

[Research Paper]

119구급대에 의한 병원 전 임신부 심장정지 소생환자 1례

이재민 · 홍수미* · 안국기** · 윤형완***†

광주보건대학교 응급구조과 교수, *전주비전대학교 보건행정학과 교수, **전주완산소방서 구급대원,
***전주비전대학교 응급구조과 교수

Out-of-Hospital Cardiac Arrest Response to a Pregnant Woman by the 119 Emergency Medical Service System: A Case Study

Jae-Min Lee · Soo-Mi Hong* · Guk-Ki An** · Hyeong-Wan Yun***†

Professor, Department of Emergency Medical Technology, Gwangju Health University,

*Professor, Department of Healthcare Management, Vision College of Jeonju,

**paramedic, Jeonju Wansan Fire Station,

***Professor, Department of Emergency Medical Technology, Vision College of Jeonju

(Received December 2, 2019; Revised December 10, 2019; Accepted December 12, 2019)

요 약

임신부에서 심정지가 발생하였을 때, 가장 중요한 것은 임신부를 소생시키는 것이다. 임신부에서의 심정지는 산모와 태아를 동시에 고려해야 한다는 점 때문에 일반적인 심정지와 다른 부분이 있다. 임신부 심정지 환자에서는 태아를 분만해야 하는지를 결정하는 것은 산모와 태아 모두를 위하여 매우 중요하다. 심폐소생술이 수행되더라도 임신부 심정지 환자가 모두 소생되는 것은 아니며, 얼마나 신속하고 정확하게 심폐소생술이 시행되었느냐에 따라 환자의 생존율이 결정된다. 임신부 심정지 환자는 30세 목격당시 보호자에 의한 빠른 인지와 신속한 신고 및 목격자 심폐소생술이 이루어져 졌으며 119구급대에 의한 전문소생술이 적용되었고, 환자와 태아 모두 적절한 치료 후 6일 만에 건강하게 퇴원한 사례이다. 병원 전 단계에서 임신부 환자가 자발순환회복(Return of spontaneous circulation, ROSC)되어 이송하는 경우와 전문심장구조술을 시행 하는 경우는 매우 드물다. 임신부 심정지가 발생하여 목격자에 의한 심폐소생술과 119구급대원에 의한 전문심장소생술로 현장에서 자발순환회복되어 생존퇴원한 1례를 경험하여 문헌고찰과 함께 보고하는 바이다.

ABSTRACT

When a pregnant woman experiences cardiac arrest, resuscitation is of the utmost importance. Cardiac arrest in pregnant women differs from cardiac arrest in the general population since both mother and fetus need to be taken into consideration. In the event of cardiac arrest, determining whether to deliver the baby is significant. Cardiopulmonary resuscitation is not always successful, and the survival rate depends on the speed and precision of the procedure. In this study, we focus on the case of a 30-year-old pregnant woman who experienced cardiac arrest and whose family was quick to perceive her condition and call the hospital. A witness performed initial cardiopulmonary resuscitation, while rescue workers performed the advanced procedure. In this case, the patient and baby received proper treatment and left the hospital after six days. It is extremely rare for a pregnant patient to achieve return of spontaneous circulation (ROSC) or receive advanced cardiac life support before reaching the hospital. However, the woman in question in this study achieved ROSC and received both cardiopulmonary resuscitation before reaching the hospital and advanced cardiac life support at the hospital. The specifics of the case are reported in the context of a literature review.

Keywords : Cardiopulmonary resuscitation (CPR), Return of spontaneous circulation (ROSC), Automated external defibrillator (AED), Out-of-hospital resuscitation, Pregnancy

† Corresponding Author, E-Mail: antikiller12@naver.com. TEL: +82-63-220-4132, FAX: +82-63-220-4109

© 2020 Korean Institute of Fire Science & Engineering. All right reserved.

1. Introduction

The cardiac arrest in a pregnant woman is different from general cardiac arrest since both mother and baby should be considered at the same time. When a pregnant woman has cardiac arrest, the most important part is to resuscitate the pregnant woman⁽¹⁾. If a pregnant woman has cardiac arrest, determining whether to deliver the baby is significant for both pregnant woman and baby^(2,3).

Death related to pregnancy itself is rare and 1 out of 30,000 pregnant patients die due to pregnancy. On the other hand, maternal death take up about 10% of mortality rate^(3,4).

The cardiopulmonary resuscitation method is same for the pregnant women and general cardiac arrest patients. With the longer gestational period, phren goes up due to womb and the chest compression shall take place by finding the center of the sternum. As the gravitational cycle passes 20 weeks, the pregnant women go through considerable amount of physiological changes such as cardiac output, blood volume, minimum ventilation volume, and oxygen consumption amount. Also, as the pregnant women's inferior vena cava is pressed by the baby, hypotension is caused by lower blood reflux and general cardiopulmonary resuscitation method only lowers the success rate of ROSC^(4,5).

