



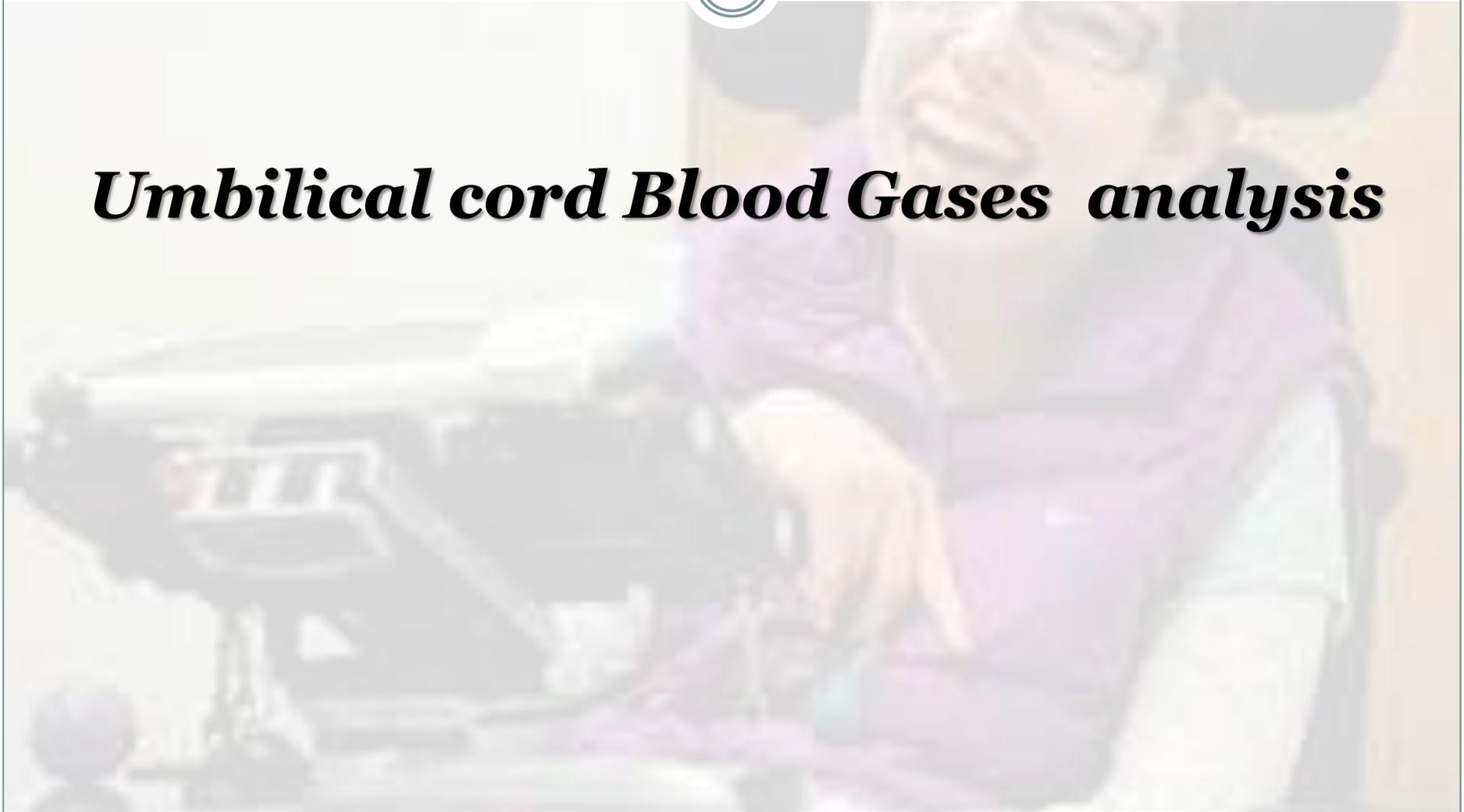
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Dr.Choupani
Neonatology





