5 years. The details of these 5 patients are summarized in Table 1.

The mean response time of the RRT (interval between the activation and arrival of the team at the scene) was 3 ± 1.2 min. The mean time for the first arrest was 4.25 ± 2.1 min after the arrival of the team, leading to a call-arrest interval of 7.25 ± 3.2 min. The arrest rhythms were ventricular fibrillation in 80% patients and pulseless electrical activity (PEA) in 20%. The mean time for ROSC was 20.4 ± 18.8 min.

In total, 4 of the 5 patients underwent coronary cineangiography; 1 patient did not undergo the procedure because a recent coronary computed tomography angiography showed insignificant luminous reductions and altered renal function, which limited the use of contrast. Two patients had coronary disease with 3-vessel pattern obstructions, 1 patient had a mild coronary lesion, and 1 patient had no obstructive lesions. Among the 2 patients with severe disease, 1 underwent surgical revascularization and the other underwent percutaneous angioplasty of 2 vessels because the patient refused to undergo surgery; the third vessel was not approached due to technical difficulties related to the calcified aspect of the lesions. Three patients underwent cardiac magnetic resonance imaging and 1 patient had pharmacological stress (dipyridamole). Of the 3 patients, 1 patient did not have fibrosis and 2 patients had late enhancement with a non-ischemic pattern.

An implantable cardioverter-defibrillator (ICD) was implanted in 4 of 5 patients for secondary prophylaxis of sudden death. The device was not implanted in the fifth patient because the patient did not have significant tachyarrhythmia (the arrest rhythm was PEA) but had acute ischemia.

During follow up, 1 of the 5 patients who was discharged died in another service.

DISCUSSION

Although unusual, the use of a hospital RRT for out-of-hospital CA care can be beneficial. The favorable outcomes likely resulted from the team's training and speed with which the treatment was provided. According to Fredriksson et al., the interval between collapse and defibrillation is strongly related to survival.¹⁰ The study compared CA survival rates in arrest rhythm in the out-of-hospital and in-hospital settings, which were 18% and 61%, respectively.¹⁰ This may be due to the prompt treatment for in-hospital cases, with less time for defibrillation, rarely exceeding 5 min within the hospital, and less time for initiation of CPR. The same is true for neurological prognosis, which tends to be better in in-hospital CA. Therefore, in patients with CA, the arrest site had an influence on survival. Similarly, the events managed by the RRT of the ICHC-FMUSP (80% of which were arrest rhythm), although in out-of-hospital settings, occurred within the hospital complex, with potentially easier and faster access to CPR maneuvers by a trained team and a mean call-arrest interval of only 7.25 min. White et al. even showed that short call-arrest intervals, such as those of the RRT of the ICHC-FMUSP, would lead to higher survival rates.¹¹

Out-of-hospital CAs, mainly in public places and with a high level of physical and psychological stress, such as casinos and airports, are usually easily witnessed and promptly assisted. These environments, such as the ICHC-FMUSP, are considered favorable in the identification of complications because they have constant surveillance and high volume of equipment and possible rescuers.¹² Security guards,

Table 1. Characteristics of the survivors of out-of-hospital cardiac arrests treated by the ICHC-FMUSP RRT.