If a woman who had been pregnant for less than 24 to 25 weeks has cardiac arrest, the baby cannot survive even after the birth. In this case, it's important to resuscitate the pregnant woman.

If a woman had been pregnant for more than 24 weeks, the baby may survive after the birth. Thus, the survival of both pregnant woman and baby shall be considered together during the cardiopulmonary resuscitation. If the pregnant woman cannot recover 4 min after the cardiopulmonary resuscitation, it's recommended to deliver the baby through emergency cesarean section. Therefore, when a pregnant woman has cardiac arrest, the cesarean operation team shall be called immediately and the decisions shall be made quickly.

Although there are active researches on cardiopulmonary resuscitation in hospital, there are only few case studies on the cardiopulmonary resuscitation on the pregnant woman before the hospital. In this case, the pregnant woman had a heart attack and was given general cardiopulmonary resuscitation by the witness and AED-applied cardiopulmonary resuscitation and airway management technique by ambulance worker emergency medical technician. This case is relatively rare as the patient had ROSC on recovered consciousness on the site.

2. A Case of Disease

It was reported and announced by the Fire Situation Room 119 that a patient was found losing the consciousness and suffering respiratory disorders, at home, and that the patient's guardian was attempting Cardiopulmonary Resuscitation (CPR) for the patient, according to the Medical Guidelines. The 13th floor of an apartment where the patient stayed was located about 3 km away from the Emergency Agency 119 and 7 min were required until the 119 Emergency Medical Service (EMS) would arrive there. While the 119 EMS were dispatching, the patient's guardian who witnessed the patient's condition was attempting CPR for the patient as told about the Medical Guidelines by the Fire Situation Room 119. Additionally, the patient was being six-month pregnant.

When the 119 EMS arrived at the spot, the patient in the unresponsiveness state was evaluated as having 3 points of Glasgow Coma Scale (GCS). The patient had CPR done by the guardian (Witness) on a bed. Then, the 119 EMS moved the patient from the bed to the floor and then did CPR and attached Automatic External Defibrillator (AED) Pad on the patient's chest.

The patient's guardian (Witness) attempted CPR for the patient for 3-5 min before the 119 EMS arrived at 7:12 am after reporting to the Fire Situation Room 119. But AED had not be used. Upon the arrival at the spot, a first rate emergency medical technician analyzed Electrocardiogram (ECG) rhythm, with AED at 7:13 am, which revealed the patient had ventricular fibrillation (Figure 1).

Immediately after having analyzed ECG rhythm, with AED, the emergency medical technician gave the first electrical shock of 15 J to the patient. Then, it was also diagnosed that the patient had ventricular fibrillation (Figure 2).

The first rate emergency medical technician gave a free airway access to the patient, for 10 s, applying advanced life support (ALS) with I-Gel, an equipment for free airway.

As it was found that the patient came to secure a free airway by means of I-Gel, that is, ALS. CPR was done for 2 min and the second electrical shock was given (Figure 3, 4). Regarding ECG rhythm, the patient was diagnosed to have ventricular fibrillation. Therefore, CPR was done again for another 2 min and then the third electrical shock was given at 7:19 am, which made the patient show a normal sinus rhythm at 7:21 am (Figure 5). Then, the pulse of the patient was examined. The result of the examination revealed that the patient had tachycardia with a cardiac impulse beating for 149 times per second and 190/90 mmHg of systolic pressure (Figure 6). Finally, the patient was moved by an ambulance

Case date and time: AM 7:13:06 Institution: HeartStart MRx
 Patient ID: Device model
 First name: Serial Number
 Last name: Adjusted "On" Time AM 7:13:06

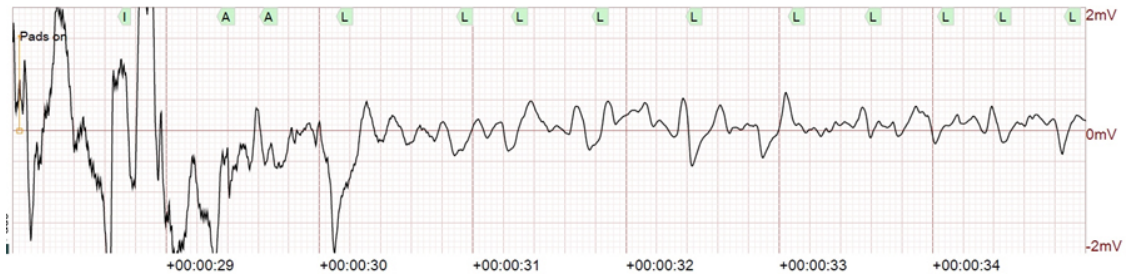


Figure 1. Rhythm was a patient's initial ventricular fibrillation (VF) rhythm that was seen with monitor mode of automated external defibrillator.

