Extracorporeal life support programme for out-of-hospital cardiac arrest during competitive sport events: the experience of the Volleyball Men's World Championship Final Six in Turin (Italy)

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ABSTRACT

The high incidence of out-of-hospital cardiac arrest refractory to standard resuscitation protocols, despite precompetitive screening, demonstrated the need for a prehospital team to provide an effective system for life support and resuscitation at the Volleyball Men's World Championship. The evolution of mechanical circulatory support suggests that current advanced cardiovascular life support protocols no longer represent the highest standard of care at competitive sporting events with large spectator numbers. Extracorporeal life support (ECLS) improves resuscitation strategies and offers a rescue therapy for refractory cardiac arrest that can no longer be ignored. We present our operational experience of an out-of-hospital ECLS cardiopulmonary resuscitation team at an international sporting event.

INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is an important cause of sudden death in developed countries. Approximately 275 000 people per year sustain OHCA in Europe, with an incidence of 84/100 000 inhabitants.[1] Return of spontaneous circulation (ROSC) occurs in 29.7% of cases, but survival to hospital discharge and overall 1-year survival remain low (respectively 8.8% and 7.7%).[2]

The main aetiology of OHCA is medical; the most common events are myocardial ischaemia and sudden cardiac death (SCD) due to heart failure, hypertrophic cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy. Moreover, it has been reported that vigorous physical activity may increase the risk of SCD.[3] The habit of extreme physical exertion is naturally typical of competitive athletes, whose lifestyle is characterised by hard and systematic physical practice exposing them to a higher risk of SCD in comparison with the general population.

The incidence of sports-related sudden death in general population is reported as 4.6 cases per million per year, with 6% of cases occurring in young competitive athletes.[4] Epidemiological analysis shows that rates of SCD in athletes are higher compared with non-athletes, with a relative risk of 2.5 of SCD in adolescents and sportsmen younger than 35 years.[5 6] Main causes of SCD in this category are hypertrophic cardiomyopathy, coronary arteries anomalies, aortic stenosis, Brugada syndrome, long QT syndrome and myocarditis.[7 8] Screening of athletes has been the subject of scientific attention in order to prevent such events, with a reduction of incidence of SCD from 4.19 to 0.87 per 100 000 young athletes per year,[9 10] but the still even the rare occurrence of SCD makes it necessary to offer an immediate resuscitation assistance during sport activity. Moreover, sudden deaths in athletes have been reported to be often refractory cardiac arrest (CA), non-responding to traditional advanced cardiovascular life support (ACLS) manoeuvres.[11–13]

Therefore, there is rising interest in the application of extracorporeal life support (ECLS) that could offer improved outcomes in case of OHCA refractory to standard resuscitation protocols. We turned this interest into a real model, creating a multidisciplinary ECLS team for OHCA during the Volleyball Men's World Championship Final Six, 2018, organised in Turin, Italy.

EVENT CHARACTERISTICS

Volleyball Men's World Championship Final Six were held in Turin, Italy, from 26 September to 30 September 2018, involving six teams, 78 athletes and more than 400 staff members. The event was held at the *PalaAlpitour* in Turin, a structure with a capacity of about 15 000 people. During the 5-day competition, 10 matches were held, with an average of 12 500 spectators per day (figure 1).

ORGANISATION OF THE EMERGENCY RESPONSE

Preparation for the event included the optimisation of every link of the chain of survival and the availability of an adequate number of resuscitation teams able to perform early cardiopulmonary resuscitation and defibrillation. However, it was our opinion that given the high number of expected spectators and the presence of many young athletes exposed to a highly competitive and vigorous physical activity, with consequent high risk of SCD, in addition to the standard resuscitative technology

Figure 1 PalaAlpitour stands.

usually provided by ACLS teams, the event mandated the availability of the best extracorporeal techniques at the site itself.

Emergency medical services (EMS) in Turin, Italy, are made up of healthcare personnel and volunteers trained respectively in ACLS and basic life support and defibrillation. To implement this pilot protocol for out-of-hospital ECLS assistance during competitive sport events, it was mandatory to support traditional EMS teams with staff experienced in routinely practising ECLS during in-hospital activity. A multidisciplinary health assistance team trained to practice ECLS directly in situ and rapidly transport patients to the referral hospital was assembled. This team was composed of cardiac anaesthesiologists, cardiac surgeons, cardiovascular perfusionists and highly skilled nurses who normally work in cardiosurgical intensive care unit (ICU) and operating room. All members of ECLS teams were hospital-based specialists of 'Città della Salute e della Scienza University Hospital' and 'Mauriziano Hospital' of Turin, Italy, with notable expertise in ECLS in ED, cardiac intensive care unit and cardiac surgery. Each member of ECLS team, firmly believing in the goodness of the initiative, participated on a voluntary basis to the initiative which, in its practical implementation, did not make it necessary to remove any human or technological resources from its normal use.

