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Case report

The use of point-of-care assessments and advanced hemodynamic monitoring in a patient with Eisenmenger syndrome for cesarean section: A case report

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ABSTRACT

Introduction: Eisenmenger syndrome should be diagnosed before pregnancy and surgically corrected if possible. Cesarean section in a patient with Eisenmenger syndrome is high risk as morbidity and mortality are very high. Delivery in hospitals with intensive care units should be recommended. Use of point-of-care assessments and advanced monitors allow accurate management.

Case presentation: A primigravid with congestive heart failure from a patent ductus arteriosus in Eisenmenger syndrome, presented with threatened preterm labor and uncontrolled hypertension prompting cesarean delivery under epidural anesthesia. Pre-induction focused echocardiography revealed normal right ventricular function and severe pulmonary hypertension. Intraoperatively, hemodynamics became unstable. The decision to use fluids, vasopressor and inotrope was guided by analyses of arterial pulse contour, central venous pressure waveform and blood exams. Hemodynamics improved and a live baby was delivered. Postoperative course was unremarkable.

Discussion: The cause of hemodynamic instability must be accurately determined as inappropriate use of fluid or medication may be detrimental to a patient with Eisenmenger syndrome. In this case, advanced hemodynamic monitoring showed changes in central venous pressure, cardiac output and systemic vascular resistance which differentiated the causes of hypotension and desaturation. Point-of-care blood analysis showed acidosis and hypoxia which may have worsened the right-to-left shunt, contributing to the desaturation. Fluid and drug infusions to address identified problems were then guided by advanced monitors.

Conclusion: The use of point-of-care assessments and advanced hemodynamic monitoring allowed accurate diagnoses and goal-directed therapies leading to improved patient safety and outcomes. The need for prolonged intensive care in this case was prevented.

1. Introduction

Patent ductus arteriosus has an incidence of one in 2000 births [1]. It is a condition where the ductus arteriosus, a fetal artery connecting the aorta and pulmonary artery, fails to close. This creates a left-to-right shunt as a result of the left-sided heart pressure being higher than that of the right. Chronic shunting of the blood to the pulmonary vasculature results in increased pulmonary pressures. When pulmonary vascular resistance exceeds that of systemic, a reversal of the shunt occurs, called Eisenmenger syndrome. This causes delivery of deoxygenated blood directly to the systemic circulation leading to hypoxia. The incidence of Eisenmenger syndrome among pregnant patients is rare at 3%. Maternal mortality is as high as 30–50% and even up to 65% in those undergoing cesarean section [2,3].

Given the high mortality associated with cesarean section in patients with Eisenmenger syndrome, strategies to improve patient safety is paramount. Although standard monitors may provide surrogate information on hemodynamics, point of care assessment and minimally invasive, advanced hemodynamic monitor allow precise diagnosis and goal-directed management.

This work has been reported in line with the SCARE criteria [4].

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2. Case presentation

A primigravid at 32 2/7 weeks age of gestation presented in threatened labor. She suffered from congestive heart failure (functional class II to III) due to a patent ductus arteriosus in Eisenmenger syndrome. Despite medical advice, the patient declined corrective surgery as she claimed to have no failure symptoms. Her pulmonary arterial hypertension was managed with sildenafil and bosentan. She had no other illnesses. Family and psychosocial histories were unremarkable. Previous echocardiography revealed right atrial and ventricular enlargement, right ventricular hypertrophy, moderate pulmonary regurgitation, good left ventricular contractility and Eisenmenger physiology. During an outpatient consult, she had persistent elevations in blood pressure, prompting hospital admission. Further exam showed oxygen saturation of 92% at room air and characteristic murmur. Radiograph showed biventricular cardiomegaly and pulmonary congestive changes. Blood tests showed increased hematocrit, mild hyponatremia, mild hypermagnesemia. The development of threatened preterm labor prompted a primary low segment cesarean section under continuous lumbar epidural anesthesia. Consultants and fellows provided perioperative anesthesia care.