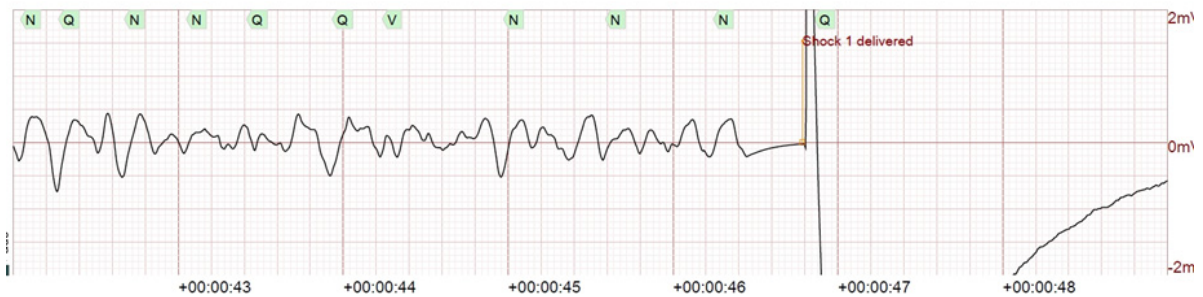


Figure 2. Ventricular fibrillation (VF) rhythm following the first electric shock.

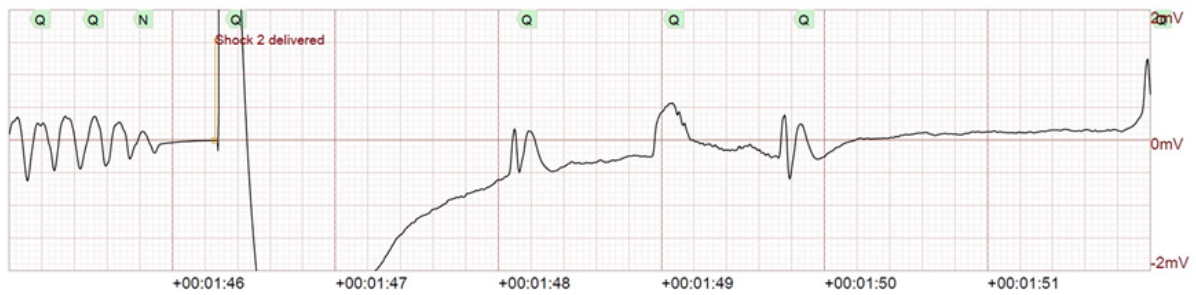


Figure 3. Ventricular fibrillation (VF) rhythm that has continued after the second electric shock.

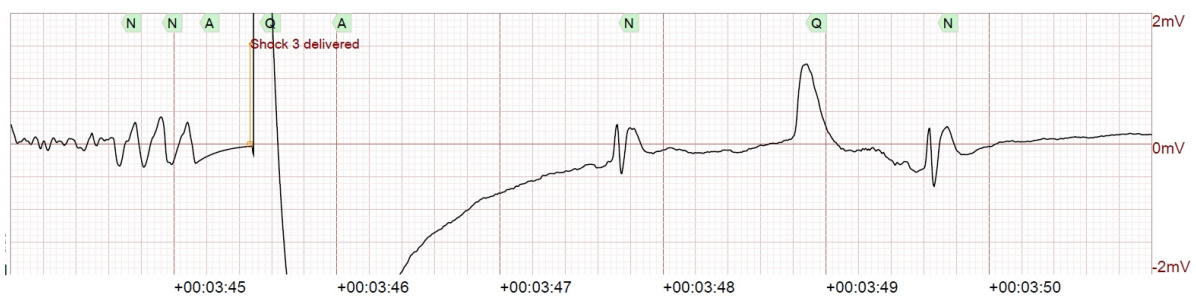


Figure 4. Ventricular fibrillation (VF) rhythm that has continued after the third electric shock.



Figure 5. Return of spontaneous circulation (ROSC) rhythm following the third electric shock and showing that irregular sinus tachycardia.

