ABSTRACT

Background: Heart disease is the main cause of death in the world. CPR is an action that can be done as a first aid in cardiac arrest patients. The aim of this literature review is to compare the effectiveness of the use of mechanical CPR (LUCAS) and manual CPR in cardiac arrest patients. Methods: This literature review using thematic analysis: simplified approach. Searching data process is done through three databases EBSCO, PUBMED and Proquest using keywords which have determine with inclusion and exclusion criteria and by do critical appraisal on articles. Results: From the 2,066 full text articles, six articles required the inclusion. After coding process, there are five categories of theme: CPR delivered in transportation, rescuer fatigue, time efficiency, minimal interruptions and return of spontaneous circulation. Main findings explained the answer of literature review questions which are the advantages and disadvantages of mechanical CPR and manual CPR, the results on patient who can survive as well as the impact of using both. Conclusion: There are differences in good quality of the effectiveness between mechanical CPR and manual CPR given by reviewing the accuracy of correct CPR based on the guidelines and return of spontaneous circulation in cardiac arrest patients.

Keywords: manual CPR, mechanical CPR (LUCAS), cardiac arrest.

Introduction

Heart disease is the leading cause of death in the world (AHA, 2014). In the United States, the incidence of cardiac arrest outside the hospital by 2014 was 424,000 with a survival rate of about 10.6% (AHA, 2014). The incidence of cardiac arrest in Indonesia reaches about 300,000-350,000 incidents annually (PERKI, 2015). Cardiac arrest is a sudden loss of cardiac function in a person who has or does not have a heart disease. Deaths in cases of cardiac arrest may occur within minutes after the heart stops.

Cardiac arrest can be resolved by early cardiopulmonary resuscitation and early defibrillation to restore of normal heart rhythm. Cardiopulmonary resuscitation (CPR) is a part of basic life support (BLS). The steps of BLS begins with chest compression, opening the airway, and give effective breaths as called C-A-B (Compression-Airway-Breathing). Chest compression is in the first step because through the chest compression will produce blood flow, especially adding intrathoracic pressure and oxygen delivery which is essential to the heart and brain (AHA, 2015).

The chain of life has tight relationship with CPR. A victim who survived by CPR has a bigger chance to restore the life than those who do not get CPR (Berg et.al, 2010). CPR must be given with high quality chest compression in right rate and depth, allow complete chest recoil, minimize
interruptions, and avoid excessive ventilation. The main success of giving CPR is the return of spontaneous circulation with palpable of pulse carotid and measurable of blood pressure (Salcido et al, 2010). Rescuer begins CPR with 30 times of chest compression with a rate of 100-120/min and a depth of 2-2.4 inches or 5-6 cm (AHA, 2015). After chest compression will continue with and using automatic or manual defibrillator as soon as possible if available.

The results according to Gianotto-Oliveira et al. (2015), a rescuer who performed manual CPR for 1 minute with 2 minutes has a significant difference of correlation with reducing the percentage of a depth of chest compression due to fatigue. The same study in evaluating a rescuer by doing manual CPR for 5 minutes can experience fatigue and significantly decrease in high quality of compression from minute to minute.

LUCAS is an automatic or mechanical CPR device developed to perform a high quality chest compression during the resuscitation process and to eliminate degradation of circulating quality resulting from a rescuer who continuous performed compression fatigue (Estock et al., 2016). The advantages of LUCAS devices are lighter weight than other mechanical chest compression devices, the procedure follows the instructions of the AHA, the longer lasting battery reaches 45 minutes and ensures the safety of the patient's arm (Pignataro, 2016). The disadvantage of this device is that there is no protection for the head when the patient is moved from the floor to the stretcher or the other way around, then LUCAS must stop briefly (pause) and pads should be placed outside the suction cup area (Pignataro, 2016).

The high incidents of cardiac arrest both in the world and in Indonesia should be balanced with increased cardiac arrest management by providing high quality CPR. Rescuer who is also a human with the limitations of physical ability into a consideration of mechanical CPR tools that can be used in order to achieve high quality CPR so that the survival rate of patients with cardiac arrest can also increase. This becomes the background of the need for a literature review on the comparison of the effectiveness between the use of mechanical CPR (LUCAS) and manual CPR in cardiac arrest patients so that it can be a reference in the treatment of cardiac arrest patients.

- **Method**

This literature review used systematic literature review approach. Database that used in this literature review were EBSCO, ProQuest and PubMed. The key words that used in this article searching for literature review were “mechanical chest compression”, “manual chest compression”, “LUCAS chest compression”, “manual CPR”, “mechanical CPR”, “LUCAS CPR”, “cardiac arrest”. In order to combine some of the key words in database, the Boolean operator that used in this review were AND, OR dan NOT.

The inclusion criterias include (1) participants in the article is human with age equal to or more than 10 years old that experience cardiac arrest and also study in manikins, (2) articles published in scientific journal in 2006 until 2016, (3) quantitative research methods, (4) English language, (5) full-text article, and (6) the article answer minimal one of the literature review. The exclusion criteria were study with animal participants.

