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Advanced cardiac life support in out-of-hospital cardiac arrest: A case study

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Abstract

Background: Public Health Center (PHC), especially in rural areas, is one of the primary healthcare facilities that have an important role in the chain of survival of out-of-hospital cardiac arrest (OHCA) patients. Despite of limited facilities, prehospital resuscitation can be performed by optimizing the available emergency facilities and infrastructure.
Purpose: To provide a comprehensive overview of the resuscitation management of OHCA patients at a PHC in East Java Province in Indonesia.
Method: Case study of a 43-year-old woman who was brought to PHC by residents after suddenly losing consciousness while working. The clinical condition when the patient arrived was unresponsive, no pulse, no respiratory effort, cold extremities, and oxygen saturation of 80%, the patient was medically diagnosed as OHCA.
Results: Resuscitation organization was carried out by involving 1 doctor, 2 nurses, and 1 midwife. The patient was given basic life support (BLS) and Advanced Cardiac Life Support (ACLS) by optimizing diagnostic tools, airway, breathing, circulation, and available drugs. The patient successfully Return of Spontaneous Circulation (ROSC) after the third cycle and successfully reached the referral hospital to receive further life support.
Conclusion: ACLS in the prehospital setting at PHC in Indonesia has a potential to be performed. Inter-professional collaboration, airway, breathing, and circulation optimization in providing BLS and ACLS on OHCA patients can increase the patient's chance of getting further care in the hospital.

Keywords: Advanced Cardiac Life Support (ACLS); Basic Life Support (BLS); Out-of Hospital Cardiac Arrest (OHCA); Public Health Center (PHC).

INTRODUCTION

The cardiovascular death rate in Asian countries is relatively high (Damasceno, 2016). This causes the incidence of Out-of Hospital Cardiac Arrest (OHCA) to also be high (Myat, Song, & Rea, 2018). As many as 79.2% of cardiac arrests occurred at home with a low survival rate (Zheng, Lv, Zheng, Zhang, Tan, Ma, & Xu, 2023). The World Health Organization (WHO) reports smoking habits, the number of obesities, and an increase in blood pressure that tends to increase every year (Kaptoge, Pennells, De Bacquer, Cooney, Kavousi, Stevens, & Di Angelantonio, 2019). This shows that the possibility of cardiac emergencies such as OHCA is quite high with a low survival rate (Onabanjo, Adeyeye, Akodu, Adaramola, & Popoola, 2023). Adequate and immediate life support in OHCA is the

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key to successful resuscitation (Forouzan, Verki, Khabazipour, & Ahmadi, 2018). The life support provided in the prehospital, especially in Indonesia, is not yet optimal and can still be further optimized (Prakash, Yadav, & Baghel, 2022; Rajeswaran, Cox, Moeng, & Tsima, 2018).

Providing life support to OHCA victims in the prehospital relies on Basic Life Support (BLS) (Olasveengen, Mancini, Perkins, Avis, Brooks, Castrén, & Morley, 2020). In many developing countries, Indonesia being one of them, the BLS implemented is still not optimal. The unavailability of an Automated External Defibrillator (AED) in public facilities and prehospital health services such as the Public Health Center (PHC) is one of the challenges faced. However, the emergency equipment and drugs available at PHC can be optimized to provide both BLS and Advanced Cardiac Life Support (ACLS) to OHCA patients. The implementation of resuscitation from the prehospital phase to the provision of ACLS in Indonesia has not been widely reported.

We report a case of OHCA in a PHC administered BLS and ACLS. Resuscitation efforts are carried out by optimizing existing facilities and infrastructure at the PHC. The resuscitation process involves existing doctors, nurses and midwives. In this study we discuss each step taken and describe the roles of the personnel involved. We hope that this case study will encourage other PHC or other prehospital health facilities to optimize the management of OHCA patients.

RESEARCH METHOD

This research is a case study that focuses on the management of OHCA patients who come to a PHC in Malang, East Java Province, Indonesia. The subject was a 43 year old woman who was brought by her family to our PHC after suddenly becoming unconscious while activity 10 minutes earlier. The patient weighs around 100 kg, but the family said that the patient had never suffered from a serious illness or complained of chest pain and tightness. Since 2 days ago the patient complained of feeling uncomfortable in the pit of the stomach (epigastrium).

When arrived, the patient did not respond to sound or pain stimuli. Her carotid pulse was not palpable, no visible effort of breathe, the acral cold with oxygen saturation (SpO2) of 80%. BLS, continued with ACLS, and transfer to hospital are carried out by using available medical facilities. Some medical tool such as ECG, pulse oximetry, blood sugar checking equipment, manual suction, and Bag Valve Mask (BVM) are used. As well as emergency drugs, such as adrenaline, 0.9% NaCl, intravenous catheters and Foley catheters. In this case, collaboration with various health workers at the PHC also carried out. A Doctor, two nurses, and a midwife are involved in resuscitation organization. Airway, breathing, and circulation optimisation were done to increase the OHCA patient's outcome.