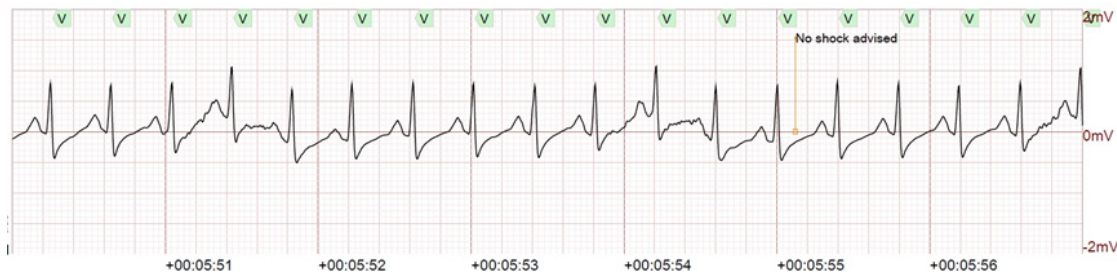


Figure 6. Sinus Tachycardia rhythm that has been continued following ROSC. The heart rate indicates 150 times/min.

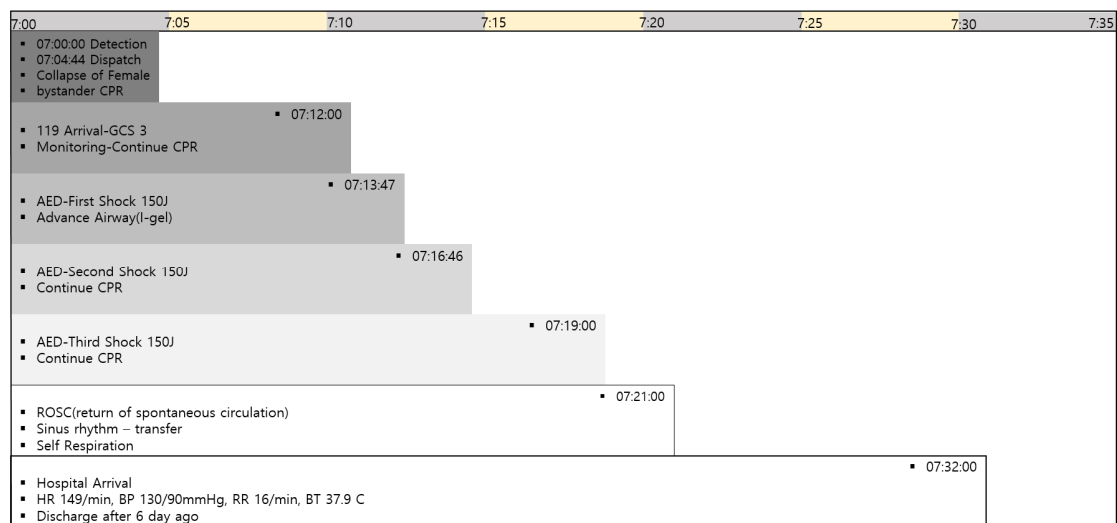


Figure 7. Process of field arrival from the rescue report.

car, in a stable condition.

Chest Compression and artificial respiration were done for 2 min before defibrillation, according to the guidelines of American Heart Association (AHA) 2015^(4,5).

It was decided to move the patient to the close emergency medical center J Hospital which is equipped with incubators. While moving, the monitoring and reevaluating of the patient were conducted. Then, it was found that the patient had a gradually stabilized rhythmic condition. 27 min passed before there was a report to the 119 Fire Situation Room and a patient was moved to a hospital. Before the 119 EMS arrived,

the patient showed a blood circulation because of the chest compression that the witness put on the patient. Afterward, the patient showed recovery of spontaneous circulation (ROSC) that minimized the hand-off time of chest compression. As follows (Figure 7) is the time range of first-aid from a request to the 119 EMS to the application of CPR based on the utilization of AED, and a visit to an emergency room.

As for the basic personal information and pathology history of the patient, the patient (Gender: Female, Age: 30 years old) was being 28-week pregnant without a hypertension, diabetes, heart diseases and allergy. It was found that the patient has

now been taking folic acid, vitamin and omega 3, and that regarding her family history, there was no particular information. According to a guardian of the patient, the patient has recently contracted upper respiratory infection (URI) and after having drunk a strawberry juice because she had heartburn, she suffered respiratory disorders (Dyspnea), that is, a cardiac arrest.

At that time when the patient was hospitalized at 7:28 am, it was measured that she had her heart rate of 149 times per second, and had 130/90 mm Hg of blood pressure. On the day when the patient had an accident, she was hospitalized and treated at an intensive care unit. Afterward, she recovered her health and left the hospital in six days. It is said that the baby who had been a fetus at that time has been growing up well in a healthy condition.

