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# ARTERIAL BLOOD GAS MONITORING IN CRITICALLY ILL ANTENATAL AND POSTNATAL PATIENTS

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**ABSTRACT** Arterial blood gas determinations (ABGs) play an important role in diagnosing derangements in acid-base balance, oxygenation, and ventilation. Frequent assessment is necessary in the management of critically ill antenatal and postnatal patients. This article reviews the technologic evolution of modern blood gas analysis and the clinical application of monitoring hydrogen ion content (pH), blood oxygen tension (PO2), and carbon dioxide tension (PCO2) acid base balance in the body.

**KEYWORDS :** Critically Ill Parturient, Haemodynamic, Intensive Care, Obstetrics, Pregnancy, Sepsis, Ventilation

## INTRODUCTION

Obstetric patients admitted to an Intensive Care Unit (ICU) present a challenge to an intensivist because of normal physiological changes associated with pregnancy and puerperium, the specific medical diseases peculiar to pregnancy and the need to take care of both the mother and the foetus. Most common causes of admission to an ICU for obstetric patients are eclampsia, severe preeclampsia, haemorrhage, congenital and valvular heart disease, septic abortions, severe anemia, cardiomyopathy and non-obstetric sepsis[1].

## AIMS AND OBJECTIVES

To assess indication of ABG in critically ill obstetric patients:

1. Identify the indications for blood gas sampling.
2. Role of arterial blood gas values and their implications to patient management.
3. Ease of ABG in clinical practice.
4. Whether ABG analysis alters diagnosis or management of optimizes quality of patient care.
5. Arterial blood gas changes during the course of treatment/management of critically ill female patient

## MATERIALS AND METHODS

The present study was be conducted in the department of obstetrics and gynaecology in association of department of Medicine of Maharani Laxmi Bai Medical College, Jhansi on 300 critically ill admitted patients.

## SELECTION CRITERIA:

A critically ill obstetric patient is the one who, because of normal or abnormal pregnancy, delivery and puerperium, or because of effects of systemic disease, develops complic ations threatening her life for which she needed intensive monitoring, therapy or life support system.

## INCLUSION CRITERIA:

Critically ill obstetric patients who need intensive care and management.

- Patient with low general condition and hemodynamically unstable.
- Pregnancy specific conditions – haemorrhages, septicemia, hypertensive disorders, amniotic fluid embolism, aspiration syndrome.
- Medical diseases that may worsen during pregnancy – severe anemia, pulmonary edema, embolism/ARDs, hepatic dysfunction.

## EXCLUSION CRITERIA:

- Patients with known case of heart disease
- Patients with known case of asthma or any other respiratory disease like COPD
- Preexisting kidney disease, nephritic disease, CKD, nephrolithiasis.
- HIV infected patients.

After taking detailed clinical history, clinical examination of the patients and relevant investigations, patients was assign a case number, and their name, age, sex, occupation socio-economic status was be noted. A detailed antenatal and postnatal history was also be noted.

## INVESTIGATIONS:

### ROUTINE EXAMINATION:

- Hb:
- TLC:
- DLC:
- P/C:
- RBC:

## CONTRAINDICATIONS TO ABG SAMPLING:

- Local infection
- Distorted anatomy
- Presence of arterio-venous fistulas
- Peripheral vascular disease of the limb
- Severe coagulopathy

## PROCEDURE FOR ARTERIAL BLOOD GAS (ABG) RADIAL ARTERY SAMPLING:

- Perform a modified Allen test to ensure adequate collateral circulation from the ulnar artery.
- Position the patient's hand with the wrist extended 20—30 degrees. Greater extension of the wrist may impede arterial flow.
- Identify the radial artery by palpating the pulse; choose a site where the pulse is prominent.
- Clean the sampling site with an alcohol wipe.
- Expel the heparin from the syringe.
- Steady your hand on the patient's hand,; then insert the needle at 45 degrees, bevel facing up.
- Be sure to insert the needle slowly to minimise the risk of arterial spasm.
- When the needle is in the artery, a flash of pulsatile blood will appear in the barrel of the needle. Most ABG syringes will then fill under arterial pressure.
- Obtain at least 3 mL of blood before withdrawing

## PRECAUTIONS AFTER SAMPLING:

- Once adequate blood has been obtained, remove the needle and apply firm, direct pressure to the sample site for at least 5 minutes (and until bleeding has ceased). Dispose of all sharps and contaminated materials

appropriately.
- Ensure no air bubbles are present in the sample, as they may compromise results. Any sample with more than very fine bubbles should be discarded. The sample should be analysed promptly: if the transit time is likely to exceed 10 minutes, then the syringe should be stored on crushed ice.

