INVASIVE HEMODYNAMIC MONITORING IN OBSTETRICS AND GYNECOLOGY

Dr. Ahmet Erk [1], Dr. Nadi Keskin[1], Dr. Murat Dikmengil[2], Dr. Baki Komsuoğlu[3]
KOÜ Tıp Fakültesi Kadın Hastalıkları ve Doğum[1], Göğüs Kalp ve Damar Cerrahisi[2] ve Kardiyoloji[3] A.D.

SUMMARY

The indications for invasive hemodynamic monitoring in obstetrics and gynecology are much the same in any other area of medicine and surgery. The clinical decision of whether to employ monitoring cannot be made according to absolute criteria but must be made on individual basis. Proper patient selection is important because not every patient will benefit from invasive monitoring. Also skilled physicians, nurses and support personnel should be available. The information collected can be used to both guide and evaluate therapeutic maneuvers. Proper management in these conditions would have a significant impact on the outcome of a critical illness or on the patients on the verge of cardiac or respiratory decompensation. Currently there is no prospective randomized study about the efficiency of the pulmonary artery catheter in obstetrics and gynecology.

Key Words: Hemodynamic monitoring, obstetrics, gynecology.

OBSTETRİK VE JNEKİOLOJİDE İNVAZİV HEMODİNAMİK MONİTORİZASYON

ÖZET

Obstetrik ve Jinekolojideki invaziv hemodinamik monitorizasyon endikasyonları diğer cerrahi ve dahili branştakilerle aynıdır. Monitorizasyon hakkındaki klinik uygulama kesin kriterlere bağlanamaz ve her vaka için ayrı ayrı değerlendirilmelidir. Her hasta invaziv monitorizasyondan fayda görmeyeceğinden uygun hasta seçimi önemlidir. Elde edilen bilgilerden tedavi yöntemlerinin yönlendirilmesi ve değerlendirilmesinde kullanılır. Bu durumlarda uygun tedavi kritik hastalığın veya kardiyak respiratuvar dekompansasyon sonucunda önemli etkisi olur. Halen jinekoloji ve obstetrikte pulmoner arter katerizasyonunun etkinliği üzerine prospektif randomize bir çalışma mevcut değildir.

Anahtar Kelimeler: Hemodinamik monitorizasyon, obstetrik, jinekoloji

In the past right heart catheterization was accomplished with semirigit catheters and fluoroscopy thereby limiting the procedure to cardiac catheterization laboratories (1). With the development of the flow-directed pulmonary artery catheter the technology moved from the laboratory to intensive care units, operating rooms, and labor and delivery rooms (2,3,4,5,6,7). Pulmonary artery catheterization provides information about left ventricular function that can not be obtained with central venous pressure monitoring. The combination of peripheral arterial and pulmonary arterial lines provides sufficient information to assess continuously both the cardiac and the pulmonary status of the patient. Use of pulse oximetry can provide continuous monitoring of arterial hemoglobin saturation. Clinical impressions can quickly be either reinforced or refuted with accurate hemodynamic measurements in critically ill patients, and therapeutic strategies can be calculated and their effects promptly evaluated.

TECHNIQUES

Invasive monitoring decision should include an assessment of the exercise of the physician to place the catheter and expertise and availability of support staff to monitor the patient and maintain the equipment. Invasive monitoring should be carried out only in units with appropriate staffing ratios to allow continuous observation of the patient.

The standard flow-directed thermo-dilution pulmonary artery catheter includes a distal lumen at the catheter tip, a proximal lumen 30 cm from the catheter tip, a balloon lumen and a thermistor. The distal lumen provides continuous measurement of the pulmonary artery pressure when the balloon is deflated and the pulmonary capillary wedge pressure (PCWP) when the balloon is inflated. The proximal port can be used to monitor CVP or to administer fluids or drugs. Both lumens can be used to withdrawal samples of venous studies for laboratory studies. Central core temperature can be measured and the cardiac output calculated when the pulmonary artery catheter is used in conjunction with a thermodilution cardiac output computer.

Additionally, fiberoptic pulmonary artery catheters are now being increasingly used, also these have additional advantage of continuous reading of the patient's mixed venous oxygen saturation.

Cannnulation of peripheral or central vessels for placement of intraarterial and pulmonary artery catheter should be accomplished by individual skilled in these procedures and familiar with the complications. An increasing number of obstetrician are familiar with line placement, beside the data collection and interpretation. (Table 1).