3. Discussion

The pregnant woman described at the case of disease was 28-week pregnant having neither particular symptoms such as heart diseases and allergy, nor having particular information on family history. But recently, she has suffered URI, and after having drunk a strawberry juice because she has heartburn before she lost her consciousness, she came to suffer respiratory disorders (Dyspnea), that is, a cardiac arrest. In general, a pregnant woman experiences physiological changes in 20 weeks of pregnancy, and after 24 week of pregnancy, the rate of fetal survival falls. In 24 weeks, the resuscitation of the pregnant woman and the fetus has to be considered. After 4 min of CPR, it is necessary to decide rapidly whether a cesarean section is done or not⁽⁶⁾.

The pregnant woman described at the case of disease was at the young age of 30. At that time when she was found fainted, her guardian (Witness) was quick to judge the situation, report immediately and attempted CPR on the patient. As a result, the patient survived. After having received an adequate treatment, both the pregnant woman and the fetus became healthy and left the hospital in 6 days after she had been hospitalized.

According to the Guidelines of CPR stipulated by American Heart Association (AHA), the survival chain of Out of hospital cardiac arrest (OHCA) involves the stages: Recognize the cardiac arrest condition and implement the medical emergency system - Do the right CPR immediately -Rapid Defibrillation- Basic and Advanced Emergency Medical Service- ALS and treatment after cardiac arrest. The case of disease shows that the patient guardian (Witness) was so quick to judge the situation and reported to 119, promptly that the

emergency medical system began to be operated. The Situation Room 119 provided the medical guidelines so that the patient's guardian (Witness) can do the right CPR at once. The 119 emergency operators must play a role of mediator of first- aid important in the early stage, for example such as telling how to do first-aid to a corresponding witness or rescuer, in a proper manner, until the 119 EMS arrives at the spot, so that the witness and rescuer can do CPR promptly^(6,7). In the case of more than some 80% of patients with a cardiac arrest, it was observed that such patients had ventricular fibrillation or PEA, for the first time. It is a known fact that defibrillation shock is only the first-aid for ventricular fibrillation or pulseless VT. Such a shock means duration required from a cardiac arrest to defibrillation. In this regard, a research by Mr. Seong-oh Hwang, etc, provides the data for the importance of the utilization of defibrillator in the spot. His research shows that ventricular fibrillation is caused by the failure of ventricular muscle to go smooth in a balanced manner, which prevents blood from flowing from the heart and eventually, brings about anoxia and death. It was reported that fibrillation lasts only for 15-20 min, 11). A prompt access of the 119 EMS utilizing AED can eventually increase survival rate^(7,9).

The case of disease reveals that the prepared 119 EMS gave a shock promptly, using AED and did the right CPR. The event also shows a successful attempt to the 3 stages of the survival chain advised by AHA. In support for it, a research by Mr. Jae-min Lee provides a case of a patient who came to survive and finally left a hospital by means of the basic and right CPR of a witness and the 119 EMS respectively out of hospital. This case shows how important it is to use CPR and AED, early^(24,25).

According to KACPR Data, 94% of patients suffering a cardiac arrest were found by witnesses, however CPR of the witness remained only 10.6%^(7,10,18). Taking it into consideration, more safety education and training (Including CPR) is necessary. More emphasis must be put on making the 119 emergency operators understand the possibility of potential cardiac arrest, promptly, and making those who ask for rescue develop ability to provide the immediate guidelines on CPR^(6,8).

The next is about whether CPR is done, and time required until CPR and defibrillation were done, respectively after a cardiac arrest.12) CPR of a person witnessing a patient with a cardiac arrest is a factor to increase the patient's survival rate up to 3~4 times. Only about 50% of patients suffering a cardiac arrest and receiving CPR out of hospital come to have ROSC, and 50% of patients having a recovery even lead to a

cerebral death or a death caused by the secondary complications such as dysfunction of circulatory system. In the long run, only 20% of patients suffering a cardiac arrest and receiving CPR out of hospital come to survive and leave the hospitals, while 10~14% of those patients come to suffer a permanent cerebral damage. The case emphasizes that CPR out of hospital comes before any other things^(8,13).

ALS implemented during the process of CPR is necessary for constant chest compression, not chest compression of 30:2. Counted as ALS is the alternative free airway such as traditional endotracheal intubation, Laryngeal Mask (LMA), Laryngeal Tube (LT), I-gel and others⁽⁸⁾. The case of disease can give an alternative free airway access and minimize the delay of chest compression, through the utilization of I-Gel by a first rate emergency technician.

It is said that minimizing the hand-off time of chest compression even while using a defibrillator is good. In case the basic CPR is not done for a patient until a defibrillator arrives or it is not identified when the patient suffered a cardiac arrest, and 4-5 min pass after the patient had suffered a cardiac arrest, it is advised to attempt CPR for about 2 min and then to utilize a defibrillator. In the case of AED that is needed in the spot, it is recommended to attempt CPR for about 5-10 min and then move the patient to a hospital nearby. The guidelines recommend that in case a patient shows unresponsiveness after three electrical shocks, he/she should be moved to a hospital nearby^(12,15).