Aside from standard monitors, arterial and central venous lines were inserted. The arterial line was connected to the Vigileo monitor. Baseline hemodynamic values and central venous pressure waveform were noted. Baseline point-of-care blood analysis was obtained (Table 1).

An epidural catheter was inserted at the L4-L5 interspace. Lidocaine was given to reach a block height of T4. While the patient was side-lying, a focused echocardiography revealed good left and right ventricular functions and severe pulmonary hypertension.

During fundal push prior to delivery, oxygen saturation went down to 90% while central venous pressure increased to 10 mmHg with elevation of the v wave. After delivery, oxygen saturation further decreased to 88% and blood pressure decreased to 70/40 mmHg. Blood loss was about 900 ml. The Vigileo monitor showed a decrease in cardiac output and systemic vascular resistance (Table 2). Point-of-care blood analysis showed uncompensated metabolic acidosis (Table 1). A tight-fitting inflatable mask was applied. Norepinephrine (0.05 μg/kg/min) and dobutamine (10 μg/kg/min) infusions were started. Cardiac-output-guided volume replacement was done. Vital signs, central venous pressure, cardiac output and systemic vascular resistance improved. Repeat point-of-care blood analysis showed compensated metabolic acidosis, mild hypoxemia, and decreased hemoglobin and hematocrit.

Hemodynamic monitoring was continued at the recovery room. Focused echocardiography showed no congestion and good biventricular contractility. Left ventricle was collapsed prompting cardiac-output-guided fluid resuscitation.

Admission to an intensive care unit was deemed unnecessary and the patient was transferred to the ward on the second postoperative day. The rest of the postoperative course was unremarkable. On follow-up, the patient was satisfied with overall care.

Table 1
Results of point-of-care blood analysis.

	Initial	15 min after delivery	After initial fluid loading	At the recovery room
pH	7.42	7.31	7.35	7.36
pCO_2 mmHg	30.5	32.9	28	28.8
pO_2 mmHg	129	113	78	82
BE mmol/L	−5	−9	−10	−9
HCO_3 mmol/L	19.4	16.8	15.3	16.1
TCO_2 mmol/L	20	18	16	17
sO_2%	99%	98%	95%	96%
Hgb	17	17.3	14.6	15
Hct	50	51	43	44
Na	136	138	140	139
K	3.9	3.7	3.6	3.9
iCa	1.22	1.19	1.11	1.14

Table 2
Intraoperative hemodynamic parameters.

	Before delivery	During delivery	Within 15 min of delivery	30 min after delivery
Cardiac output (L/min)	10.3	5	8.4	7.1
Systemic vascular resistance (dynes/s/cm^{-5})	1362	971	771	1051
Central venous pressure (mmHg)	7	10	16	10
Central venous pressure waveform	V wave at baseline level	V wave elevated from baseline level	V wave returned to baseline level	V wave returned to baseline level

3. Discussion

The choice of anesthesia for cesarean delivery in patients with Eisenmenger syndrome is not well established. At present, there is no study comparing the morbidity or mortality rates of general versus regional anesthesia in these cases.

In essence, maintenance of stable hemodynamics is more important than the choice of anesthesia. Compared to just utilizing standard monitors, patient safety and outcomes may be improved by using advanced equipment. Focused cardiac ultrasound evaluates cardiac pathology through real-time assessment of cardiac size, structure, and function [5]. Point-of-care blood analyzer provides immediate, laboratory-quality, diagnostic results. Vigileo is a minimally invasive hemodynamic monitor employing arterial pulse contour analysis to provide data on stroke volume variation, cardiac output and systemic vascular resistance. Although this monitor requires controlled ventilation, fluid responsiveness may still be predicted when there is a change of at least 9% in cardiac output [6]. The generated absolute values may not be accurate in this case but the numeric trends may still be helpful.