The critical appraisal used the JBI Critical Appraisal for Experimental Studies sheets to choose the relevants articles, good quality for literature review (Queen's Joanna Briggs
Collaboration, 2015). This literature review was quantitative research using thematic analysis simplified approach.

- **Results**

The result of review in order to see the advantages and disadvantages of mechanical CPR and manual CPR using right accuracy CPR based on guidelines and the return of spontaneous circulation of the cardiac arrest patients. Result quality is seen from the number of the patient based on how long the survival of the patient and also the impact of the use of LUCAS and manual CPR in cardiac arrest patient.

Searching of the articles with the key words in database obtained results: EBSCO 589, PubMed 330 and ProQuest 16.686 articles, so the total number of articles was 17.605. After filter the articles by deleting the duplicates about 121 articles, so the result was 17.484 articles. The articles chose based on inclusion and exclusion criterias, so the final number of the articles was 6 articles. The next step is critical appraisal using the JBI Critical Appraisal for Experimental Studies sheet.

- **Discussion**

There are five categories of themes based on analysis: CPR during transportation, rescuer fatigue, time efficiency, minimal interruption and the return of spontaneous circulation.

1) CPR during transportation
CPR mechanical tool allows the CPR during transportation (in ambulance). Giving manual CPR is a difficult thing because it needs the more rescuers whereas the space of the vehicle is limited. AHA recommends the rescuer giving the CPR continuously until the return of spontaneous circulation of the patient. If a rescuer doing CPR continuously, that rescuer will experience fatigue that can decrease the quality of CPR, but switching rescuers in giving CPR also difficult because of the limited space in ambulance and can increase the hand-off-time. The rescuer security in giving CPR during transportation also be noticed because there is no safety belt for rescuer and also can cause the unexpected motion because of the condition of road. It can cause unstable hand positioning while doing manual CPR then it can decrease the quality of CPR. Doing CPR during transportation also influence the emotional and the concentration of the driver. This is proven by the review results that show the high number of ambulance accidents in year 1988 and 1997 in America that is more than 350 people become victims and 23,000 experience injuries (Fox et al., 2012). Mechanical CPR (LUCAS) able to giving CPR continuously automatically and if there any shock during transportation, LUCAS will be remain stable and constantly giving CPR.

2) Rescuer fatigue
Giving CPR continuously can result fatigue and will decrease the quality of CPR given because the quality of CPR depends on the endurance of the rescuer. High quality chest compression with right depth and rate, complete chest recoil and minimal interruption can increase the return of spontaneous circulation of the patient and patient survival post-cardiac arrest. Mechanical CPR can give high quality CPR continuously automatically without fatigue effect.

3) Time efficiency
Doing CPR while move the patient to ambulance can shorten the delay time. Short time is needed to increase the good neurological result for patient post-cardiac arrest. Mechanical CPR allows giving CPR while move the patient from the stretcher to the ambulance and then send to the
hospitals for the emergency care. Manual CPR can be also given but with longer time because the rescuer must doing CPR continuously until the return of spontaneous circulation so can be brought to the hospitals. Mechanical CPR (LUCAS) eases the rescuer in preparing the defibrillation and ventilation and also giving another care for that patient, so the time efficient and action effectiveness more assured.

4) Minimal interruption

Hand-off-time during switching rescuer on CPR can increase interruption; meanwhile the minimal interruption is the very important indication in giving high quality CPR. Minimal interruption can assure the sufficient cerebral perfusion and heart and also increase the quality of life post-cardiac arrest.

5) The return of spontaneous circulation

The rate of compression that more than more than 100 – 120 times per minute can cause the failure in achieve the return of spontaneous circulation in cardiac arrest patient. The return of spontaneous circulation in cardiac arrest patient is the important achievement in high quality CPR that marked by palpable carotid artery and measured blood pressure. Based on article review, the return of spontaneous circulation in cardiac arrest patient with mechanical CPR (LUCAS) has higher result than manual CPR.

The comparison between the effectiveness of mechanical CPR (LUCAS) and manual CPR reviewed from CPR right accuracy, the return of spontaneous circulation, survival time post-cardiac arrest and impact of mechanical CPR and manual CPR.

1) CPR right accuracy

AHA recognize that the main challenge in giving high quality CPR are inconsistent
CPR only 5 menit with the total number of CPR was 124 times per minute and right CPR only 75 times per minute with interruption 35% (Tranberg et al., 2015). So, from 2 articles can be found that mechanical CPR more effective in giving CPR according to AHA guidelines rather than manual CPR. Manual CPR can be effective if the rescuer does not experience fatigue (Barcala et al., 2014).

