CARDIAC ARREST IN PREGNANCY: END-TIDAL CO_2 MONITORING COULD GUIDE MANAGEMENT IN THE PREHOSPITAL SETTING

***Steinar Einvik,[1] Thomas Lafrenz,[2] Stein-Vegar Johansen,[3] Ingrid Marie Ringen,[4] Per P. Bredmose[5]**

1. Department of Emergency Medicine and Prehospital Services, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway
2. Department of Anaesthesia and Intensive Care, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway
3. Department of Cardiothoracic Anaesthesia, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway
4. Department of Gynecology and Obstetrics, St. Olavs Hospital, Trondheim University Hospital, Trondheim, Norway
5. Air Ambulance Department, Oslo University Hospital, Oslo, Norway
**Correspondence to steinar.einvik@stolav.no*

Steinar Einvik was the prehospital physician on-site. Ingrid Marie Ringen performed perimortem caesarean section in the Emergency Department. Thomas Lafrenz and Stein-Vegar Johansen were the leading physicians inside the hospital Emergency Department. Per P. Bredmose made important contributions to the discussion section. Steinar Einvik was the major contributor to the manuscript. All authors read and approved the final manuscript.

Disclosure: The authors have declared no conflicts of interest.
Consent: Written informed consent was obtained from the patient's husband for publication of this case report.
Received: 18.03.16 **Accepted:** 09.09.16
Citation: EMJ Cardiol. 2016;4[1]:107-110.

ABSTRACT

This case report describes a 27-year-old pregnant woman with a gestational age of 26 weeks and 3 days who developed cardiac arrest in her home. Resuscitation was started immediately and continued on arrival at the hospital. Guidelines for resuscitation of cardiac arrest during pregnancy in-hospital include that a perimortem caesarean section (PMCS) should be performed if there is no return of spontaneous circulation within 4 minutes. The guidelines for prehospital treatment in such circumstances are more controversial. The triage on-site was based on the end-tidal carbon dioxide ($ETCO_2$) monitoring showing that the quality of resuscitation being done was proficient and after a short on-scene time the patient was transported to the emergency department for PMCS on arrival. The resuscitation of the mother was not successful but the baby survived with no known sequelae after a total arrest time of 28 minutes before delivery. Monitoring of $ETCO_2$ in resuscitation of cardiac arrest in pregnancy might be helpful in making the decision on whether to perform PMCS on-site or at a somewhat more appropriate location in the hospital.

Keywords: Perimortem caesarean section (PMCS), return of spontaneous circulation, end-tidal carbon dioxide ($ETCO_2$), ventricular fibrillation, arrhythmogenic right ventricle dysplasia (ARVD).

INTRODUCTION

Cardiac arrest in pregnancy is rare, occurring in only 1 in 30,000 pregnancies, and survival from such an event is exceptional. A comprehensive scientific statement about cardiac arrest in pregnancy includes a recommendation that a perimortem caesarean section (PMCS) should be performed if there is no return of spontaneous circulation within 4 minutes.[1] End-tidal carbon dioxide ($ETCO_2$) predicts survival in out-of-hospital cardiac arrest and low values predict poor survival in the non-

pregnant population.[2] We present a case from St. Olavs Hospital, a hospital caring for 4,000 births annually.

CASE REPORT

A 27-year-old woman, *gravida* four, *para* one, was pregnant at gestational age of 26 weeks and 3 days. She had complained of several episodes of palpitations, which were self-limiting. On one occasion she sought medical attention and was referred to cardiologic outpatient clinic. Unfortunately, there is no electrocardiogram available from this consultation. She had not seen the cardiologist by the time of the arrest.