ABG sampling was done at 0 hrs of admission and 24 hrs of admission in critically ill obstetric patients. Then changes in arterial blood gas was observed according to the intervention given. Outcome of patient as recovery or mortality was observed and compared.

## RESULT:

**Table 1: Distribution of cases according to antepartum/ postpartum period**

| Parameters | Number of cases | Percentage |
|---|---|---|
| Antenatal | 168 | 67.2% |
| Postnatal | 82 | 32.8% |
| Total | 250 | 100% |

**Table 2: Distribution of cases according to diagnosis and its outcome**

| Diagnosis | No. of cases | Improved without ventilation (n=140) | Recover on ventilation (n=84) | Mortality on ventilation (n=26) |
|---|---|---|---|---|
| **Obstetrics** | **156** | | | |
| **Eclampsia (antepartum/ postpartum)** | 47 | 30 | 15 | 2 (7.6%) |
| **Severe pre-eclampsia** | 15 | 10 | 4 | 1 (3.8%) |
| **Obstetric hemorrhage** | 56 | 36 | 16 | 4 (15.3%) |
| **Major postpartum hemorrhage** | 38 | 26 | 9 | 3 (11.5%) |
| **Non obstetrics** | 94 | | | |
| **Severe anaemia related complications** | 37 | 23 | 11 | 3 (1.5%) |
| **Septicemia** | 24 | 8 | 14 | 2 (7.6%) |
| **Hepatic dysfunction/ hepatic encephalopathy** | 15 | 3 | 9 | 3 (11.5%) |
| **Pulmonary embolism** | 3 | 0 | 1 | 2 (7.6%) |
| **ARDs/Pulmonary oedema** | 7 | 0 | 3 | 4 (15.3%) |
| **Other** | 8 | 4 | 2 | 2 (7.6%) |

Out of total mortality, 15.3% of mortality occur due to obstetric hemorrhages, 11.4% of death occurred due to pregnancy induced hypertension including eclampsia, severe preeclampsia, impending eclampsia and HELLP syndrome. 61.5% of mortality was due to non obstetric indirect cause.

**Table 3: ABG at 0 hr and its outcome**

| Acid base disorders | Improved conservatively | Ventilator support | |
|---|---|---|---|
| | | Survivors | Death |
| Compensated metabolic acidosis | 103 | 22 | 06 |
| Decompensated metabolic acidosis | 32 | 54 | 10 |
| Metabolic alkalosis | 4 | 2 | 2 |
| Respiratory alkalosis | 2 | 6 | 8 |
| Total (%) | 140 (56%) | 84 (33.6%) | 26 (10.4) |

Out of total admitted patients, 56% of them were improved by doing conservative management and monitoring in ICU without ventilatory support ,whereas 110(44% ) of them went on mechanical ventilation in which 33.6% of total patients survived during the course of treatment and successfully discharged after weaning from ventilator ,whereas 10.4% of total patients died while on mechanical ventilation in which most common acid base disorder was decompensated metabolic acidosis ( 38.4%)diagnosed at the time of admission. out of 250 patients,103 patients diagnosed with compensated metabolic acidosis improved successfully without ventilatory support while 28 of them required ventilation and 23% of total mortality was attributed by compensated metabolic acidosis group of patients.

