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GUEST EDITORIAL

Balancing haemodynamic priorities in obstetrics: back to basics

DG Bishop,[1] RA Dyer,[2] M Crowther[2]

[1] Discipline of Anaesthesiology and Critical Care, School of Clinical Medicine, University of KwaZulu-Natal, South Africa
[2] Department of Anaesthesia and Perioperative Medicine, University of Cape Town, South Africa
Corresponding author, email: *davidgbishop@gmail.com*

The case presented by Davies and Hofmeyr illustrates the consequences of systems failure to patient care.[1] A patient with severe preeclampsia and an uncorrected cardiac lesion (in this case, Tetralogy of Fallot [TOF]) should be managed in a tertiary/quaternary setting, by a multidisciplinary team including a specialist obstetrician, anaesthesiologist, and cardiologist. The underlying cardiac condition should have resulted in early antenatal discussion regarding the threat of pregnancy to maternal life, including whether termination of pregnancy should be recommended. This complex decision was precluded by late booking of the pregnancy. The patient subsequently missed a high-risk clinic appointment, further preventing timely access to the specialised care she required. This is regrettably a common occurrence in South Africa. The NCCEMD report (2020–2022) showed that 57% of maternal deaths were deemed potentially preventable during this triennium.[2] The major causes of death included obstetric haemorrhage (16%), hypertensive disorders of pregnancy (15%), and medical and surgical disorders (14%).[2] It should be self-evident that when these conditions coexist, mortality risk increases significantly. In Africa, while the complication rate following caesarean delivery is 2–3 times higher than in high-income countries, the risk of dying is 50 times higher.[3]

The patient presented at 33 weeks gestation with severe preeclampsia and uncorrected TOF. Management of concurrent cardiac conditions should ideally be guided by experienced senior clinicians, with access to specialised monitoring equipment, drugs, cardiovascular support devices, and critical care services. Key principles in such complex cases include immediate referral to the anaesthesia provider within the hospital. In this case, there was an unfortunate delay until complications occurred. If experienced clinicians are unavailable on site, there should at least be telephonic discussion. This case represents a scenario that could be faced by practitioners at any level in the South African health system, as both preeclampsia and unrecognised or uncorrected cardiac pathology are relatively common problems. Anaesthetists must have an approach to balancing the haemodynamic priorities of each condition. The clinical team is to be congratulated on their astute clinical management of this vulnerable patient. Her subsequent in-hospital demise due to COVID-19 infection was indeed tragic.

It may be useful to consider in isolation each of the conditions that affected the cardiovascular system, before discussing an approach to the coexistence of all this pathology.

The expected haemodynamic changes associated with the four underlying conditions are as follows:

1. Cardiovascular changes in normal pregnancy

The physiological changes of advanced pregnancy are an important aspect to consider in any patient presenting for anaesthesia. During normal pregnancy, the heart increases in size, secondary to increased blood volume and increased stretch and force of contraction.[4] Left ventricular hypertrophy results in a 5–10% increase in mass,[5] and is accompanied by increased annular diameters of the mitral, tricuspid and pulmonary valves, such that 94% of women have some evidence of tricuspid and pulmonary regurgitation.[4] Heart rate increases by almost 25%, stroke volume by 20%, and the cardiac output consequently increases to 50% of pre-pregnancy values. This may be accompanied by a mild degree of diastolic dysfunction. Aortocaval compression in the supine position may also lead to hypotension, mainly secondary to preload reduction. This may have particular clinical significance when there is multiple cardiac pathology.

2. Pregnancy – specific cardiovascular disease; preeclampsia

Preeclampsia is a common condition in pregnancy in South Africa, which results in increased vascular tone and an increased sensitivity to vasoconstrictors.[4] It is usually a hyperdynamic state, with normal to increased cardiac output and moderately increased systemic vascular resistance.[4] Concentric ventricular hypertrophy and diastolic dysfunction often occur.[6] Transthoracic echocardiography in the typical case of uncomplicated preeclampsia with severe features, has shown what has been termed an "inovasoconstrictor state," with increased left ventricular mass, increased inotropy, normal to increased cardiac output, and an elevated systemic vascular resistance.[7] This may uncommonly progress to severe systolic dysfunction, even precipitating low ejection fraction cardiac failure. Early onset disease is more likely to show evidence of systolic dysfunction and severe diastolic dysfunction.[8] For the majority of patients, haemodynamic management priorities

focus on afterload reduction, accompanied by fluid restriction and seizure prophylaxis.

3. Congenital heart disease: Tetralogy of Fallot

This is the commonest cyanotic congenital heart disease, and the authors have correctly dealt with the relevant background information.[1] With surgical correction, most patients tolerate pregnancy reasonably well, although a proportion will still have cardiac pathology, such as pulmonary regurgitation and right ventricular dysfunction.[9] In the unrepaired TOF, patients present with a ventricular septal defect, an overriding aorta, right ventricular outflow tract obstruction (infundibular, valvular, or both) and right ventricular hypertrophy. In addition to the haemodynamic consequences of the cardiac lesion, these patients are also at increased risk of arrhythmias and infective endocarditis. The unrepaired form is rarely seen in adults in high-income countries, and in these patients pregnancy is not recommended due to significant maternal risk.[4] The key goal of management is to prevent right-to-left shunt across the ventricular septal defect, by maintaining sufficient afterload. High filling pressures should be maintained in order to enhance right ventricular output, especially in the presence of right ventricular compromise. Tachycardia is also poorly tolerated due to right ventricular outflow tract obstruction. Management priorities are, therefore, to maintain the preload, and in particular the afterload, while avoiding tachycardia.