At home on the day, she had felt uncomfortable with palpitations for some seconds before she lost consciousness. Bystanders immediately called the emergency dispatch centre. After a minute, bystanders started chest compressions guided by the dispatch operators. The first heart rhythm upon arrival by ambulance personnel 7 minutes later showed low amplitude ventricular fibrillation. Two shocks of 200 joules were delivered with standard placement of pads without effect. Advanced cardiac life support was continued and a laryngeal mask was successfully inserted. Three minutes after the arrival of the air ambulance crew (flight anaesthesiologist and paramedic) the heart rhythm had degenerated to asystole and the patient was put on an automated chest compression device (LUCAS™, LUCAS 2, Jolife, Lund, Sweden). $ETCO_2$ showed 5.5 kPa (41 mmHg) with LUCAS ongoing, but no pulses were detected and rapidly diminishing $ETCO_2$ values were seen when LUCAS was paused. The air crew personnel decided to 'load and go' to the Emergency Department (ED) at St. Olavs Hospital, a 5-minute drive from the scene.

The relevant hospital resources were alerted by the dispatch centre when the ambulance started driving to the hospital. In the ambulance, the patient was tilted to the left side with continuous chest compressions using LUCAS. $ETCO_2$ remained between 5 and 6 kPa (37.5 and 45.0 mmHg).

Within 2 minutes after arrival in the ED, the baby was delivered by PMCS, some 28 minutes after the maternal arrest. Initially the baby was bradycardic (heart rate 70–80 bpm) which rapidly rose with ventilations. No chest compressions were needed. The Apgar score was 1-2-3. The baby was immediately intubated and put in an incubator for proper treatment.

The resuscitation of the mother continued following guidelines for adult advanced cardiac resuscitation.[3] The $ETCO_2$ was kept at approximately 5–6 kPa (37.5–45.0 mmHg) throughout the resuscitation, correlating to an arterial blood gas value of 10 kPa (75 mmHg). The first lactate value was 9.2 mM, corresponding to a pH of 6.95. The resuscitative efforts gave no improvement in physiologic status and the patient was put on extracorporeal membrane oxygenation (CARDIOHELP™ Extracorporeal Life Support System, Maquet Medical Systems, Getinge Group, New Jersey, USA) which was accomplished 45 minutes after arrival in the ED.

In the Cardiothoracic Intensive Care Unit, the patient was dependent on full extracorporeal life support. The resuscitative efforts were futile and approximately 10 hours after the arrest the circulatory support was withdrawn and the patient died.

The autopsy concluded with a diagnosis of arrhythmogenic right ventricle dysplasia (ARVD), confirmed by histological examination.

DISCUSSION

This case, in our view, illustrates some interesting learning points:

1. Prehospital Care

The algorithm of prehospital resuscitation of cardiac arrest in pregnancy points out the need for PMCS to be done on-site given there was no response to cardiopulmonary resuscitation for 4 minutes.[3,4] The main reason for this is to improve the circulation to the mother by relieving the aortocaval pressure caused by the enlarged uterus at 20–24 weeks of pregnancy.[5] Hence the mother is prioritised when pregnant and in cardiac arrest. In our case, the high $ETCO_2$ at all times illustrated effective resuscitation,[2] although the best cardiac output in resuscitation of the non-pregnant population is 30% of normal.[3] Another indicator of good resuscitation is the fact that a surviving child is delivered, who survives with no cerebral sequelae detected 12 months after the incident. The child's psychomotor development will be monitored by paediatric out-patient examinations twice annually.

It was a 5-minute drive to the ED, where all appropriate resources needed were available. If the on-site $ETCO_2$ values had been lower i.e. 1–2 kPa (7.5–15.0 mmHg), the suspicion for an

obstruction to the circulation like pulmonary or amniotic fluid embolism would have been stronger. Resuscitation in such conditions is often futile.[6] In this situation, with low $ETCO_2$, there would have been an urgent need for immediate PMCS to relieve aortocaval compression. The prehospital anaesthetist on scene decided to 'load and go' to the ED, the alternative was to stay on-site and perform PMCS.

The prehospital anaesthetist was not trained to do such a procedure and the risk was then extensive bleeding to the mother with no health personnel available to take care of the child. Instead, the patient was met by a team in the ED, where the obstetrician recently had been in the Medical Simulation Center at St. Olavs Hospital training for this procedure (PMCS). The main reason for the 'load and go' decision to the ED was the relatively high $ETCO_2$ when compressions were carried out with the LUCAS.

Prehospital PMCS has very limited survival rates, as reported by others, and is so seldom performed worldwide that it cannot be regarded as a standard of care.[7] If there is indication for prehospital PMCS to be done, we think there should be an experienced prehospital physician to do the procedure.