30.7% of total mortality was seen in patients diagnosed with respiratory alkalosis

| Acid base parameters | Survivors | | Non-survivors | | P value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| **pH (0 hr)** | 7.256 | 0.798 | 7.047 | 0.161 | <0.001 |
| **pH (24 hr)** | 7.345 | 0.063 | 7.147 | 0.110 | <0.001 |
| **PaCO2 (0 hr)** | 28.635 | 8.034 | 38.554 | 16.657 | 0.677 |
| **PaCO2 (24 hr)** | 30.026 | 7.318 | 27.775 | 7.213 | <0.602 |
| **HCO3 (0 hr)** | 13.993 | 3.144 | 10.254 | 2.554 | <0.001 |
| **HCO3 (24 hr)** | 17.144 | 3.635 | 11.075 | 5.710 | <0.001 |
| **Lactate (0 hr)** | 3.223 | 2.909 | 7.136 | 3.078 | <0.001 |
| **Lactate (0 hr)** | 1.953 | 1.675 | 7.325 | 5.099 | 0.003 |
| **BE (0 hr)** | -11.773 | 5.257 | -7.736 | 3.539 | <0.001 |
| **BE (24 hr)** | -8.887 | 4.21 | -18.25 | 6.628 | 0.95 |

ABG analysis was done at '0' hour of admission and repeated after 24 hours while giving treatment and the results were compared between survivors and non survivors. The results were found statistically significant ($p < 0.001$). Non survivors showed a lower mean pH, bicarbonate, and a higher lactate and base excess than survivors. The mean pH changes from '0' to '24' hrs were found (7.04-7.14) on lower side as compared to survivors i.e7.25 at '0' hr to 7.34 at '24' hours. Mean Bicarbonate concentration was 10.25 -11.07 in non survivors as compared to survivors i.e 13.99 -17.14.

Higher incidence of lactic acidosis among non survivors with higher mean value and increase in lactate level in non survivors (from 7.13 to 7.32).whereas in survivors mean lactate level is much lower as compared to non survivor at '0' hr i.e 3.22 and decrease in mean of 1.95 when repeated at 24 hr in survivors .thus indicating lactate may be a factor useful in prognostification

## DISCUSSION:

Critical care is a bonafide part of obstetric practice. A critically ill obstetric patient is the one who, because of normal or abnormal pregnancy, delivery and puerperium ,or because of effects of systemic disease ,develops complications threatening her life for which she needed intensive monitoring, therapy or life support system. Care of critically ill pregnant patients presents a unique challenge as the assessment, monitoring and the treatment must take into account both maternal and fetal well being.

There are different modalities and investigation for monit oring the critically ill patients in intensive care unit. One of the important investigation is arterial blood gas analysis. The process of analysis and monitoring of arterial blood gas is an essential part of diagnosing and managing the oxygen status and acid base balance of the high risk patients as well as in the care of critically ill patients in ICU.

Our study is a prospective, observational and cohort study

conducted in department of obstetrics and gynaecology in Maharani Laxmi Bai medical college, jhansi. It is aimed to identify indications of ABG sampling in obstetric patients, changes in arterial blood gas values during the course of treatment and its relation with the outcome of patients in form of survivors or mortality.

Obstetrics admission rate to maternal ICU was 0.9% and 3.4% in a study done by Mabie et al[2] and lewinsohn et al[3] respectively.

Age is one of important prognostic factors. In our study maximum number of patients were in age group of 25-29 years (35.6%) with second most common age group is of 21-24 yrs (33.6%). The mean age distribution of age in studies done by Patidar et al[4] was 56% for the age group of 21-30 yrs and 14.7% for those above 30 years and that done by Rochet et al[5] was 72% for the age group of 21-30 years. These studies thus show that majority of the obstetrics patients requiring critical care in the group 21 -30 years which is comparable to ours study.

In our study ,majority of patients belonged to lower socio-economic status i.e 50.4% ,whereas 34.4% were of lower middle group and only 9.2% patients belonged to upper lower socio-economic status .only 4.8% of critically ill female patients were of upper middle class, whereas only 1.2% of them were of upper socio economic group.