2) The return of spontaneous circulation
The main goal of giving CPR in the cardiac arrest patient is to return the spontaneous circulation of the patient and minimal impact to the neurological function of the patient. Some of the articles reviewed the effectiveness of mechanical CPR and manual CPR. The effectiveness of CPR equal to or more than 70% right CPR is considered as good CPR indicator (Barcala et al., 2014). The return of spontaneous circulation is the success of CPR in cardiac arrest patient in order to survive. The result of the first article review in using mechanical CPR (LUCAS) and manual CPR shows that the return of spontaneous circulation manual of the post-cardiac arrest patient was 52 from 1,652 patients (32%) in mechanical CPR and 855 from 2,819 patients (31%) in manual CPR (Perkins et al., 2015). The third article shows the result of using mechanical CPR was 72 out of 216 patients (33,3%) and in manual CPR was 51 from 188 patients (27,1%) (Lin et al, 2015). Those reviews show that the usage of mechanical CPR (LUCAS) more effective in returning the spontaneous circulation rather than manual CPR.

3) Survival post-cardiac arrest
Survival of the patient post-cardiac arrest is influenced by many factors, either in post-cardiac arrest nursing care or the CPR as the first aid when cardiac arrest happened. The first article review the usage the mechanical CPR and manual CPR shows that 45 from 196 patients (29%) can survive during hospitalisation and 14 from 196 patients (9%) can survive after hospital discharge. In the mechanical CPR the patient survive with coronary angiography was six (86%), with percutaneous coronary intervention was one (14%), with the therapeutic hypothermia was one (14%), with the cardiopulmonary support was two (29%) whereas in manual CPR survival of the patient with coronary angiography was 25 (56%), with the percutaneous coronary intervention was seven (16%), with the therapeutic hypothermia was 26 (58%) and with the cardiopulmonary support was 0% (0), but after 30 days the patient that can survive was two patient with the cardiopulmonary support in the usage of CPR LUCAS (Tranberg et al., 2015). The second article from Perkins et al., (2015), shows the patient can survive after one day with mechanical CPR was 377 from 1,652 patients (23%), after 30 days was 104 (6%), after 3 months was 96 (6%), and after 12 months was 89 (5%) whereas in manual CPR, after one day of cardiac arrest was 885 from 2,819 patients (31%), after 30 days was 193 (7%), after 3 months was 182 (6%), and after 12 months was 175 (6%). Those studies using the ratio of mechanical CPR mekanikal and manual CPR was 2 : 1, so the total results show that there is no difference between the result of using mechanical CPR and manual CPR. The third article from Rubertsson et al., (2014) shows the quality of the patient post-cardiac arrest can survive after four hours with mechanical CPR was 307 from 1,300 patient (23,6%), after ICU discharge was 158 (8,1%), after hospitals discharge was 117 (9 %), after one month was 105 (8,1%) and after six months was 111 (8,5%) whereas in manual CPR, the
patient post-cardiac arrest can survive after four hours was 305 from 1289 patients (23.7%), after ICU discharge was 153 (11.9%), after hospitals discharge was 118 (9.2 %), after one month was 109 (8.5%) and after six months was 104 (8.1%). Fourth article review from Lin et al., (2015) show the results in patient post-cardiac arrest with mechanical CPR can survive after hospitals discharge was 48 from 216 patients (22.2%) and with manual CPR was 33 from 188 patients (17.6%). This result shows that there is no significant difference between the result of either mechanical CPR or manual CPR.

4) The impact of the usage of mechanical CPR and manual CPR.
The article review shows that there is the impact after using the mechanical CPR and manual CPR in patient post-cardiac arrest. In mechanical CPR, there was 7 cases include: respiratory tract bleeding, ruptured spleen, pneumothorax, fracture of vertebral thoracal, chest trauma, and abdominal distention. Whereas in manual CPR there was three cases include: abdominal aorta aneurysm, chest trauma and pneumothorax (Rubertsson et al., 2014). Other article shows that in mechanical CPR usage there was seven cases includes three cases of chest injury, two cases of chest wound and two cases of mouth bleeding, but in manual CPR there was no serious impact reported (Perkins et al., 2015). Review result show that there are impacts in using of mechanical CPR and manual CPR but those impacts were not fatal cases. Those impacts can be addressed when the patient in nursing care.

• Conclusion
There are five categories of big themes to answer the comparison of the effectiveness between mechanical CPR and manual CPR in cardiac arrest patient include: CPR during transportation, the rescuer fatigue, time efficiency, minimal interruption and the return of spontaneous circulation. Review articels show that there are differences in effectiveness between using the mechanical CPR and manual CPR in cardiac arrest patients. The difference is that mechanical CPR more effective than manual CPR. These can be reviewed from the right accuracy CPR according to guidelines and the return of spontaneous circulation of the cardiac arrest patients. But, from the survival rate data and the impact for the patient post-cardiac arrest show that there are no significant differences.

References
Barcala, F. R., Abelairas, G. C., Queiroga, A. C., & García, S. J. L. (2014). CPR quality reduced due to physical fatigue after a