A total of 12 'health teams' per day were organised as follows:

- Two ECLS teams provided support for athletes, staff and referees in the field as well as viewers in the ground floor stand. The teams were made up of a cardiac anaesthesiologist, a cardiac surgeon, a perfusionist, a nurse and two volunteers. The team was equipped with a biphasic manual defibrillator pacing, an automatic chest compression device and appropriate devices to safely and quickly mobilise victims of CA or other injuries to the ECLS room.
- Ten stand teams provided initial assistance over ten preidentified sectors of the stadium. Each team was composed of three members: a physician (anesthesiologist, sport medicine physician or an anaesthesiology/ICU fellow), a nurse and a volunteer equipped with a biphasic manual defibrillator pacing and an emergency backpack with everything needed to perform ACLS until the arrival of the ECLS team.

All health team members were connected by radio with other teams, the 'event healthcare manager', the territorial emergency system and the event organisation and security staff.

Members of the teams trained using simulations of scenarios of ECLS in situ at *PalaAlpitour*. This allowed adaptation to the structure and to optimise time of intervention and communication with other teams.

ECLS ROOM

In order to provide the most extended and the fastest life support assistance to viewers and players, the arena-like structure of *PalaAlpitour* was analysed to identify the optimal place to set up the 'ECLS Room' and the best pathways in and out of it (figure 2).

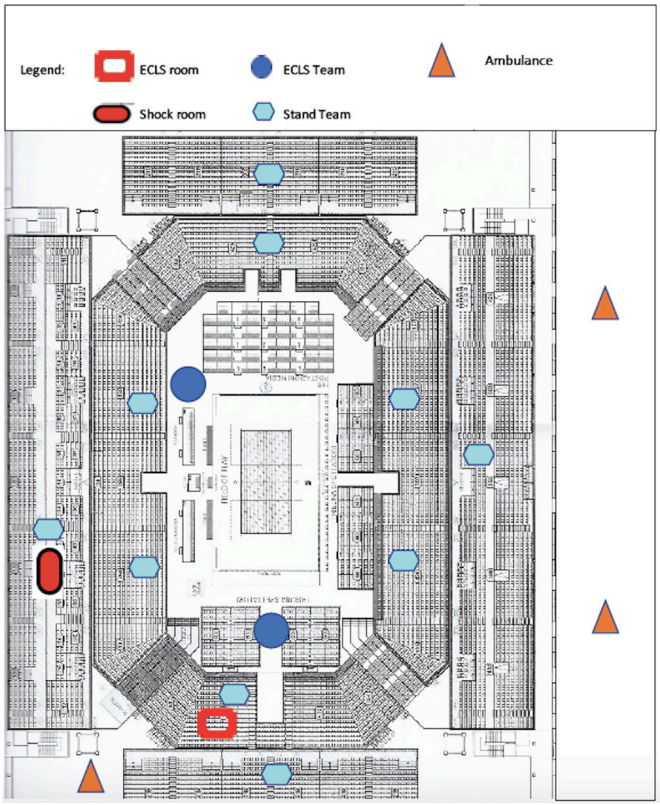

Figure 2 Planimetry of PalaAlpitour. ECLS, extracorporeal life support.

The ECLS room was equipped with a mechanical ventilator, a cardiac ultrasound machine, a suction unit, 10 infusion pumps, a blood gas analyser, an activated clotting time (ACT) analyser and everything needed to rapidly cannulate and connect patients to the ECLS machine (figure 3). Two ambulances equipped for ECLS transport were positioned near the primary ECLS room. A second smaller shock room was set up in the stands to assist any non-critically ill patients or as a backup in case of primary ECLS room already occupied.

CA PROTOCOL

In case of any acute event, the nearest health team would respond to perform the first evaluation. If the case was a CA, they would initiate ACLS and alert the two ECLS teams by radio (figure 4).

While the first ECLS team was preparing for ECLS implantation in the ECLS room, the second ECLS team would go to the site of the arrest and assist the first team providing bag

Figure 3 ECLS room. ECLS, extracorporeal life support.

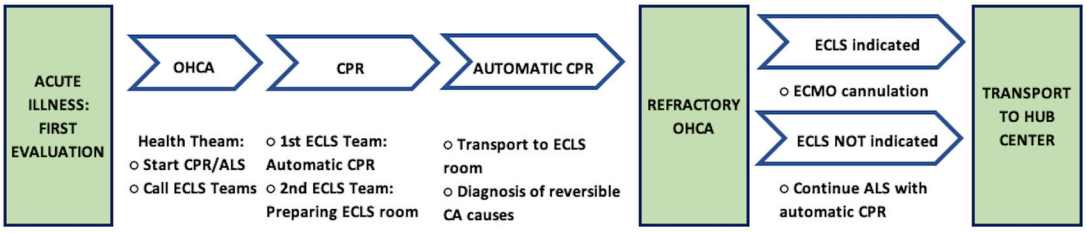

Figure 4 ECLS protocol. CA, cardiac arrest; ECLS, extracorporeal life support; OHCA, out-of-hospital cardiac arrest.

mask ventilation, heart rhythm analysis, immediate defibrillation if needed and closed chest massage until an automatic chest compression device was positioned. The aim of this stage of resuscitation is to quickly start ACLS with early defibrillation, if indicated, and rapidly transporting the victim to the ECLS room, where further invasive manoeuvres would be performed.