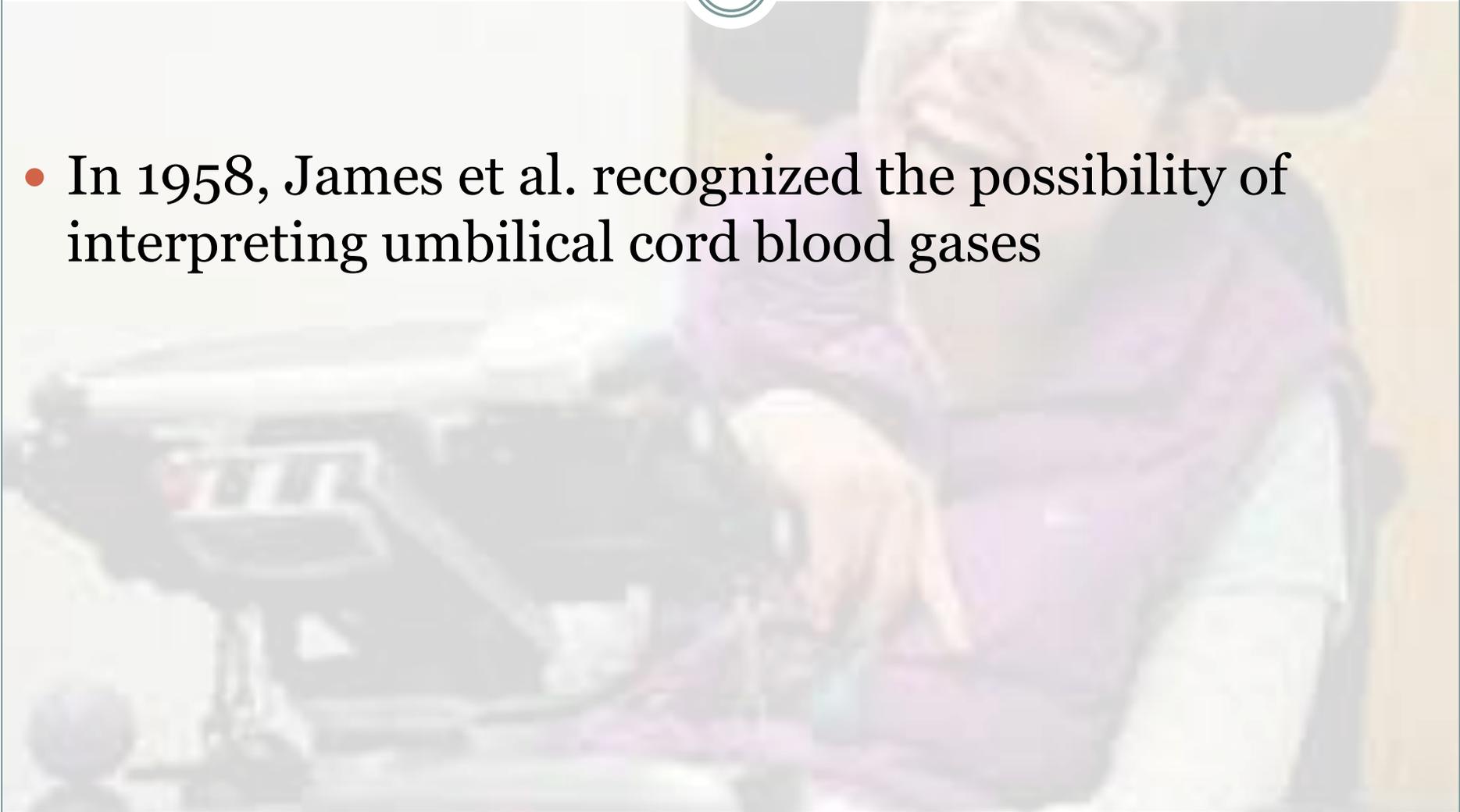
Umbilical cord Blood Gases analysis



History of UBGs

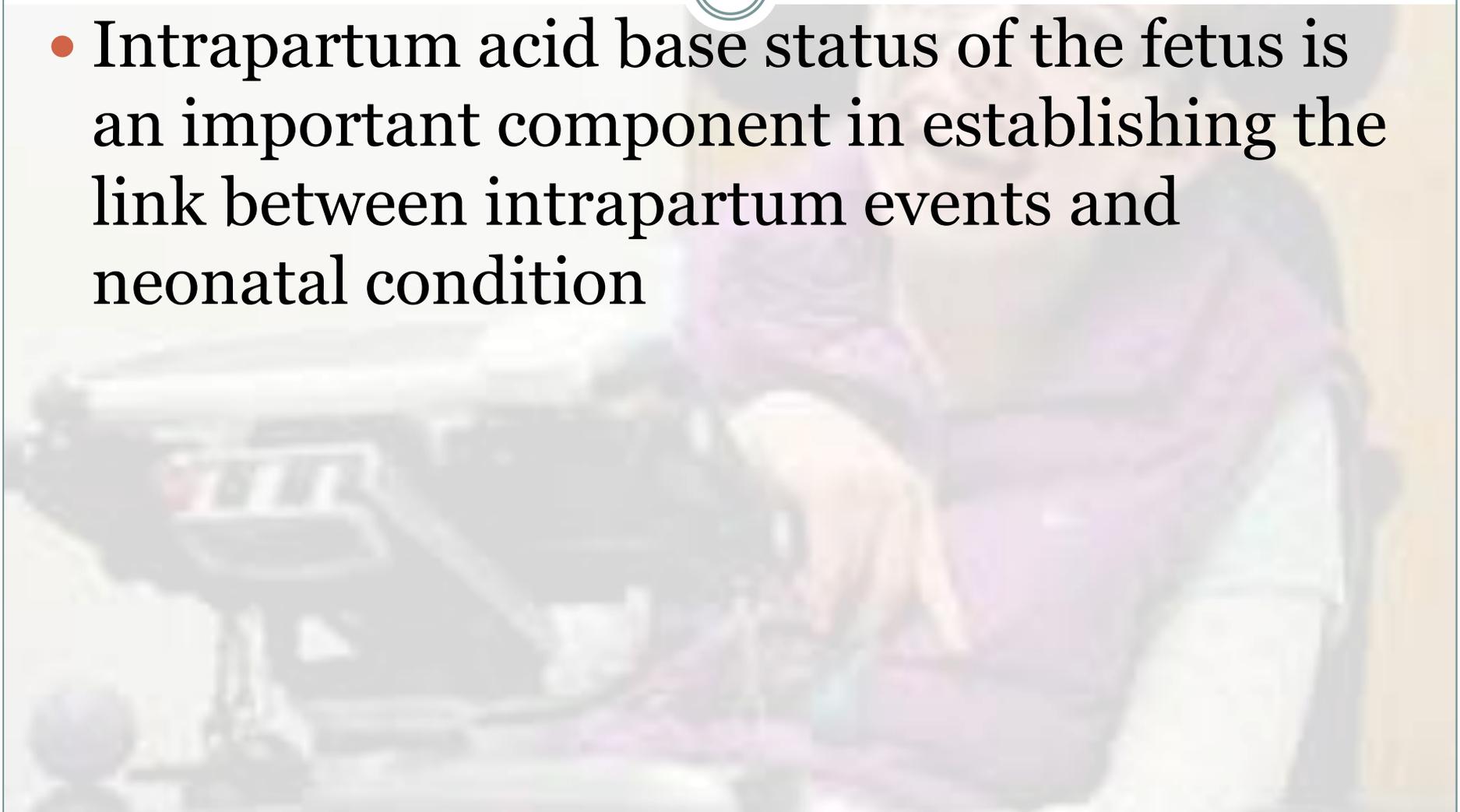


- In 1958, James et al. recognized the possibility of interpreting umbilical cord blood gases