In our study, maximum number of critically ill patients are antepartum i.e 67.2%, whereas 32.8% of patients were of postpartum. Karnad et al[6] also reported the majority rate of 21.6% in both antepartum & postpartum group. In our study, maximum no. of obstetrics admission occurred during antepartum period with maximum admission in 3rd trimester (34.4%) followed by postpartum period (32.8%). Only 17% admission in 1st and 2nd trimester. These concepts of gestational age highlights the maximum occurrence of complications in 3rd trimester and postpartum period and thus the importance of close suspension of patients during these periods .distribution of gestational age (antepartum, postpartum) in previous studies done by Karnad et al[6] (46.6%,53.3%), Basket et al[7] (18%,82%) and El Soth et al. (62%,38%) was comparable to our studies.

In our study, maximum number of admissions were either multipara or multigravida. Mentel et al[8] and Bhattacharya et al[9] showed highest mortality in women with there or more parity .thus the results in these studies are consistent with our observations of critically ill patients in multiparous group.

73.6% of the critically ill patients were referred from the primary health care centers and district hospitals of periphery showed inadequate and improper management of obstetric complications leading to high rate of morbidity and mortality in rural areas. Our primary health facilities should be staffed with trained midwives supervised by obstetricians & secondary care hospitals in the state should have obstetricians and facilities for providing emergency services.

Out of total admitted patients, only 32.8 % patients were booked mothers while rest of 67.2% were unbooked i.e they have no ANC registration ,no previous antenatal check ups and investigations. The study showed positive correlation between unbooked mothers and increase risks of maternal adverse outcomes. Educating the communities at the gross roots level about the benefits of receiving antenatal care and supervised delivery by skilled attendants will have a significant impact on improving pregnancy outcomes in our locals.

Basket et al. in[7] studied the obstetrics patients requiring ICU admission over period of 14 yrs. The study concluded that the main indications for the maternal transfer to ICU are hypertensive disorders, hemorrhages, and sepsis along with medical disorders. One study conducted at Parkland hospital showed that 1.7% of almost 22,000 women delivered required admission to ICU and the most common indications compelling transfer are hypertensive disorders (40%) ,obstetrical hemorrhage (15%) and pulmonary insuffic iency(9%). In our study 62.4% of critically ill patients admitted due to direct obstetric causes, the most common being hypertensive disorders (24.8%) including antepartum, postpartum eclampsia, severe and impending eclampsia and related complications, most common HELLP syndromes. Second most common indication is obstetric haemorrhages (22.4%) which includes antepartum haemorrheges, rupture uterus, ruptured ectopic pregnancy, uterine perforation, incomplete abortions etc. 15.2% are admitted due to major blood loss in post partum period (PPH) . Non obstetrics or indirect cause includes septicemia, severe anaemia related complications ,pulmonary insufficiency due to embolism or ARDS and other causes. Thus the present study is comparable with various previous studies like Baskett et al[7]., Mahutte et al[10],.EL-solh et al[11] and Karnad et al[6] which have shown PIH, maternal haemorrhages and medical disorders of pregnancy were the most common indications requiring maternal transfer to ICU.

The need for mechanical ventilation evaluated in the study. Baskett et al[7] showed 45% of the critically ill obstetric patients required mechanical ventilation .Tang et al. and Lapinsky et al[12] in their studies showed mechanical ventilation was required in 12-55% of the obstetric patients admitted to an ICU. .44% of the total number of patients require support of artificial mechanical ventilation which is comparable to various studies.

Lewinsohn et al[3],Tang et al[13]. , and Sriram et al[14] reported mortality rates of critically ill obstetric patients admitted to ICU in the range of 0% to 36% thus coinciding with mortality found in the present study (10.4%). Direct and indirect causes of maternal mortality in studies done by Bhattacharya et al[9] was 83.6% & 16.4%, by Patel et al[15] was 63.7 % and 36.3% and by Sharma et al. was 56.3% and 437% respectively. The present study showed 34.6%. mortality due to direct obstetric causes. Rochat et al[5], Bhattacharya et al[9] and Baskett et al[7]. reported mortality of 18-20 % due to obstetric hemorrhages and 27-30% due to sepsis and pulmonary insufficiencies. We found 15.3% mortality due to obstetric hemorrhage and 11.7% due to major PPH while 11.4% due to PIH.