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RESEARCH RESULTS

Table 1. Characteristics of the subject

Variable	Value/note
Biodata	
Age (year)	43
Gender	Female
Occupation	Peddler in traditional markets
Education	Elementary school
Medical diagnosis	Out-of-hospital cardiac arrest (OHCA)
Physical examination	
Consciousness	Unresponsive
Pulse (carotid)	Not palpable
Respiratory rate	No sign of breathing effort
SpO2 (%)	80
Height (cm)	150
Weight (kg)	100

Table 1 describes the patient's demographic data, namely a 43 year old woman, has a primary school education, and works as a trader in a traditional market. Clinical condition upon arrival, unresponsive to stimulation, carotid pulse was not palpable, no visible respiratory effort and SpO2 80%. The patient has an overweight physique with a body weight of around 100 kg and a height of 150 cm. The patient was diagnosed as Out-of Hospital Cardiac Arrest (OHCA).

Table 2. Resuscitation management of the OHCA case

Resuscycle	Subjective	Objective	Assessment	Planning
PREHOSPITAL PHASE				
0	Sudden unconsciousness	No response No pulse RR: - BP: - SpO2: 80%	OHCA	• Chest compression → CPR 30:2 • Head tilt chin lift maneuver • ECG • Blood sugar test
I	The patient is still not responding	No response No pulse RR: - BP: - SpO2: 96% (on BVM) ECG: asystole GDA 124 mg/dL	OHCA (non-shockable rhythm)	• Continue CPR 30:2 • Head tilt maneuver • Insert iv line → loading 250 cc 0,9% • Epinefrin 1 mg (iv) every 3 minutes→ administered first Epinephrine • Evaluation every 2 minutes (1 cycle)

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Resuscycle	Subjective	Objective	Assessment	Planning
II	The patient is still not responding	No response No pulse RR: - BP: - SpO2: 98% (on BVM) ECG: asystole	OHCA (non-shockable rhythm)	• Continue CPR 30:2 • Head tilt maneuver • Epinephrin 1 mg (iv) every 3-5 minutes • Evaluation every 2 minutes (1 cycle)
III	The patient is still not responding	*Vital sign:* No response No pulse RR: - BP: - SpO2: 98% (on BVM) ECG: asystole	OHCA (non-shockable rhythm)	• RJP 30:2 • Head tilt maneuver • Epinephrin 1 mg (iv) every 3-5 minutes → administer second epinephrin • Evaluation every 2 minutes (1 cycle)
End of siklus III	The patient is still not responding	*Vital sign:* No response Pulse: palpable RR: 8x/minute, shallow BP: 60/palpation SpO2: 98% (on BVM) ECG: sinus bradycardia (HR: 42x/minute)	Return of Spontaneous Circulation (ROSC)	• Stop CPR • Airway: Head tilt manuver, suction • Breathing: assisted with BVM • Circulation: add 250 cc of NaCl 0,9% • Transfer for post-cardiac arrest care • Education to the patient's family → get informed consent • Insert a Foley catheter • Coordination wth ambulance driver. • Medical communication with the destination hospital
INHOSPITAL PHASE				
Handover	The patient is still not responding	*Vital sign:* GCS E1V1M1 Pulse: palpable Heart rate 40x/minute RR: 8x/minute → 20x/minute (assisted with BVM) BP: 60/palpation SpO2: 99% (on BVM)	Post cardiac arrest	Post cardiac arrest care ECG 12 lead sinus bradycardia with ST elevation in II, III, AVF

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In table 2 can be seen the actions taken from the time when the patient arrived at the PHC until the patient was admitted to the referral hospital. Resuscitation efforts were carried out involving 2 nurses doing chest compressions, 1 midwife as a circular, and 1 doctor as a leader and controlling the patient's airway and breathing.

Initial resuscitation efforts were performed by performing chest compressions while preparing resuscitation equipment. The action was continued with 30 chest compressions and 2 ventilations by nurses and doctors. Because an oropharyngeal airway was not available, airway optimization was performed with a head tilt maneuver by adding a pillow under the patient's upper back. The chin lift maneuver was performed when the patient first arrived while preparing the BVM. After the BVM was ready, breathing efforts were assisted using the BVM by providing ventilation of 600-800 cc (half the volume of an adult BVM) each ventilation.