2. Why Did the Patient Arrest?

The main hypothesis is thought to be that the patient arrested due to a primary arrhythmia, most likely ARVD as mentioned. ARVD is an autosomal dominant inherited disease of the heart muscle characterised by fibrofatty degeneration of the cardiomyocytes which leads to electrical instability and contractility abnormalities.[8] During pregnancy, plasma volume, cardiac output, and heart rate increase by as much as 30% compared to a normal non-pregnant state.[1] This means the heart has an increased workload and in susceptible individuals this could lead to a fatal arrhythmia.[8] Prior to the day that the patient arrested, she had several syncopal episodes, most likely because of a self-limiting malignant arrhythmia. On the day she arrested the main hypothesis is that her heart rhythm rapidly degenerated to ventricular fibrillation as opposed to the more benign developing episodes as described above. We do not know whether cardiac arrest caused by ARVD is especially difficult to resuscitate. Theoretically, as outlined above, cardiac arrest caused by pulmonary or amniotic fluid embolism might have low $ETCO_2$ values when resuscitated.[6] In such cases PMCS on-site could be more beneficial than in our case to improve the circulation. In this case the $ETCO_2$ levels were indicating no obstruction to the circulation, and that good quality resuscitation was being done.

3. Why Did the Child Survive with No Cerebral Sequelae Detected 12 Months After the Incident While the Mother Died?

The main hypothesis supporting this fact is the good-quality resuscitation done by the bystanders immediately available on scene when the mother arrested. This resuscitation continued when the ambulance personnel arrived and during transportation to the ED with the automated chest compression and ventilation devices working and being delivered to the patient. The $ETCO_2$ values were satisfactory at all times throughout the resuscitation, illustrating that the circulation was as good as it could have been in this critical situation.

The caesarean section team in the ED finished the procedure within 2 minutes after arrival. There was a neonatal intensive care team taking care of the child when delivered; this slowly improved the child's clinical condition, despite the Apgar score being 3 after 10 minutes.

The baby was delivered some 28 minutes from the arrest mark, which is an unusually long time span considering the good outcome. This time frame has been described previously in the literature although it is rare.[9]

CONCLUSION

Cardiac arrest in pregnancy is a critical condition with high mortality. In this case we describe a surviving baby and a non-surviving mother after a high-quality resuscitation and a long time span from arrest to delivery. Monitoring of $ETCO_2$ in resuscitation of cardiac arrest in pregnancy might be helpful in deciding whether to perform PMCS on-site or at a somewhat more appropriate location in the hospital.

REFERENCES

1. Jeejeebhoy F et al. Cardiac Arrest in Pregnancy. A Scientific Statement from the American Heart Association. Circulation. 2015;132(18):1747-73.

2. Levine RL et al. End-Tidal carbon dioxide and outcome of out-of-hospital cardiac arrest. N Engl J Med. 1997;337(5):301-6.

3. Resuscitation Council (UK). Guidelines 2010. 2010. Available at: https://www.resus.org.uk/archive/guidelines-2010/. Last accessed: 7 April 2016.

4. Parry R et al. Perimortem caesarean section. Emerg Med J. 2016;33(3):224-9.

5. Jeejeebhoy F, Windrim R. Management of cardiac arrest in pregnancy. Best Pract Res Clin Obst Gynaecol. 2014;28(4):607-18.

6. Spöhr F, Böttiger BW, "Management of the Patient with Fulminant Pulmonary Embolism Undergoing Cardiopulmonary Resuscitation," Konstantinides SV (ed.), Management of Acute Pulmonary Embolism 2007, New Jersey: Humana Press, pp.113-47.

7. Bowers W, Wagner C. Field perimortem cesarean section. Air Med J. 2001;20(4):10-1.

8. Güdücü et al. Management of a rare case of arrhythmogenic right ventricular dysplasia in pregnancy: a case report. J Med Case Rep. 2011;5:300.

9. Dijkman et al. Cardiac arrest in pregnancy: increasing use of perimortem cesarean section due to Emergency skills training? BJOG. 2010;117(3):282-7.