Data Collection And Interpretation

Heart rate and rhythm are observed through the use of continuos electrocardiograph monitoring. Continuous measurements of CVP and pulmonary artery pressure and intermittent measurements of PCWP are afforded directly by use of the pulmonary artery catheter. Cardiac output can be measured by thermodilution. Systemic arterial pressure can be measured by sphygmomanometer and percutaneous arterial cannulation the latter also provides easy access for arterial blood sampling Mean pressure values can be determined for both the pulmonary arterial and the systemic circulation by electronic dampening of the respective tracing or by calculation with standard formulas. Additional hemodynamic values that reflect cardiopulmonary function and vascular resistance can be calculated as shown in Table 1. Stroke volumes a measure of the amount of the blood pumped per contraction by the hearth. Both cardiac output and stoke volume can be corrected for body size by dividing these values by body surface area to obtain the cardiac index and stroke index. Body surface area can be determined from the standard nomograms, but this data reflect the values for nonpregnant subjects (8). These values are not known for the pregnant. Resistance to flow can be calculated from the right and left ventricles through determination of pulmonary and systemic vascular resistance, respectively. Pulmonary shunts and arterial-venous oxygen content differences are calculated by analysis of simulta-neously obtained samples of mixed venous blood drawn from the distal port of the pulmonary artery catheter, and arterial blood (9).

Hemodynamic values for healthy nonpregnant women can be compared with those obtained in health primiparous women studied in lateral recumbent position at 36-38 weeks of gestation and 11-13 weeks postpartum (Table 2) (10). Compared with nonpregnant woman, a normal pregnant women in the third trimester will have an increased cardiac output. The increased cardiac output is accounted for primary by an increased in stroke volume, but also increased hearth rate. Mean arterial blood pressures were not different when measured in the late third trimester and at 3 months postpartum. In contrast, both the systemic and pulmonary vascular resistance, as determined by invasive monitoring are significantly lower during the third trimester of pregnancy.

Assessment of cardiac function consists of evaluation of preload, afterload, hearth rate, and myocardial contractility. If any of these variables is abnormal, initial therapy should be targeted at correcting the specific dysfunction. Invasive monitoring allows for almost instantaneous assessment of therapeutic maneuvers. Additionally, significant pulmonary dysfunction in the face of normal cardiac function must include a systemic examination of each area that can lead to hearth failure.

Preload is determined by end-diastolic intraventricular pressure and volume, thus setting the initial myocardial fiber length. Preload can be increased by the administration of crystalloid solution, colloid solution, or blood and can be decreased by the use of diuretic, a vasodilator, or by phlebotomy.

Afterload is the tension of the ventricular wall during systole and is dependent on ventricular end-diastolic radius, aortic or pulmonary arterial diastolic pressure and ventricular wall thickness. Afterload like preload can be increased or decreased as mandated by clinical circumstances. Increases can be mediated via alpha-adrenergic agonists such as

Table 1. Formulas.

Mean presure = [systolic pressure + 2(diastolic pressure)]/3
Stoke volume (SV) (ml/beat)=cardiac output (CO)(L/min)/Heart rate (beat/min)
Stoke Index (SI) (ml/beat:m^2) = Stroke Volume (SI)/Body Surface Area (BSA) (m^2)
Cardiac Index (CI)(L/min/ m^2)= Cardiac output (CO) (L/min)
Pulmonary Vascular Resistance (PVR) (dyne cm sec^5)=[(MPAP-PCWP)/CO] X 80
Systemic vascular resistance (SVR) (dyne cm sec^5)=[(MAP-CVP/CO] X 80
MPAP= Mean pulmonary artery pressure (mm Hg)
MAP= Mean systemic arterial pressure (mm Hg)
PCWP=Mean pulmonary capillary wedge pressure. (Mm Hg)
Conversion Factor= 1 mm Hg/1 L/ min= 80 dyne cm sec^5.

Table 2. Hemodynamic values in healthy nonpregnant, pregnant, and postpartum subjects (9,10).