One midwife installed the Electrocardiogram (ECG) device, checked blood sugar levels, inserted an intravenous line and load 0.9% NaCl 250 cc. After the ECG was installed, an asystole rhythm was obtained, and random blood sugar levels were found to be 124 mg/dL. Resuscitation efforts were continued by performing 30 compressions 2 ventilations and 1 mg intravenous adrenaline every 3 minutes.

After the first cycle of resuscitation, the ECG was still asystolic, so resuscitation efforts were continued. Until the end of the third cycle after the second intravenous administration of 1 mg adrenaline, a sinus bradycardia heart rhythm was obtained with a heart rate of around 40 times per minute. Chest compressions were stopped and vital signs were measured. It was found that consciousness was still unresponsive, the pulse was weak palpable, the heart rate was 42 times per minute, shallow breathing 8 times per minute, blood pressure 60 per palpation, and SpO2 99% (on BVM with 100% oxygen).

Efforts to optimize the airway were made by removing fluid with manual suction and head tilt chin lift maneuvers. The patient's breathing efforts were assisted by providing rescue breathing, namely by adding 1 additional ventilation for every 1 spontaneous breath of the patient of around 600-800 cc (half the volume of BVM). Efforts to optimize circulation were made by provide additional loading of 250 cc of NaCl 0.9%, and insert a Foley catheter to monitor urine production. We use the ECG to monitor the patient's heart rhythm, and pulse oxymetry to monitor the patient's SpO2 and pulse.

We immediately prepared a referral for post-cardiac arrest care at an adequate hospital (which has an emergency specialist consultant and has an Intensive Care Unit) which is around 20 km away. The midwife provided education to the family and asked for informed consent, the doctor conducted medical communication with the Emergency Room of the intended hospital and made a referral letter, while two nurses prepared the patient, equipment and medicine and carried out monitoring.

As soon as the family agreed to the referral process, we transferred the patient into an ambulance. Two nurses accompanied the patient. ECG, pulse oxymetry, and tensiometer were used for monitoring during the transfer process.

Transportation took about 25 minutes. The patient had a cardiac arrest during the trip and was given 1 cycle of 30:2 CPR and the pulse was palpable again with a picture of sinus bradycardia rhythm. Upon arrival at the destination hospital's emergency room, vital signs were GCS E1V1M1, the pulse was weak with a heart rate of 40 beats per minute, SpO2 98% (on BVM), blood pressure 60 per palpation, and a 12-lead ECG picture was interpreted as Acute Myocardial Infarction in the inferior part of the heart. The patient treated in the intensive care unit, but died a day later.

DISCUSSION

Unlike countries that have developed a comprehensive emergency system, in Indonesia the limited facilities, equipment, and medicines in primary health care in the prehospital are still a challenge. In this case study, we report a case of OHCA at a PHC and received ALS actions that adjusted to PHC availability. In this case, we used

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the BLS and ACLS algorithms from the American Heart Association (Olasveengen et al., 2020). The involved nurses and midwife were BLS certified, while the involved doctor was ACLS certified.

According to the BLS algorithm, when finding someone with no pulse, immediately perform 30 chest compressions with 2 ventilations. In this study case, when the patient first arrives, the officers perform chest compressions, head tilt chin lift maneuvers, and provide ventilation using BVM. This is in accordance with the recommendations of the AHA and the International Consensus on Cardiopulmonary Resuscitation to perform chest compressions immediately after finding a patient with no pulse (Olasveengen et al., 2020). In this case study, two nurses took turns performing chest compressions every 2 minutes (1 resuscitation cycle) to maintain the quality of the compressions given. This is different from the results of a study stating that rotation every 1 minute can reduce fatigue in rescuers (Mathew, Kundra, & Vinayagam, 2024). In the other side, rotation every 2 minutes is the recommendation of the AHA to minimize interruptions during the resuscitation process. AHA recommend rotation at the end of each cycle along with the patient evaluation (Olasveengen et al., 2020). In addition, it is also to make the resuscitation organization more effective with 2 chest compression providers.

After knowing the patient's cardiac arrest rhythm is asystole (non-shockable), the officer follows the ACLS algorithm for non-shockable cardiac rhythm, namely administering epinephrine every 3-5 minutes intravenously. Immediate administration of emergency medication to cardiac arrest patients can improve patient outcomes (Hooper, Nolan, Rees, Walker, Perkins, & Couper, 2022). If the intravenous route is unsuccessful, the rescuer can administer medication through the intraosseous route (Tan, Chin, Koh, Said, Rahmat, Fook-Chong, & Ong, 2021).