Case No	Sex, age (years)	Personal background	RRT maneuvers (response time, CA rhythm, interventions performed, and duration of CPR maneuvers)	Post-CA examinations	Post-CA cardiac approach	Outcome
1	Male, 64	SAH, dyslipidemia, and ischemic cardiomyopathy	3 min PEA OTI, adrenaline rush 10 min	ECG: LBBB ECHO: increase in the left chamber, indirect signs of pulmonary hypertension, and significant diffuse LV hypokinesia (LVEF 25%). CC: important lesions in RC, AD, and CX (Figure 1A and B) Stress MRI: myocardial fibrosis with a non-ischemic pattern	Patient refused to undergo coronary artery bypass grafting surgery. Angioplasty of AD and CX (RD not addressed due to severe calcification of lesions)	Discharge after 21 days
2	Female, 70	SAH and thyroid papillary carcinoma	2 min VF (1st shock 4 min after CPR) Defibrillation, OTI, adrenaline rush, amiodarone, saline solution, sodium bicarbonate, calcium gluconate, and magnesium sulfate 53 min	ECG: AIVR Previous ECG: long QT (Figure 1C) ECHO: akinesia of the LV inferior and inferior septal walls (LVEF 40%) CC: no obstructive lesions	ICD	Discharge after 50 days
3	Male, 61	SAH, smoking, alcoholism, mycosis fungoides, and polycythemia vera	3 min VF (1st shock 2 min after CPR) Defibrillation 6 min	ECG: ST depression and T-wave inversion in lateral wall ECHO: diffuse LV hypokinesia (LVEF 30%) CATE: significant lesions in RC, CX, and Dg2 (Figure 1D, E, and F)	Myocardial revascularization surgery and ICD	Discharge after 30 days
4	Male, 61	SAH, smoking, dilated cardiomyopathy, and moderate aortic insufficiency	5 min VF (1st shock 7 min after CPR) Defibrillation, OTI, adrenaline rush, amiodarone, and saline solution 17 min	ECG: LBBB ECHO: diffuse LV hypokinesia (LVEF 35%), moderate AOI, and ectasia of the aortic arch and ascending aorta (Figure 2A) CC: RC 40% (Figure 2B) MRI: no fibrosis	ICD with atrioventricular resynchronizer	Discharge after 23 days
5	Male 70	SAH, smoking, dilated cardiomyopathy, and chronic atrial fibrillation in anticoagulation	2 min VF (1st shock 4 min after CPR) Defibrillation, IOT, adrenaline rush, and amiodarone 16 min	ECG: 1st-degree AVB ECHO: left chamber enlargement, diffuse LV hypokinesia (LVEF 25%), significant MVI, moderate TRIL, and signs of pulmonary hypertension CC: did not undergo MRI: diffuse and extensive myocardial fibrosis with a non-ischemic pattern and suspected infiltrative process (Figure 2C and D)	ICD	Discharge after 21 days. Death in another service after 3 days

*PEA, pulseless electrical activity; AVB, atrioventricular block; LBBB, left bundle branch block; CC, coronary cineangiography; RC, right coronary artery; ICD, implantable cardioverter-defibrillator; CX, circumflex artery; AD, anterior descending artery; Dg2, second diagonal branch; ECG, electrocardiogram; ECHO, transthoracic echocardiogram; LVEF, left ventricular ejection fraction (reference value $\geq 55\%$); VF, ventricular fibrillation; SAH, systemic arterial hypertension; AOI, aortic insufficiency; MVI, mitral valve insufficiency; TRIL, tricuspid insufficiency; ST depression, ST segment depression; OTI, orotracheal intubation; CA, cardiac arrest; CPR, cardiopulmonary resuscitation; AIVR, accelerated idioventricular rhythm; MRI, magnetic resonance imaging; LV, left ventricle

administrative employees, and health professionals in our hospital receive training in basic life support, and despite having started CPR maneuvers before the arrival of the RRT in some cases, they do not use the AED. This leads us to believe that the disclosure that this equipment is available in the sectors is as important as practical training.

It is also known that the profile of patients with out-of-hospital CA is different from that of patients with in-hospital CA¹²; however, the population in the ICHC-FMUSP complex

is composed of patients who are followed in a tertiary hospital with severe health problems, making the individual characteristics more similar to those of patients with in-hospital CA than to those with out-of-hospital CA.

Among the 11 patients managed by the team, five were discharged from the hospital (45.5%) with preserved neurological level. Our service has no structure or human resources training for cooling patients, and therefore, none of the patients underwent therapeutic hypothermia, even though it is

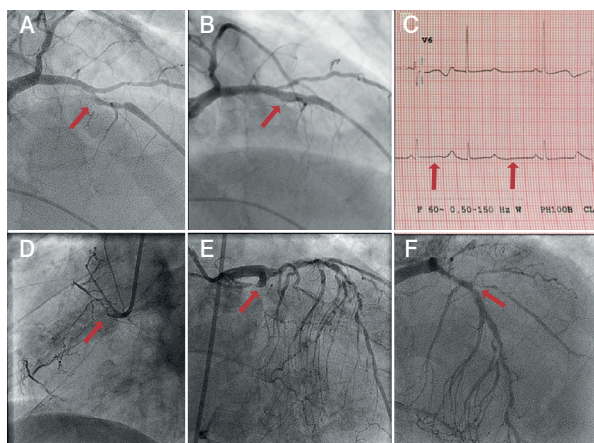


Figure 1. Post-cardiac arrest diagnostic investigation: case 1, coronary cineangiography of the anterior descending artery with significant lesion in the middle third (A) and re-establishment of flow after angioplasty (B); case 2, electrocardiogram showing long QT interval and atrioventricular block 2:1 (C); case 3, coronary cineangiography showing right coronary artery occluded in the proximal third (D), circumflex artery occluded in proximal third (E), and second diagonal branch sub-occluded in the proximal third (F).