The case of disease shows that CPR was done in accordance with the Guidelines of CPR and the Guidelines of spot work by an emergency technician. A witness attempted the basic CPR immediately after the patient was found suffering from a cardiac arrest. The 119 EMS arrived at the spot after 7 min. Upon the arrival at the spot, they applied AED and then an electrical shock in 46 s, which showed that the patient had ventricular fibrillation. Therefore, CPR was done for 5 min through a total of three electrical shocks, and eventually, there appeared ROSC, and an alternative free airway was secured by first rate emergency technicians. Medication was necessary for an arrhythmia treatment at the spot. However, medication was not administered due to a limit of medications regulated in the work scope of emergency technician. Eventually, the patient was reevaluated and monitored before being moved to a hospital. Treatment after ROSC assumes the extremely important part to reduce hemodynamic instability, MODS (Multiple Organ Dysfunction Syndrome) and early death and disorders by cerebral damage^(20,21). The case of disease shows tachycardia rhythm immediately after ROSC, which was an unstable sign to lead

to ventricular fibrillation again.

It is considered that the 119 EMS led by a first rate emergency technician provided the proper basic and advanced emergency medical services at the fourth stage of survival chain. Advanced Cardiac Life Support (ACLS) is done by a skilled emergency technician or doctor. They can not only do CPR and defibrillation but also ACLS such as medication or endotracheal intubation^(12,17). Such an attempt helps a reaction from ventricular fibrillation to defibrillation, and therefore maintaining a normal rhythm after a successful defibrillation.

It was reported that in order to do the adequate ACLS for a patient suffering from a cardiac arrest, Basic life support (BLS) team of 3 people at least must arrive at the spot and do BLS and defibrillation, and plus ALS team of 2 skilled people (First rate emergency technicians) must arrive at the spot to do ACLS such as medication and ECG monitoring⁽¹⁶⁾.

This case of disease shows some differences from any other general cases in that the case is related to a pregnant woman⁽⁹⁾.

A pregnant woman usually undergoes physical and physiological changes with the month of pregnant growing⁽¹⁰⁾. In the circulatory system, cardiac output increases according to the age of a fetus. By the period of 20 week of pregnancy, cardiac output increases up to 30-45% and the rate remains until the delivery of fetus.

The amount of blood rises. In 7 week of pregnancy, the amount of blood rises by some 11% and up to 45~50% until the delivery of fetus. These developments result from the increase of plasma, which induces physiological anemia causing a problem with oxygen supply during the process of CPR. In such a case, the total vascular resistance declines and vascular pressure is also reduced at the level of some 30% of a normal level. Regarding the change in the respiratory system, the influence of progesterone facilitates respiration and increases the volume of respiration on a daily basis, which brings the volume of respiration to rise per second. Functional residual capacity puts the pressure on diaphragm, with the size of uterus growing, and eventually declines to show a compensated respiratory alkalosis.

Increased Oxygen demand and basal metabolism reinforce the production of CO₂, which causes a pregnant woman to easily have acidosis in a state of lack of CO₂ emission, and badly affects ROSC. In the digestive system, exercise tolerance and lower esophageal sphincter are weakened by the influence of progesterone that increases the risk of absorption.

Firstly, for breathing assistance, securing an active airway is necessary. A pregnant woman has airway edema and weak mucous membrane that can put the brake on securing a free airway. Considering this, a small size of endotracheal tube that

a pregnant woman might need must be in progress. Secondly, regarding the position of the administration of CPR, it is advised to move a pregnant woman to the left of the uterus system in order to keep the bigger uterus from putting the pressure on aorta and vein. Then, it is important to press the pregnant woman's hip with a prop or insert the rescuer's arm or knee into the pregnant woman's hip in order to keep the position. Thirdly, for circulatory assistance, it is important to secure a fast intravenous route access. It is required that the intravenous route below diaphragm such as femoral vein or sapherous vein, should be avoided. Defibrillation is not prohibited. There has been no report that defibrillation caused the side effects on fetuses⁽¹¹⁾. Fourthly, medication during the process of CPR, is provided at the same level and capacity as in Advanced Cardiac Life Support (ACLS) applied to normal people. But medicines that might cause problems in theory, for example, contraction boosters such as alpha- adrenergics or ephedrine can reduce blood flow between uterus placenta. Therefore such types of medicines need attention. Lidocaine can also bring about fetal acidosis, beta-blocker and bicarbonate can accelerate fetal bradycardia and acidosis, respectively that also need attention. As for capacity of medicines, a normal capacity is utilized. But in the case of a pregnant woman, the increase of distributed capacity must be considered. In order to obtain an effect preferred, increasing capacity of medicines without hesitation is necessary. Lastly, in the case of possible complications during the process of CPR for a pregnant woman, they could cause a fracture in rib or breast bone, including hemothorax and vascular peritoneum. There can also appear a rupture in the internal organs such as spleen or liver, or the damage in the fetal nervous system caused by trauma. The case of disease shows that a first rate emergency technician secured an active airway access, utilizing I-Gel, for breathing assistance. To avoid the pressure of aorta and vein, the technician carried out circulatory assistance, utilizing a blanket under the right hip. Yet, the relevant organizations must make the improvement and efforts to secure an intravascular route access and administer ACLS promptly and effectively by organizing two first rate emergency technicians in the 119 EMS.