AHA also recommended to consider an advanced airway (Olasveengen et al., 2020). An advanced airway can be in the form of an endotracheal tube or the use of a supraglottic airway. Generally, PHC are not equipped with advanced airway tools and medication. However, this does not prevent optimal airway and breathing assistance provided to the patients with the available equipment. A study stated that the use of BVM was not inferior to endotracheal tube intubation in the prehospital in increasing the 28-day survival rate of patients (Carney, Totten, Cheney, Jungbauer, Neth, Weeks, & Daya, 2021). PHCs are generally not equipped with simple airway devices such as an oropharyngeal airway (OPA) to prevent the tongue from blocking the airway. Several airway maneuvers suggested in BLS and ACLS are very useful and can be applied in this case. This maneuver is done by pressing the patient's forehead and pulling the chin until the head is tilted up like someone is about to sneeze (sniffing position). However, this maneuver is not allowed in cases of trauma with suspected cervical spine injury. In this case, the patient is known to have no history of injury before becoming unconscious, so this maneuver can be given (Tintinalli, Stapczynski, Ma, Yealy, Meckler, & Cline, 2016).

The patient in this case is an overweight person, it is difficult to do this maneuver alone, so a block/padding can be given on the upper back to help maintain the position (Tintinalli et al., 2016). Another efforts to optimize the airway can use manual suction which is also available at PHC to remove fluid from the airway.

Not all breathing devices are available in PHC. BVM is one of the breathing devices that is generally available in PHC. Although the guidelines recommend advanced airway, several studies have reported that the use of BVM is not inferior to the use of endotracheal intubation (Beydilli, İlhanKorkmaz, Güngör, Kırpat, Kozacı, Avcı, & Atik, 2020; Carney et al., 2021). In addition, to decide to use advanced airway in the prehospital setting, various things must be prepared for patient safety (Davis, Bosson, Guyette, Wolfe, Bobrow, Olvera, & Levy, 2022).

The technique of providing ventilation in the prehospital has received little attention. Some health workers, especially in the prehospital, assume that providing more ventilation will be better for the patient. In fact, providing excessive tidal volume can

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be dangerous for the patient, because it can cause the alveoli to rupture and cause pneumothorax which actually causes complications in the patient (Merrell, Scott, Stambro, Boukai, & Cooper, 2023). The tidal volume required is 6-8 cc/kg body weight. If the patient's weight is around 100 kg, like the subject in this case study, then the patient needs a tidal volume of 600-800 cc for each ventilation (Tintinalli et al., 2016). The volume of the adult BVM self-inflating bag is generally 1500 cc, so it is sufficient to press it about half the bag to enter the appropriate tidal volume. Excessive oxygen delivery has also been reported to be associated with poor neurological outcomes in survivors (Henlin, Michalek, Tyll, Hinds, & Dobias, 2014).

ECG is an important tool for implementing ACLS in the Health Center. By knowing the heart rhythm in cardiac arrest patients, officers can take the next steps that must be taken according to the ACLS algorithm. Unlike AED, the use of manual ECG requires health workers who can interpret ECG images and understand the ACLS flow. Checking blood sugar levels in all patients who come with delirium is an important protocol. This is to rule out causes of decreased consciousness that can be immediately corrected due to hypoglycemia. Emergency drugs available at PHC can be used to optimize circulation in cardiac arrest. These medications include IV catheters, Foley catheters, 1 mg epinephrine injection, and resuscitation fluids such as 0.9% NaCl.

One of the important actions to be able to administer drugs is to find access. Intravenous access is the most common route for administering resuscitation drugs. When inserting an intravenous line, it is recommended to use a large needle (G 16-G 20) and in a large vein at (least in the cubital area (Tintinalli et al., 2016). This is because most of resucitation drugs are irritating blood vessels. So that patent venous access can facilitate the process of administering drugs. Small access is prone to blockage and can inhibit the resuscitation process. However, one in nine critical patients is reported to have difficult venous access (Fields, Piela, Au, & Ku, 2014). In that situation, intraosseous access can be an alternative recommendation access (Feinstein, Stubbs, Rea, & Kudenchuk, 2017; Hooper et al., 2022). According to the OHCA chain of survival, the next chain after ALS is post cardiac arrest care. Patients then referred to adequate hospitals for further treatment. Before making a referral, medical communication with the destination hospital to ensure the availability of the necessary facilities and infrastructure (Jentzer, Clements, Murphy, & Wright, 2017; Jentzer, Herrmann, Prasad, Barsness, & Bell, 2019).

CONCLUSION

It can be concluded that ACLS has the potential to be performed at PHC. Inter-professional collaboration, airway, breathing, and circulation optimization in providing BLS and ACLS on OHCA patients can increase the patient's chance of getting further care in the hospital. This case study is expected to encourage other PHCs to optimize resuscitation efforts for OHCA patients.

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