





Cardio-protected hospital, antithesis of sudden death: A proposal of the “Hospital General de Cienfuegos”

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Abbreviations

AMI: acute myocardial infarction

CRA: cardiorespiratory arrest

CPR: cardiopulmonary resuscitation

GALCAP: HGAL cardio-protected hospital (by its acronym in Spanish)

HGAL: Hospital Gustavo Aldereguía Lima

IHCRA: in-hospital CRA

RRT: rapid response teams

SD: sudden death

ABSTRACT

In-hospital sudden death and cardiopulmonary cerebral resuscitation problems could have a common structured response. However, most hospitals lack a solution-oriented strategy. This paper provides detailed update on the main alternatives to reduce lethality of in-hospital sudden death and presents a proposal from the “Hospital General de Cienfuegos”. The institutional approach for greater survival and lesser disability when facing sudden death will be based on multidisciplinary initiatives primarily centered on quality and prevention in the different stages of cardiopulmonary cerebral resuscitation. A cardio-protected hospital comprises management, organizational, assistance, academic and logistical processes for every single link of the survival chain in a medical emergency event, mainly sudden cardiac arrest. The proposal of the “Hospital General de Cienfuegos”, a cardio-protected facility, brings together all elements of an integrated cardiopulmonary cerebral resuscitation system aimed at quality, safety and satisfaction of patients and caregivers.

Keywords: Sudden death, Sudden cardiac death, Cardiopulmonary resuscitation, Hospital rapid response team, Cardiac arrest, Hospitals

Hospital cardioprotegido, antípoda de la muerte súbita: Propuesta del Hospital General de Cienfuegos

RESUMEN

Los problemas de muerte súbita y reanimación cardiopulmocerebral intrahospitalarias pueden tener estructurada una respuesta común; sin embargo, en la mayoría de los hospitales no se dispone de una estrategia orientada a su solución. Este trabajo actualiza sobre las principales alternativas para reducir la letalidad por muerte súbita intrahospitalaria y presenta una propuesta del Hospital General de Cienfuegos. El abordaje institucional para mayor supervivencia y menor discapacidad ante la muerte súbita dependerá de iniciativas multidisciplinarias enfocadas a la calidad y prevención, en los diferentes eslabones, de la reanimación cardiopulmocerebral. Un hospital cardioprotegido integra procesos gerenciales, organizativos, asistenciales, académicos y logísticos para todos los eslabones de la cade-

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na de supervivencia ante una emergencia médica, principalmente la parada cardíaca súbita. La propuesta del Hospital General de Cienfuegos como institución cardioprottegida agrupa todos los elementos de un sistema integrado de reanimación cardiopulmocerebral enfocado hacia la calidad, seguridad y satisfacción de pacientes y prestadores.

Palabras clave: Muerte súbita, Muerte súbita cardíaca, Reanimación cardiopulmonar, Equipo hospitalario de respuesta rápida, Paro cardíaco, Hospitales

INTRODUCTION

Mortality rates from cardiovascular disease have declined over the past fifty years thanks to massive international efforts centered on prevention and control. Yet today it is still the leading cause of death in most developed countries and in some underdeveloped ones including Cuba^{1,2}.

Cardiovascular disease is a major health and social problem. In America, cardiovascular disease accounts for one in every six healthcare dollars spent and total cardiovascular expenditures increased by 147% between mid-1996 and 2015¹. Despite emerging health care practices and further opportunities for biomedical innovation, the future hardly looks bright¹.

In our country, cardiovascular diseases are also the leading cause of death with a rate of 241.6 per 100.000 inhabitants (figures that have increased since 2000); where ischemic diseases account for 64.9%, mainly (45.3%) due to acute myocardial infarction (AMI)².

There is a linear relationship between cardiovascular disease, AMI (an alarming fact is that 20% to 40% of myocardial infarctions occur in patients previously undiagnosed with cardiovascular disease)¹, and sudden death (SD).