The case of disease is about 1 patient suffering a cardiac arrest who had ROSC after having received CPR out of hospital. The patient is a case that showed an improvement in cardiac impulse through the advanced CPR at the first-aid spot, out of hospital. The patient was hospitalized for a short period of time and both the pregnant patient and the fetus were healthy without having problems.

In South Korea, most of patients suffering a cardiac arrest

receive first- aid from the 119 EMS. There are appearing many practical problems that must be improved in order to rescue an increasing number of patients suffering a cardiac arrest. The rate of administration of BLS (Basic Life Support) by the 119 EMS at the spot or while moving patients, accounts for 66.3%, while that of ACLS out of hospital is 9.1%, and the frequency of the utilization of AED remains only 5%⁽¹⁶⁾. It was identified that a few people have utilized AED and that BLS does not determine greatly the outcome on a cardiac arrest⁽⁵⁾.

The number of the 119 EMS of South Korea dispatching is 2-3. The first rate emergency technicians and nurses account for 24.8% (2476 people) and 2.7% (163 people), respectively. The second rate emergency technicians who took education and training for a short period of time account for 33.2% (1985 people). Non-professional personnel only in charge of driving and moving patients reach 39.2% (2346 people)⁽¹⁴⁾. Such a composition of personnel reflects that patients suffering a cardiac arrest don't receive even BLS. Raised as a problem is the work condition in which advanced work guidelines about patients suffering a cardiac arrest are not provided. Any patient who survives and leaves a hospital after CPR at the first-aid spot is to be awarded a heart saver badge. It is considered that such a system must be actively reinforced so that the 119 EMS can heighten job achievement. In particular, the heart saver will be given to the general public, and the current level of BLS by bystander is being raised by the nation's CPR training. The use of special 119 EMS (Paramedics) now enables emergency drug administration (Epinephrine, Amiodarone, Acetaminophen, EPI-pen, NTG), Intraosseous Injectio (IO), and 12-Lead EKG. cutting the umbilical cord due to an emergency delivery has also ever proceed without problems through the medical director⁽²⁶⁾. This is a good step forward in increasing Out of hospital survival.

In order to protect the life and safety of the Korean people, the relevant organizations or bodies should show a co-operative attitude to solve problems by luring first rate emergency technician personnel. the advanced medical guidelines and work scope of emergency technicians administering the advanced CPR must be expanded in order to heighten the survival and discharge rates of patients.

The necessity to provide the advanced education and training on first- aid is required in order to specialize the 119 EMS. Given the fact that there has been a quite rare case in foreign countries where a pregnant patient had ROSC through ACLS out of hospital, it is considered that obtaining a great deal of information, understanding accurate first- aid and researching about it are necessary so that ACLS out of hospital can heighten the survival and discharge rates of patients.