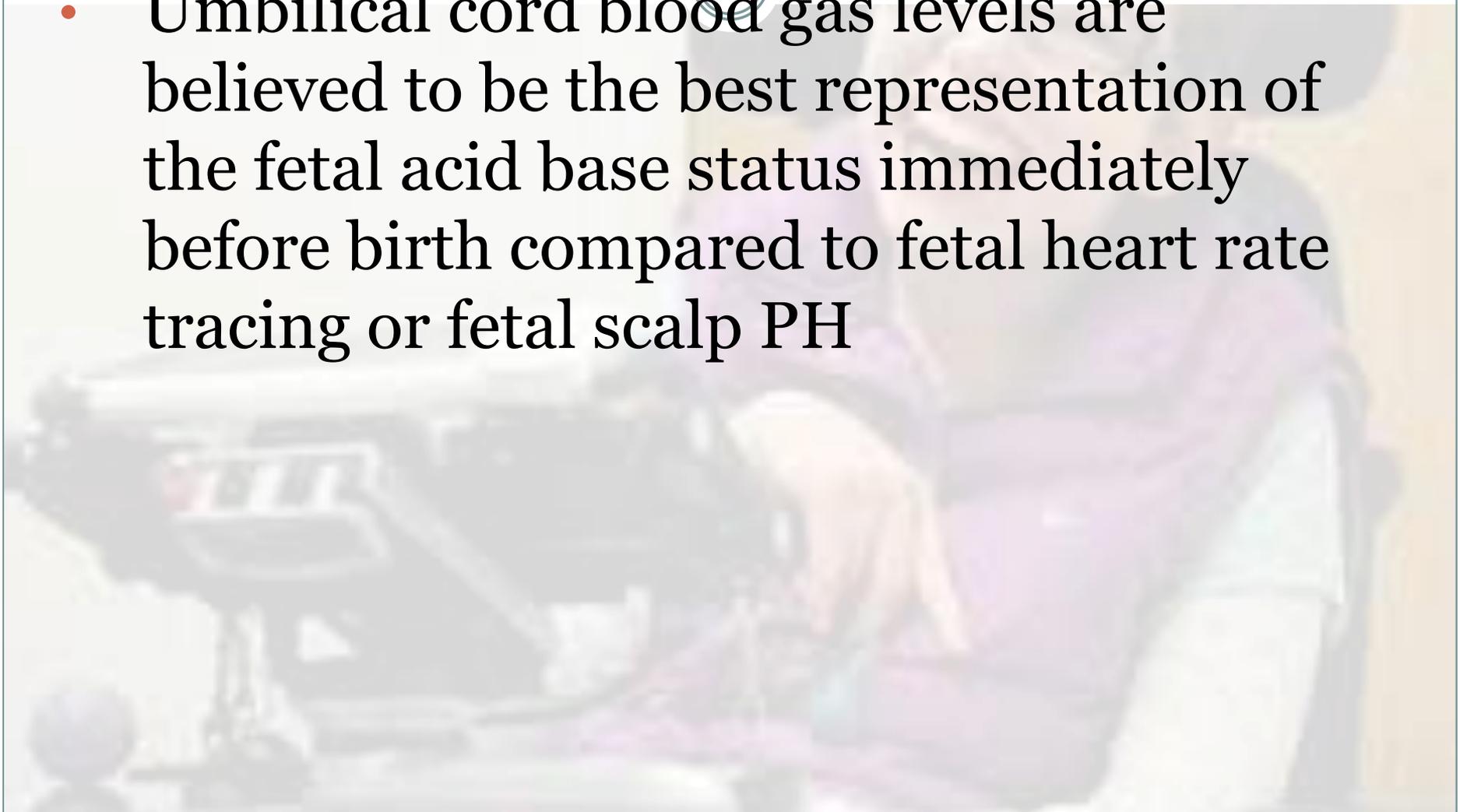




- Intrapartum acid base status of the fetus is an important component in establishing the link between intrapartum events and neonatal condition