Although with a few variations, it is generally accepted that SD refers to an unexpected death or arrest statistically associated mostly to cardiovascular causes (but also to pulmonary embolism, stroke, and aortic syndromes, among others) which occurs within one hour of symptom onset when witnessed or, if unwitnessed, when the individual was observed to be alive within the previous 24 hours^{3,4}.

Sudden death is known to be the leading cause of 15-20% of all deaths in developed countries which makes it a global health problem, although genetic factors and associated comorbidities may have an impact on variations across the different geographical areas³.

The most common causes of sudden cardiac ar-

rest differ in their two main occurrence scenarios. Acute coronary syndrome (16%), acute respiratory failure (12%) and toxicological emergencies (11%) prevail in the outpatient setting. Meanwhile, respiratory diseases rank first (22%), followed by cardiovascular disease (8%) in the in-hospital setting⁵; although Andersen *et al*⁶ report different values, up to 40% for the former and 60% for the latter. Discharge survival rates are also variable (between 6-60%), although with lower figures for adequate neurological recovery (0-40%), depending on the causes and care at the site of cardiorespiratory arrest (CRA)⁵.

Sudden death has also been studied in Cuba and it is thought to cause 10% of natural deaths among the population⁴. Control actions for specific diseases such as AMI have been carried out, and work-research groups have also been formed for its integrated and cross-sectoral management in order to tackle it⁴. In-hospital SD has been less researched than out-of-hospital SD. Its assessment has lacked uniform diagnostic and metric criteria across facilities. Another contributing aspect is the number of areas where patients can be hospitalized and employees' job profiles. That is why tackling it continues to be a huge challenge today^{6,7}.

In many countries, both family members and patients can decide whether to resuscitate in the event of cardiac arrest, which is a statistical bias for SD and cardiopulmonary resuscitation (CPR) as an approach; with the subsequent modification of successful CPR data; and we quote: an estimated 63% of in-hospital CRA (IHCRA) with chances of circulatory recovery could have been declared "non-resuscitable".

Even with these limitations, the estimated in-hospital CRA rates, range from 1-13 per 1000 discharges; with an initial circulatory recovery between 32-54%^{7,8} of which 3.7×1000 are in patients admitted outside intensive care units⁷. It is noteworthy that 45% of CRA in adults and 65% in children occur in these units⁷. Armstrong *et al*⁹ report an incidence of CRA of 22.7 per 1000 admissions and a discharge survival

of 17% in intensive care units.

Another aspect to be highlighted is that since IHCRAs differ from out-of-hospital causes, the electrical forms of CRA are also different. In hospitals, 61.5% to 89.7% of initial rhythms are “nonshockable”, although this is also due to cardiac and respiratory causes^{6,9}. These figures are higher than in the out-of-hospital setting. It is remarkable that the causes of IHCRAs commonly show a progressive deterioration that allows CRA to be predicted, and this is an important therapeutic breach¹⁰.

A wide range of organizational and academic actions have been developed to solve this problem⁶. Since 2005, countries such as Spain have a national CPR plan and some institutions have joined to the cardio-protected settings strategy¹¹.

Over the first decade of the 21st century at the *Hospital General Universitario Dr. Gustavo Aldereguía Lima* (HGAL) in Cienfuegos, a number of actions were developed to deal with this issue but lacked an in-hospital holistic approach. They are as follows: The creation of a Comprehensive Heart Care Unit, a pioneer of this concept in the country since 2001. It established action and training protocols in advanced CPR for all workers. The relatives of infarcted patients were also taught later. The merger of intensive care, intermediate care and rehabilitation, guaranteed immediate attention for all patients in case of emergency. In 2005, the Provincial Center for Medical Emergencies was made available, with an advanced organization, but intended only for emergency care for patients coming from the primary health care level. In 2011 proposals were designed for in-hospital care to CRA and for safe in-hospital transfer of severely ill patients. A rapid response team was made up to this end¹², although it was not implemented.