Hypotension and desaturation may be caused by different factors including problems with cardiac output (affected by preload, contractility and afterload), systemic vascular resistance, arterial oxygenation and hemoglobin level. Static parameters such as heart rate, blood pressure, and central venous pressure poorly differentiate these causes. In a healthy individual, a trial of intervention based on these static parameters is usually tolerated. However, in a patient with significant cardiac disease as in this case, accurate diagnosis and directed therapy is imperative as an inappropriate intervention may be detrimental or even fatal. This justifies the use of point-of-care assessments and advanced hemodynamic monitoring.

In this case, the patient became hypotensive before and after the delivery of the baby. The cause of hypotension had to be accurately determined as both inadequate and excessive fluid therapy may aggravate the problem. The hypotension prior to the delivery was determined to be due to the decreased cardiac output (as shown by the Vigileo monitor) resulting from the increased preload due to the fundal push, which led to right ventricular dilatation (evidenced by the sudden increase in central venous pressure and elevation of the v wave in the central venous pressure waveform) [7].

The persistent decrease in cardiac output after delivery may be due to the unreplaced blood loss as evidenced by point-of-care blood analysis values. This was addressed by crystalloid infusion, guided to achieve a 10% change in cardiac output [8]. The decreased cardiac output may have also been from the reduced contractile force of the right ventricle

from inadequate perfusion from hypotension. This was addressed by dobutamine infusion [9,10].

The worsening desaturation after delivery may be due to the combined effects of unreplaced blood loss, and decreased systemic vascular resistance (as shown by the Vigileo monitor) from sympathetic blockade of the epidural anesthesia which worsened the right-to-left shunt. These were addressed by norepinephrine infusion [9,10] and cardiac-output-guided fluid replacement.

Although cannot be directly measured, further elevation of pulmonary vascular resistance must be avoided in this case. Increases in pulmonary vascular resistance will result in the worsening of the right-to-left shunt leading to hypoxemia. Epidural anesthesia was chosen to preserve spontaneous ventilation to minimize mean airway pressures, thereby preventing increases in pulmonary vascular resistance [11]. Regular point-of-care blood analysis, capnography and temperature monitoring were employed. The acidosis and hypoxia (Table 1) may have increased the pulmonary vascular resistance. This caused a worsening of the right-to-left shunt which manifested as desaturations during and after the delivery of the baby. Careful volume replacement, and the use of norepinephrine and dobutamine improved the acid-base balance and oxygenation, leading to the improvement of the patient's oxygen saturation.

The use of point-of-care assessments and advanced hemodynamic monitoring entail additional cost. Considering the high mortality rate associated with Eisenmenger syndrome, this expense may be justified. The effectiveness of these technologies in diagnosis and management have been shown to improve patient outcomes. Studies on perioperative treatment algorithms based on minimally invasive hemodynamic monitors showed reduced complications and duration of hospitalization [12]. In addition, the use of a pulmonary artery catheter with continuous cardiac output monitoring is more expensive and comes with more risks than minimally invasive monitors. Point-of-care blood analysis has been shown to expedite and improve patient care [13]. Although the use of these technologies is more expensive than the use of standard monitors alone, these technologies may improve patient outcomes, and reduce the need for intensive care and length of hospital stay, thereby decreasing overall cost.

4. Conclusion

Enhancing patient safety and outcomes is challenging in a patient with Eisenmenger syndrome for cesarean section under epidural anesthesia. In this case, arterial pulse contour analysis, central venous pressure waveform analysis and point-of-care assessments, including echocardiography and blood analysis, facilitated accurate differentiation and appropriate management of the decreased cardiac output and systemic vascular resistance, and increased pulmonary vascular resistance brought about by surgical manipulation, blood loss and anesthetic technique. By utilizing these technologies, further complications and subsequent admission to an intensive care unit were prevented.

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Ethical approval

Not applicable.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Maria Teresita B. Aspi contributed in conceptualization, provision of resources, writing of original draft, reviewing and editing. Prince Mark F. Ocsan contributed in provision of resources and writing of original draft.

Research registration

Not applicable.

Guarantor

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Declaration of competing interest

None of the authors declare a conflict of interest.

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