4. Postpartum haemorrhage

Haemorrhage results in a decreased intravascular volume, leading to diminished preload and an initial sympathetic response, causing an increase in heart rate and myocardial contractility. Failure to correct hypovolaemia may result in multicomponent shock, with vasodilatation and impaired myocardial contractility. Treatment goals rely on rapid restoration of the blood volume with fluids, ideally including blood component therapy. Pharmacological support may be required while attending to the cause of bleeding and the replacement of blood loss, and ephedrine and adrenaline are the most suitable agents for this purpose. Phenylephrine is theoretically a less suitable choice given its alpha receptor selectivity. However, animal studies have suggested that this agent may assist with mobilisation of splanchnic venous blood in the shocked state, suggesting that it may be used to supplement the β inotropic effects of adrenaline.[10]

Uterine atony is suspected to have contributed to this particular patient's postpartum haemorrhage, with a resultant coagulopathy. It is unclear from the case report if there were contributing surgical factors. The medical management strategies for uterine atony are limited in this case. Rapid oxytocin administration can cause hypotension and arrhythmias, and preeclampsia precludes the use of ergometrine. Misoprostol would have been a reasonable agent to consider.

Balancing haemodynamic goals

Anaesthetic teaching often focuses cardiovascular priorities on individual components: heart rate, rhythm, preload, contractility, and afterload. In this case, the focus should be on preload, afterload and heart rate. This patient presented with hypertension (BP 157/103 mmHg), and a reasonably stable clinical condition. An echocardiogram done a week before had confirmed the cardiac lesion, and suggested that the ejection fraction was preserved. The systolic blood pressure was below the immediate target of 160 mmHg, recommended in the national guidelines.[11] At this point, the focus should have been on preventing eclampsia (using magnesium) while attempting to preserve afterload, given the uncorrected TOF. This required careful titration in a monitored setting. However, she was administered two further medications that cause afterload reduction: methyldopa and nifedipine. The dramatic reduction in afterload likely precipitated increased right-to-left shunt, hypoxaemia, and ultimately impaired myocardial contractility – which then worsened the shunt in a vicious cycle. Following the development of hypotension and hypoxaemia, the patient suffered a seizure, compounding the clinical deterioration.

The choice to do a general anaesthetic in this case was appropriate. Both severe preeclampsia and eclampsia may be managed under regional anaesthesia, provided preconditions are met.[12,13] Similarly, uncorrected TOF may also be managed under regional anaesthesia in specialist settings, using methods such as titrated epidural anaesthesia with strict preservation of the afterload.[14] However, when these conditions occur concurrently, and especially given the hypoxia and haemodynamic instability, general anaesthesia is preferred. Additionally, the use of positive pressure ventilation may have augmented myocardial contractility, and the use of positive end expiratory pressure would have improved hypoxia in the setting of pulmonary congestion. It is interesting that the attending anaesthetists chose to extubate the patient at the end of surgery; an argument could be made for at least a brief period of postoperative ventilation, particularly considering the risk of pulmonary oedema in eclampsia, and the probability of further haemorrhage.

How should clinicians approach cardiovascular assessment in these dynamic scenarios with complex cardiac pathology? While clinical acumen remains important, point-of-care cardiac ultrasound (either transthoracic or transoesophageal) is invaluable, as are other cardiac output monitors. However, this equipment and the clinical skills required to correctly interpret these devices are not routinely available outside specialist centres. A general strategy, prior to the onset of haemorrhage, might have incorporated the following management objectives:

1. High afterload, but maintain blood pressure below 160/110 mmHg.
2. Preserve intravascular volume.
3. Avoid tachycardia, aiming for heart rate < 80 beats per minute.

4. Maintain cardiac contractility and sinus rhythm where possible.

Postpartum haemorrhage changed the emphasis in management. In this case, the clinicians were limited by unavailability of the full range of blood component therapy, in particular cryoprecipitate to correct hypofibrinogenaemia, and platelet transfusion.

In the absence of cardiac output monitors, anaesthetists need to use all available clinical information. Fluid restriction, although recommended in preeclampsia,[15] no longer applies when there is acute hypovolaemia. Estimation of intravascular volume status requires an assessment of the overall symptom complex.[16] Heart rate and blood pressure are relatively late markers of hypovolaemia in obstetrics, but response to fluid administration remains an important clinical sign. Peripheral perfusion, acid-base status, urine output, and lactate level all provide further information.

In terms of invasive monitoring, the measurement of systolic pressure variation (SPV) and/or stroke volume variation (SVV) on the arterial trace in the ventilated patient are critical.[16,17,18] It is unclear whether a central venous catheter was inserted. Given the need for inotropic support, this would have been reasonable. Modern teaching is that central venous pressure (CVP) measurement is of little value in the assessment of volume status.[16,19] However, in the setting of rapid haemorrhage, a persistently low CVP would have further supported fluid administration. Finally, although not without risk, veno-arterial extra-corporeal membrane oxygenation (VA ECMO)[20] and/or resuscitative endovascular balloon occlusion of the aorta (REBOA)[21] are increasingly being employed in high-resource environments for the management of haemodynamic instability in patients with complex obstetric cardiovascular pathology, and fulminant postpartum haemorrhage. However, in limited resource environments, the patient remains dependent on the astute clinical judgement of the anaesthesia provider in urgently deciding on the clinical priorities for cardiovascular intervention in these vulnerable patients.

ORCID

DG Bishop https://orcid.org/0000-0001-9861-3646

RA Dyer https://orcid.org/0000-0002-8165-9098

M Crowther https://orcid.org/0009-0004-6072-7735

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