In-hospital SD and CPR are two unresolved issues that may have a similar structural response. However, most hospitals lack information on this subject and do not have a robust action strategy. This paper aims to update on the main organizational and academic alternatives to reduce in-hospital SD lethality and present the HGAL's proposals to be accredited as a cardio-protected institution.

GENERAL STRATEGIES

Faced with high frequency and lethality events such as SD and IHCRAs, health institutions have devel-

oped strategies and actions, with different names and scopes; among the most common are: a) systems for early detection and treatment of potential cardiac arrest events, b) programs for early access to defibrillation, c) in-hospital CRA risk mapping, d) CPR action protocols, e) creation of in-hospital CPR committees, f) implementation of CPR rapid response teams, and g) standardization for CRA-CPR-related data collection, all linked to a regular education and training program for health and non-health personnel⁶.

The chain of survival, conceived since the beginning of the 90s of the 20th century, is still used as a guide to plan future actions. It should be borne in mind that not all links in the chain of survival weigh the same and that the former are most likely to save more lives⁵. Therefore, early recognition, timely call and immediate medical team response are crucial.

Based on the 2015 American Heart Association (AHA) and International Liaison Committee on Resuscitation (ILCOR) guidelines, the adult chain was divided into out-of-hospital and in-hospital care pathways, depending on the characteristics of patients (many already exposed), as well as the structural and process elements involved in the care system. For the in-hospital environment, survival will depend on an appropriate surveillance system (for warning and rapid response), and on a multidisciplinary team to guarantee comprehensive care at CRA and post-resuscitation¹⁰.

Efficiency rates of any of these actions is one of the most controversial aspects. Thus, alive hospital discharge survival at 30 days after patient discharge and adequate neurological-cardiovascular status at both stages are accepted. Special considerations will be made with those who die in the emergency room, previous “do not resuscitate” decisions and end-stages of chronic diseases⁷.

ORGANIZATIONAL ACTIONS

Over time, the organizational response to in-hospital CRA has been different even within a given hospital. We currently have protocols and technologies in place, but similar institutions still disagree on interpretation, organization and adherence.

For a basic approach to the process development in any hospital, **box 1** shows detailed answers to all questions.

The AHA's best practices for addressing IHCRAs

are structurally divided into three temporal sections: prearrest, intra-arrest, and postarrest. The first, which includes the preparation of the medical facility, entails the following actions⁷:

- Placement of defibrillators readily accessible for response in less than two minutes with informative banners showing action codes and protocols
- Establishment of rapid response teams
- Training in life support, as well as team leadership and resource management
- Organization for institutional response (some hospitals have implemented a “code blue” and have designed systems for rapid prevention/identification of patients at risk).
- Its process of quality and legality (some countries include “do not resuscitate” patients)
- Cardiovascular monitoring for risk groups (patients with coronary syndromes and arrhythmias)
- Documentation.

Activities during CRA include: ensuring organization, training and logistics for quality CPR as the main element for survival; regular assessment of residents' and specialists' skills; setting up feedback systems ideally in real time; all based on the best evidence⁷.

The key to successful postarrest management is the organization of multidisciplinary medical teams for CRA care, transfer and admission protocols for intensive care unit, and postarrest syndrome guidelines (including therapeutic hypothermia, hemodynamic control, neuroprotection, coronary angiography, among others)^{6,7}.

The implementation of the various “medical rapid response teams” (RRT) has provided an alternative to solve the problem by reducing CRA rates. However, its benefit in terms of effectiveness and mortality reduction has not been proven^{5,6,13}. Although there is no agreed upon methodological design, indicators and measurement frequency, a major factor could be the clinical conditions underlying CRA in this setting.

On the other hand, the effectiveness of these RRT is increased with an adequate strategy for their implementation, education and organizational culture. Those who focus on teaching staff and encourage a proactive attitude to sound the alarm on any deteriorating patient will have better results¹³. Jung *et al*⁸ found that RRT implementation, with teaching modules, publicity and training through simulations, re-

duced both unexpected and overall hospital mortality.