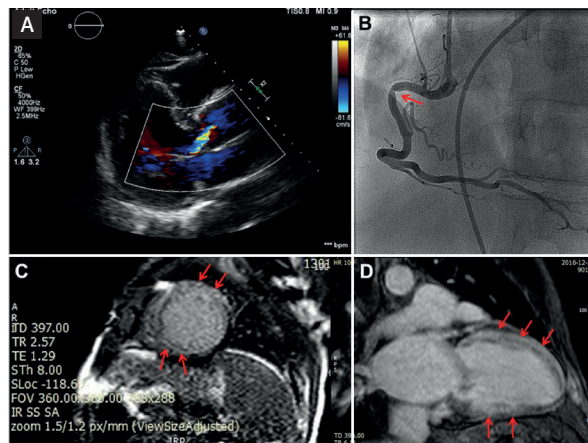


Figure 2. Post-cardiac arrest diagnostic investigation: case 4, transthoracic echocardiogram with color Doppler showing moderate aortic insufficiency (A) and coronary cineangiography of the right coronary artery with slight lesion in the proximal third (B); case 5, cardiac magnetic resonance imaging with gadolinium showing extensive and diffuse myocardial fibrosis, with a non-ischemic pattern, reaching the entire thickness of the lateral and inferior walls of the left ventricle, in the short (C) and long axes (D).

a current international recommendation in post-CPR care.¹³ The short response time of our team (mean 3 ± 1.2 min) may have been the main factor related to favorable neurological outcomes. Response times ≤ 6.5 min and shorter intervals in delivering the first shock are associated with better neurological outcomes in patients with witnessed out-of-hospital CA,^{14,15} although this association has not been statistically confirmed for in-hospital CA.¹⁶

In Brazil, it is estimated that approximately 30% deaths are caused by cardiovascular disease.¹⁷ The prevalence of severe coronary disease in our patients was 50% (2 of 4 patients who underwent coronary cineangiography). A study that performed coronary cineangiography in patients without obvious non-cardiac causes for sudden CA found that 71.4% of these had significant coronary disease.¹⁸ In addition to 3-vessel severe coronary disease, these 2 patients also had significant left ventricular (LV) systolic dysfunction. The guidelines recommend surgical treatment in patients with LV systolic dysfunction (ejection fraction [EF] $\leq 35\%$) associated with significant trunk lesion or 3-vessel pattern with significant lesion in the anterior descending artery.¹⁹

In total, 4 of 5 patients received an ICD. Brazilian recommendations for implantation of this device in the secondary prevention of sudden cardiac death include survivors of arrest, non-reversible-cause CA with life expectancy of at least 1 year, and EF of $\leq 35\%$ (Class I) or EF of $\geq 35\%$ (Class IIa). Of the 4 patients who received ICD, 3 had an EF of $\leq 35\%$.

The remaining 1 patient had an EF of 40% in addition to long QT interval syndrome, which also require implantation of the device depending on the life expectancy.²⁰

One patient with an ICD died 3 days after being discharged. Although we do not have access to the clinical history related to death, the death may have occurred due to complications related to anticoagulation by atrial fibrillation or implantation of the device and progression of the underlying heart disease resulting from a probable infiltrative process.

CONCLUSION

Although unusual, the application of a hospital RRT for out-of-hospital CA care can be beneficial. The favorable outcomes likely resulted from the team's training and speed with which the treatment was provided. Cardiac investigation of survivors showed that patients with severe diseases required coronary artery bypass grafting and ICD implantation, which are characteristics frequently found in individuals who have sudden CA. Therefore, they would benefit the most from the care by a specialized team.

CONFLICTS OF INTEREST

The author declares that he has no conflicts of interest in this work.

AUTHORS' CONTRIBUTIONS: All authors participated significantly in the preparation of the manuscript and are responsible for its content. All authors approved the final version of the manuscript. FAS conceived the original idea of reporting the experience of the RRT of the ICHC-FMUSP and led the drafting and preparation of the manuscript. ANDN helped in obtaining data and formatting tables and figures and participated in the discussion of the results. NHFF helped in obtaining data and collecting images and participated in the discussion of the results. MBMP conceived the original idea of reporting the experience of the RRT of the ICHC-FMUSP and conducted a critical analysis of the manuscript. LSHL conceived the original idea of reporting the experience of the RRT of the ICHC-FMUSP and conducted a critical analysis of the manuscript. EFP supervised the preparation of the manuscript and reviewed the manuscript and its intellectual content.

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