Parameters (Units)	Nonpregnant	36-38 Weeks of Gestation	Postpartum
Heart rate (beats.min)	60-100	83 ± 10	71 ± 10
Central venous pressure (mm Hg)	5-10	3.6 ± 2.5	3.7 ± 2.6
Mean pulmonary artery pressure (mm Hg)	15-20	---------	----------
Pulmonary capillary wedge pressure (mm Hg)	6-12	7.5 ± 1.8	6.8 ± 2.1
Mean arterial pressure(mm Hg)	90-110	90.3 ± 5.8	86.4 ± 7.5
Cardiac output(L/min)	4.3-6.0	6.2 ± 1.0	4.3 ± 0.9
Stroke volume(ml/baet)	57-71	74.7	60.6
Systemic vascular resistance(dyne cm sec^5)	900-1400	1.210 ± 266	1.530 ± 520
Pulmonary vascular resistance(dyne cm sec^5)	<250	78 ± 22	119 ± 47

while decreases can be achieved with number of vasodilating agents. Sodium nitroprusside infusions are used most commonly to decrease afterload in medical, surgical intensive care units, while hydralazine is the agent most commonly used in obstetrics.

Myocardial contractility (inotropic state of the hearth) is defined as the force and velocity of ventricular contractions when preload and afterload held constant. Beta-sympatomimergic agents such as dopamine and isoproterenol are effective in improving cardiac output acutely. Depending on the cause of the myocardial failure, either short-term and long-term therapy with digitalis may be necessary.

Hearth rate is one of the variable to evaluate the patient. Although it is very rare in obstetrics-gynecology patients, hearth block can compromise cardiac output. In this circumstance treatment with either atropine or cardiac pacing is indicated. Similarly, sustained tachycardia can lead to hearth failure due to shortened systolic ejection and diastolic filling times or myocardial ischemia, especially in the presence of stenotic cardiac valvular lesions. The pathophysiologic basis of tachycardia should be determined and corrected. Hearth rate can also be controlled with propranolol or digoxin. Calcium channel blokers can also control hearth rate, but safety of these medications for pregnant patient is not known.

INDICATIONS

Clinical conditions that invasive hemodynamic monitoring may assist in management of obstetric and gynecologic patient is (11,12):

* Sepsis with hypotension or oliguria.
* Pulmonary edema.
* Hearth failure.
* Oliguria or anuria.
* Severe pregnancy induced hypertantion (PIH).
* Intraoperative or intrapartum cardiovascular decompansation.
* Respiratory distress syndrome.
* Shock of undefined etiology.
* Chronic hearth disease (e.g. NY Hearth association Call III or IV cardiac disease, peripartum or intraoperative ischemia or myocardial infarction).
* Prodthetic heart valve dysfunction and pregnancy (12).

It is clear that invasive monitoring will not be necessary in every patient with one of these conditions, nor is this an all-inclusive list of indications for monitoring. Pregnancy is not a contraindication for invasive monitoring and the same standards and criteria should be used. Also monitoring can be used in prophylactically in seriously ill patients. In the patient with acute and unexpected pulmonary edema can quickly be differentiated from hearth failure with assessing the PCWP. Volume status of the patient can be assessed by ventricular preload or filling pressures, and this is very critical in patients with massive volume loss, oliguria and sepsis. These information is necessary for guiding further therapeutic manipulations. CVP monitoring can help us to asses the right ventricular function and systemic vascular compliance. Primary disadvantages this method relate to the fact that CVP levels may not necessarily be elevated in the presence of left ventricular failure and pulmonary congestion and, conversely, may be elevated in patients without evidence of pulmonary edema (13). Pulmonary capillary wedge pressure can be reliably assessed by CVP monitoring only in the absence of cardiopulmonary disease. It has been noted that in the presence of dissociated right and left hearth function, absolute CVP values correlate poorly with left-sided filling pressures, and even changes in this modality may be misleading.

The complications of invasive hemodynamic monitoring depends on duration of monitoring and conduction with gaining vascular access. Peripheral arterial cannulation can be associated with hematoma formation, infection and thrombosis. Serious complications are less than 1%. Gaining central venous access for either a pulmonary artery catheter or CVP catheter can also cause wall damage, infection, arterial puncture, pneumothorax, persistent bleeding. The pulmonary artery catheter unlike CVP lines frequently will cause transient arrhythmias (15-27%) as it is passed through the hearth, but only 1% of the patients require pharmacological treatment. A significant complication is disconnection of the catheter from the intravenous line. Most of the complications are related with the experience of the physician. Given broad range of medical and surgical patients with conditions necessitating invasive monitoring, 3% will sustain a major complication including death (14,15).

In conclusion the need for monitoring, potential benefits must be weighed against the reported risks, taking into consideration that many complications, such as arrhythmias and pneumothoraces, are more likely to occur when dealing with a patient in extremes.

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