In reviewing the issue, McGaughey *et al*¹⁴ conclude that a rapid response system would be more effective if it was integrated by experienced professionals and had appropriate protocols. While in the hospital ward environment, a “traditional” hierarchical referral system, high workload and unavailability of resources could have a negative impact.

Which patients will require immediate action? How to make a timely diagnosis? This is a core issue in all organizational models; and in this sense, identifying the causes of CRA can help to know which patients should receive both preventive and corrective actions. There are several proposals and multiple algorithms for triage, including those for electronic identification: Early Deterioration Indicator, Modified Early Warning Score and National Early Warning Score⁵. The electronic-based cardiac arrest triage (eCART), already implemented in several institutions, seems to have higher levels of sensitivity, perhaps because it includes a number of demographic, laboratory, and clinical parameters (vital signs, including oxygen saturation and neurological response)¹³.

However, this topic also poses other difficulties for a logical analysis of its usefulness. In a study conducted in Australia¹⁵, the most frequent cause of emergency group activation in hospitals was a drop in the Glasgow coma scale, followed by changes in cardiovascular parameters. But institutions with RRT mobilized the team quite frequently (24.2%) only because of the professionals' “concern” about certain

Box 1. Questions to assess how the organizational process of response to in-hospital CPR is undertaken.

- What protocol is followed?
- Who is called?
- What communication system allows instant response team activation?
- Is it available and on the scene in less than two minutes?
- Is there a defibrillator?
- What are the safety measures for the patient?
- Does the crash cart meet the logistical requirements to ensure life support?
- Who keeps medical records?
- Does the staff have the skills for proper CPR?
- How is the quality of the process managed?

cases even if there was no specific reason.

Another decisive aspect is that quality CPR should be carried out in the shortest possible time during CRA. This is why international recommendations emphasize on this aspect^{6,10}. Concerning drug therapy, there is also consensus on adherence to AHA and ILCOR– CPR guidelines. They also define procedures for the last link in the chain of survival, (post-CPR care), which are focused on the basic triggering cause, hemodynamic and respiratory support, as well as neuroprotective care^{6,10}.

THE CUBAN CONTEXT

In the Cuban context, without advanced technologies or much equipment deployed outside critical care units, hospitals must have a program for prevention and behavior in the face of unexpected cardiac arrest. This is also an indicator for quality care in other medical emergencies.

In this context, we can easily implement such a strategy by having an extensive teaching program and a continuous monitoring system for severe critically ill patients or with clinical changes based on a group of clinical and laboratory parameters already recognized⁸, such as: heart rate ≤ 40 or ≥ 140 beats per minute, blood pressure ≤ 80 mmHg, respiratory rate ≤ 8 or ≥ 30 per minute, pulse oximetry $<90\%$ with supplemental oxygen at more than 6 L/min, seizures or sudden changes in consciousness and coma, or CRA.

A commonly neglected element is that of registration systems for CRA. To address this issue, which often takes on a medico-legal connotation, several variants of medical records have also been implemented. It is important to record everything that has happened in order to apply appropriate action protocols and to have available data to improve the quality of the process and suggest improvement initiatives for resuscitation teams¹⁵. The Utstein style is recommended for a monitoring, reporting, research, and evaluation system of CPR in the different scenarios¹⁵.

In the Cuban context, where ethically and legally all patients are “resuscitable”, a statistical differentiation would have to be made when executing a CPR program for IHCR, since results will be different between patients receiving CPR due to primary or unexpected CRA and those suffering from CRA due to a chronic incurable disease and dying.

ACADEMIC ACTIONS

There are a number of reasons for the need to integrate a broad educational program into in-hospital CPR. Some of these have already been discussed:

1. Undergraduate life support training in the medical sciences is poor. It was only from the 2016-2017 school year that basic CPR in medicine was introduced¹⁶.
2. Knowledge and skills once acquired are lost in a short time⁵ (that is why updates of less than two years are almost globally recommended)¹⁵.
3. Practitioners who could respond to such events can be very varied, having little or no experience¹⁷.
4. Most studies assessing the knowledge and skills of health professionals, even in scenarios such as emergency services and operating rooms, report poor results^{17,18}.