References

1. D. H. Lee, G. B. Klim, E. K. Eo and Y. J. Cheon, "Case Reports : A Case that Pregnant Woman was Performed Emergency Cesarian Section During CPR", The Korean Society of Emergency Medicine, Vol. 18, No. 1, pp. 80-83 (2007).
2. H. J. Yoon, Y. D. Kim and Y. S. Jee, "Cardiac Arrest in a Pregnant Woman with Pregnancy-induced Hypertension - A Case Report -", Anesthesia and Pain Medicine, Vol. 11, No. 3, pp. 269-272 (2016).
3. J. E. Whitty, "Maternal Cardiac Arrest in Pregnancy", Clin Obstet Gynecol, Vol. 45, No. 2, pp. 377-392 (2002).
4. S. Morris and M. Stacey, "Resuscitation in Pregnancy", BMJ, Vol. 327, pp. 1277-1279 (2003).
5. J. Sora, C. D. Deakin, J. P. Nolan, G. Abbas, A. Alfonzo, A. J. Handley, D. Lockey, G.D. Perkins et al., "European Resuscitation Council Huidelines for Resuscitation 2005 Section 7. Cardiac Arrest in Special Circumstance", Resuscitation, Vol. 67, pp. 135-70 (2005).
6. R. W. Neumar, M. Shuster, C. W. Callaway, L. M. Gent, D. L. Atkins, F. Bhanji, S. C. Brooks, A. R. de Caen et al., "Part 1: Executive Summary. 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care", Circulation, Vol. 132, pp. 315-367 (2015).
7. L. B. Becker and P. E. Pepe, "Ensuring the Effectiveness of Community-wide Emergency Cardiac Care", Ann Emerg Med, Vol. 22, pp. 354-365 (1993).
8. F. Bhanji, A. J. Donoghue, M. S. Wolff, G. E. Flores, L. P. Halamek, J. M. Berman, E. H. Sinz and A. Cheng, "Part 14: Education. 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care", Circulation, Vol. 132, pp. 561-573 (2015).
9. D. K. Mauer, H. W. Gervais, W. F. Dick and G. A. Rees, "Cardiopulmonary Resuscitation (CPR) During Pregnancy. Working Group on CPR of the European Academy of Anaesthesiology, Europe, Vol. 10, No. 2, pp. 437-440 (1993).
10. B. S. Selden and T. J. Burke, "Complete Maternal and Fetal Recovery after Prolonged Cardiac Arrest", Ann Emerg Med, Vol. 17, pp. 346-349 (1988).
11. J. E. Tintinalli, G. D. Kelen and J. S. Stapczynski, "Emergency Medicine", A Comprehensive Study Guide. 6th ed, New York McGraw-Hill, pp. 94-98 (2008).
12. J. E. Tintinalli, G. D. Kelen and J. S. Stapczynski, "Emergency Medicine", American College of Emergency Physicians, McGraw-Hill, pp. 61-78 (2004).
13. S. W. Lee and Y. S. Hong, "Cardiac Arrest in Emergency Department", The Korean Society of Emergency Medicine, Vol. 11, No. 2, pp. 176-190 (2000).
14. NEMA, "Fire Fighting Administration Data and Statistics", pp. 276-280 (2009).
15. O. D. Limmer, H. D. Grant and R. H. Murraray, "Emergency Care", Prentice Hall, pp. 402-417 (2009).
16. Y. W. Jang, "Comparison of Needs and Importance of Pre-hospital First Aid Perceived by 119 Paramedics and Emergency Medical Personnel", Master Thesis, Graduate School of Nursing, Dong-A University (2006).
17. Seoul National University College of Medicine, "Establishment of Clinical Practice Guidelines for Training Emergency Medical Service", pp. 195-210 (2007).
18. K. K. Hee, "The First Responder's Retention of Knowledge and Skills of Cardiopulmonary Resuscitation", Gyeonggi College Journal, Vol. 29 (2001).
19. K. Lee, S. D. Shin and J. K. Kim, "Appropriate Analysis of Emergency Medical Services on Site and in Transportation", Ministry of Health and Welfare, pp. 19-28, 106-109 (2009).
20. H. J. Kim, Y. S. Kim, S. M. Kim and S. Chol, "In-hospital Utstein-style Evaluation of the CPR Performed by ACLS Teams on Cardiac-arrest patients in a General Hospital", Journal of The Korean Society of Emergency of Medicine, Vol. 13, No. 4, pp. 450-458 (2000).
21. H. S. Lee, S. P. Chung, U. J. Kim, S. M. Chung, H. G. Kang and S. H. Kim, "Evaluation of in-Hospital Cardiac Arrest According to the in-Hospital Utstein Style", Journal of The Korean Society of Emergency of Medicine, Vol. 10, No. 1, pp. 70-71 (1999).
22. Y. S. Park, Y. M. Kim and S. H. Kang, "Predictors of Survival from Out-of-Hospital Cardiac Arrest by Four Levels" Vol. 34, No. 2, pp. 484-513 (2014).
23. S. Y. Shin and J. Y. Jeong, "The Comparison of Effectiveness in Prehospital Protocol Education on CardioPulmonary Resuscitation", Korea Academia-Industrial Cooperation Society, Vol. 10, No. 11, pp. 3418-3426 (2009).
24. H. W. Yun, J. M. Lee and J. Y. Jung, "Out-of- hospital Resuscitation if Cardiac Arrest by 119 Emergency Medical Service System", Fire Science and Engineering, Vol. 24, No. 5 pp. 142-149 (2010).
25. H. W. Yun, "A Case Study About Dementia Dignosis of Cardiac Arrest Patient Alived by ACLS on 119 EMS Field", J Korean Health & Fundamental Med Sci, Vol. 4, No. 3, pp. 136-142 (2011).
26. Nation Fire Agency, "Special 119EMS (paramedic) standard Guidelines", pp. 85-100 (2019).