Once in the ECLS room, the anaesthesiologist would secure the airway through endotracheal intubation, institute invasive BP monitoring and peripheral and central venous lines. A second level evaluation to identify reversible causes of CA would be performed using transthoracic echocardiography and blood gas analysis.

After 10 min of ACLS without ROSC, the team would start ECLS manoeuvres.[14] Cardiac surgeons from both ECLS teams would proceed with peripheral cannulation, surgically positioning a 19–23 French cannula in femoral artery and a 15–23 French cannula in femoral vein. Correct cannulation would be guided by cardiac anaesthesiologist using transoesophageal echocardiography (TEE). In case of TEE evidence of aortic dissection, cardiac surgeons would proceed with surgical cannulation of right axillary artery and femoral vein. After cannulation, the perfusionist would start ECLS with appropriate setting. Patients would receive an initial unfranctioned heparin bolus of 100 units per kg body weight at the time of cannulation and then as continuous infusion to achieve an ACT range of 180–220 s.[15]

During ECLS, the 'event healthcare manager' would contact the territorial emergency system to activate the hub centre to receive the patient, alerting cardiac catheterisation lab staff, imaging staff and theatres.

After ECLS positioning, the victim would be moved to the ECLS ambulance, with the cardiac anaesthesiologist and surgeon, the perfusionist and the nurse, and rapidly transported to the referral hospital. Here, hospital staff would receive the patient, determining aetiology of CA by total body CT and coronary angiography if recommended by a cardiologist. The ECLS team would return to *PalaAlpitour* without participating in the hospital evaluation.

Contraindications for ECLS were known contraindications to therapeutic-dose anticoagulation, for example, active bleeding or certain recent major surgeries, and severe aortic regurgitation.[16]

In case of contraindications to ECLS, or in case of ROSC within 10 min of ACLS, the team would rapidly transport the patient to the hospital for administration of postresuscitation care.

DISCUSSION

During 5 days of competition, no CA occurred among athletes or among spectators. Nevertheless, high incidence of SCD in athletes despite actual prevention programmes, frequent cases of OHCA among common spectators and the rapid evolution of resuscitation techniques using mechanical circulatory support give us the belief that current ACLS protocols no longer represent the best standard of care in sporting events with high competitivity levels and with a notable public appeal.

Increasing use of early ECLS technique for OHCA is an important evolution of last decade, adding to our resuscitation strategies in the case of refractory CA. The results of several studies, which show survival improvement with a good neurological outcome, can no longer be ignored.[17–20] However, a model of ECLS assistance available directly on site at highly competitive sport events with large attendance has never been reported in literature.

Nevertheless, an advanced model of ECLS assistance is a time-consuming and resource-consuming approach to OHCA, whose application requires important medical expertise with a consequent high economic cost.[21 22] The organisational model is very complex, requiring a strong trainee period for personnel involved, with simulations directly in situ, and a perfect synchrony with territorial emergency system to rapidly transport patients to referral hospitals to continue diagnosis and therapies.

The success of such an ambitious programme requires the collaboration of a multidisciplinary team, able to guarantee the best expertise during each resuscitation phase. To date, the optimal team composition for ECLS for OHCA has not been characterised. A survey conducted on performance of ECLS in USA showed that nearly all programmes involve cardiac surgeons, perfusionists and emergency physicians.[23] In our local practice, the task of managing ACLS and ECLS is under the responsibility of anaesthesiologists, but the same role can be performed by other physicians, for example, emergency physicians, given adequate training and expertise in ECLS techniques.

In conclusion, we believe that that despite high economic cost and skills required for ECLS, events such as the Volleyball World Championships, with high level of competition and large

Table 1 Personnel involved

Personnel			
	Role	**Involved per day**	**Hours of assistance per day**
Cardiac anaesthesiologists	Leader of ECLS teams	2	10
Cardiac surgeons	ECMO cannulation	2	10
Sport medicine physicians	Event healthcare manager	1	10
Anaesthesiology/ICU fellows	Leader of stand teams	10	10
Perfusionists	ECMO management	2	10
Nurses	Assistance during ACLS and ECLS	4	10
Volunteers	Help for ECLS teams or stand teams	24	10

ACLS, advanced cardiovascular life support; ECLS, extracorporeal life support; ECMO, Extracorporeal Membrane Oxygenation; ICU, intensive care unit.

public appeal, justify the taking the opportunity to supplement standard resuscitation strategies with the application of ECLS at the scene, improving survival and neurological outcomes. With more sporting events including this in their preparation, ideas for overcoming logistical difficulties and improving safety would emerge.

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