What are the most suitable alternatives?

The training program should include all workers regardless of their occupational profiles. Nursing staff is key because they are numerous, witness almost all events and have more direct contact with patients. From a pedagogical perspective, the program should focus on skill development. These are best acquired using high-fidelity mannequins and real-time feedback devices. Short-term courses with integrated video sessions or interactive computer programs are more suitable¹⁵. As part of the training, mainly in advanced courses, it is better to deal with management issues, such as teamwork and leadership.

CARDIO-PROTECTED HOSPITAL

All of the above aspects may influence in-hospital mortality, especially that resulting from unexpected CRA or SD; but they are single pieces that, for a sustained impact, need good gearing and networking. Conceptions, whether for a hospital plan in case of CPR or to become a cardio-protected institution, could be part of these links and obtain more efficient results.

This idea of a “cardio-protected area” has been applied for several years in places where there are elements capable of responding to CRA in less than five minutes, mainly within the hospital area. The strategy is already bearing fruit in several countries

that have certified places where a large number of people circulate or stay: the most important are shopping centers or malls, airports, train stations, subways, universities, hospitals, stadiums, schools, among others.

Cardio-protected spaces should have basic criteria such as: having people trained in CPR, easy and rapid access to automatic external defibrillators and a way to record and organize the system^{11,19}.

Similar initiatives have also yielded positive results in the communities. Several studies have shown survival benefits following public access defibrillation programs in Europe, the United States and Latin America²⁰. The Heart Safe program within communities in Minnesota¹¹, where there were previously trained personnel, increased basic CPR before the ambulance arrived from 83% to 95%, after being designated as cardio-protected, as well as the use of the automated external defibrillator (AED) from 63% to 77%; similarly, although not significantly, it increased survival at discharge from 17 to 20% in resuscitated patients. The city of Girona, in Spain, stands out as the first to be a “cardio-protected territory” since 2011¹⁹. In its first 4 years, 231 events were recorded and although most corresponded to asystole (42%), the AEDs analyzed presented excellent safety and specificity, with moderate sensitivity. The device successfully treated half of the patients who had shockable rhythms.

It is worth mentioning that a “cardio-protected” hospital must have those resources and procedures of an accredited facility. Although both concepts differ in terms of measurement criteria and their indicators. However, the authors consider the second to be more specific, comprehensive and precise regarding the subject of in-hospital CPR. The Joint Commission International²¹, in its Hospital Accreditation Indicators, states that staff members providing patient care and other personnel identified by the organization should be trained and able to prove adequate competence in resuscitation techniques (basic or advanced). Such appropriate level of training should be repeated at set intervals or within time limits identified by a recognized training program. It could be done every two years if lacking the program. Policies and procedures outline the use of resuscitation services throughout the organization, especially for patients in a coma or on life support. In the Cuban guidelines for hospital accreditation²², the standards “Attendance to an emergency” and “Assistance to critically ill patients” do not have a comprehensive vision for the IH CRA, and its indica-

tors do not cover the areas of treatment for patients outside the emergency room or critical care units.

Although the idea of a cardio-protected institution is mainly associated with the availability of defibrillators, all of the elements mentioned above, which are part of the links in the chain of survival, should also be considered in a project aimed at reducing IH CRA mortality and disability. The research by Huschak *et al*²³ agrees with this as they found that only 48% of in-hospital CRAs received CPR, and only 8% had a shockable rhythm at the start; with a response time of 4.3 ± 4 minutes. Similarly, there was no difference between CPR with and without a defibrillator in terms of mortality.

The type of defibrillator is also an element to consider. Previous experiences show poor efficacy of AEDs in the hospital setting; especially, because of the time without compression required to analyze the rhythm and its association with decreased survival in CRA with nonshockable rhythms²⁴.