Most common acid base disorder diagnosed by '0' hour ABG sampling at the time of admission was metabolic acido sis(80.4%) in which 38.4% of them are diagnosed with decompensated metabolic acidosis found in patients diagnosed with hypertensive disorders, hypovolemic shock due to hemorrhages, septicaemia and shock. Only 3.2% of total patients belong to metabolic alkalosis group in patients of hyperemesis gravidarum and severe diarrhoea. 6.4% of total patients belongs to respiratory alkalosis occur in patients with ARDS, pulmonary oedema, Pulmonary embolism etc.

Out of total admitted patiens,56% of them were improved by doing conservative management and monitoring in ICU without ventilatory support, whereas 110 (44%) of them went on mechanical ventilation in which 33.6% of total patients survived during the course of treatment and successfully discharged after weaning from ventilator ,whereas 10.4% of total patients died while on mechanical ventilation in which most common acid base disorder was decompensated metabolic acidosis (38.4%) diagnosed at the time of admission. Out of 250 patients, 103 patients diagnosed with compensated metabolic acidosis improved successfully

without ventilatory support while 28 of them required venti lation and 23% of total mortality was attributed by compensated metabolic acidosis group of patients. 30.7% of total mortality was seen in patients diagnosed with respiratory alkalosis.

ABG analysis was done at '0' hour of admission and repeated after 24 hours while giving treatment and the results were compared between survivors and non survivors. The results were found statistically significant ($p< 0.001$). Non survivors showed a lower mean pH, bicarbonate, and a higher lactate and base excess than survivors. The mean pH changes from '0' to '24' hrs were found (7.04-7.14) on lower side as compared to survivors i.e7.25 at '0' hr to 7.34 at '24' hours. Mean Bicarbonate concentration was 10.25 - 11.07 in non survivors as compared to survivors i.e 13.99 -17.14.

Our study showed higher incidence of lactic acidosis among non survivors with higher mean value and increase in lactate level in non survivors (from 7.13 to 7.32). Whereas in survivors mean lactate level is much lower as compared to non survivor at '0' hr i.e 3.22 and decrease in mean of 1.95 when repeated at 24 hr in survivors. As compared to study done by Gnnerson et al[16] out of 851 patents, 64% had metabolic acidosis and 45% had mortality. The mortality rate was highest for lactic acidosis (56%) among all causes. Also when compared with Albright (201) USA studies showed lactic acidosis as a prognostic indicator for increase in maternal morbidity, admission to ICU ($p<0.01$) or acute monitoring unit ($p<0.01$) and longer hospital stay ($p<0.01$). Thus indicating lactate may be a factor useful in prognostification. Lactate level can serve as one of the earliest markers of damage that has been caused at tissue level. Lactate accumulates as a result of anaerobic metabolism at tissue level in presence of inadequate oxygen delivery. Common conditions leading to lactic acidosis in ER are hypoxemia due to any reason, severe anaemia or shock. Higher lactate level at the time of admission with shock were found associated with increase duration of intensive care unit stay and mortality. Paladino L et al[17] in their interesting work added lactate and base deficient to traditional vital signs in patients with trauma. lactate levels are considered to be an indirect marker of hemorrhage as bleeding leads to decreased tissue perfusion. They found that adding these parameters identifies major injuries with a sensitivity of 76.4% than vital signs alone that were able to recognize major injuries with40.9% sensitivity.

Lactate level are an important marker in patients with sepsis and septic shock. Our results indicates lactate level and serial estimation both are prognostically important in predicting outcome of patients.

Effect of interventions like inotropic supports and blood transfusion on outcome of patients and found statistically significant. Out of 26 mortality, 76.9% patients required inotropic supports 38.4% of total mortality required blood transfusion more than 5 units.

## CONCLUSIONS

With present study, we concluded that ABG analysis is an important prognostic tool while monitoring critically ill obstetric patients in intensive care unit. Patients with lower pH, higher lactate or lower bicarbonates at presentation are considered as high risk patients and should be shifted to ICU for intensive monitoring to avoid maternal mortality. Regular monitoring of ABG, parameter and obsessing the changes in parameter can help providing early warning of deterioration and can judge the effectiveness of therapeutic intervention, thus an predict the good and poor outcome and duration of stay in intensive care unit

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