The authors believe that, unlike in-hospital CPR—where defibrillators play a key role—in low-resource situations, organizational and academic elements would take on a leading role. A multicenter study²⁵ that estimated the standardized risk of survival by in-hospital CRA concluded that best practices were: monitoring chest compressions interruptions (the main quality indicator), periodic (monthly) assessment of CRA cases, and having a “CPR champion” (possibly for leading the process, introducing improvements and controlling quality). Another group of strategies such as routine mortality review, simulation training, rapid response team availability, use of devices during CPR to improve quality, audiovisual feedback and mechanical devices had no impact on survival.

HGAL's proposal as a cardio-protected institution

The HGAL project as a cardio-protected hospital (GALCAP) arises from the need for better medical care in the face of “unexpected” cardiac arrest. The process reviews have exposed gaps in almost all areas, causing dissatisfaction in the medical team, patients and families. Shortcomings have also been found in the institution's professional staff when assessing the required expertise to deal with it; therefore, regular training is necessary¹².

GALCAP is also integrated with other actions in the territory to improve comprehensive and integrated attention when dealing with medical emer-

gencies. The national project *Formación e Investigación en Apoyo Vital en Emergencias y Desastres* (FIAVED) works through universities to restore life support courses, which are necessary in the Cuban context²⁶.

Methodologically, its design is based on international^{10,21} and national²⁶ recommendations for the management and construction of an integrated resuscitation system. It also draws on the experience of the provincial health system in Cienfuegos, which since 1997 has managed an integrated medical emergency system, a Comprehensive Heart Care Unit and a Provincial Medical Emergency Center.

A set of process, structure and results indicators will assess the project's effectiveness from the diagnostic stage (**Box 2**).

To achieve such goals, GAL-CAP will integrate five main groups of actions related to the specific objectives. In the first, the process of comprehensive medical care for cardiac arrest in the HGAL will be characterized (for which the process, knowledge-skill level among health care professionals, perceived need in CPR by other job profiles, design of the risk map for in-hospital CRA, and resources available for quality CPR will be assessed). The second will redesign the comprehensive medical care process for cardiac arrest in the HGAL, by defining the components of an integrated resuscitation system¹⁰ (structure indicators, processes and results; including resources, organization, action guidelines and continuous training), and subsequent validation.

In a third one, focused on “assurance”, the management (acquisition and location) of the material medical assurance for a quality CPR will be carried out (through projects in the different platforms). A fourth group of actions will develop a broad CPR training process reaching all job profiles (it will be necessary to define courses by profile, teaching staff, logistics and continuous training system). The fifth and last group of actions will be characterized by certifying the services, departments and hospital areas as cardio-protected areas.

Box 2. Indicators to assess the impact of the Gustavo Aldereguía Lima Hospital project as a cardio-protected hospital.

Process indicators
- Having a practical action plan available
- Ensuring a high level of adherence to the guide
- Having a program to prevent sudden death and provide rapid diagnosis
- Having a comprehensive information and training program
Structure indicators
- Having a trained resuscitation team
- Having defibrillators and all the necessary supplies for advanced quality CPR in less than three minutes
Performance indicators
- Achieving reduced in-hospital emergency response times
- Improving the in-patient safety faced with a CRA
- Increasing survival rates after discharge from cardiac arrest
- Improving patient and health care provider satisfaction
- Ensuring compliance with the standards for a “cardio-protected hospital” certification

CRA, cardiorespiratory arrest; CPR, cardiopulmonary resuscitation.

CONCLUSIONS

The institutional approach for increased survival and reduced disability in the face of sudden death will depend on multidisciplinary initiatives focused on quality and prevention in the different CPR phases. A cardio-protected hospital integrates managerial, organizational, assistance, academic and logistic processes for every link in the chain of survival in case of a medical emergency, mainly sudden cardiac arrest. The proposal of the Hospital General Universitario Dr. Gustavo Aldereguía Lima de from Cienfuegos as a cardio-protected facility brings together all the elements of an integrated cardiopulmonary resuscitation system centered on quality, safety and satisfaction of patients and health care providers.

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