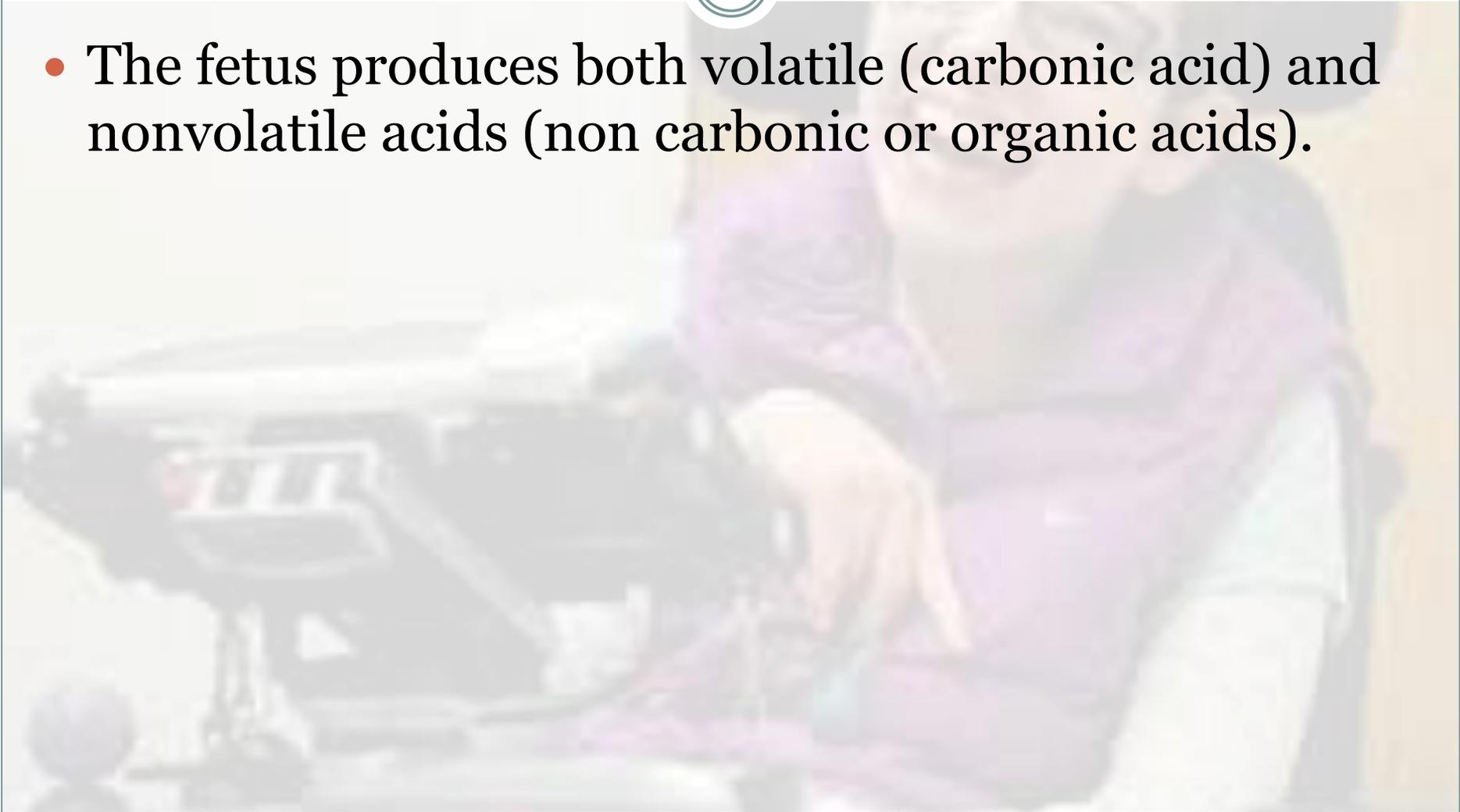
- Umbilical cord blood gas levels are believed to be the best representation of the fetal acid base status immediately before birth compared to fetal heart rate tracing or fetal scalp PH



Fetal acid-base physiology



- The fetus produces both volatile (carbonic acid) and nonvolatile acids (non carbonic or organic acids).



Carbonic acid



- The fetus produces carbonic acid (H_2CO_3) during oxidative metabolism (aerobic glycolysis). The rate of CO_2 production, in turn, is equivalent to fetal oxygen consumption
- carbonic acid dissociates to water and CO_2 , which readily diffuses across the placenta. Diffusion of CO_2 across the placenta is facilitated by a lower PCO_2 in the mother during pregnancy, secondary to hyperventilation

Organic acids



- organic acids result from fetal anaerobic metabolism. Unlike carbonic acid, the organic acids are cleared very slowly across the placenta . Metabolic acidemia develops when the primary buffer, bicarbonate (HCO_3), as well as other buffers decrease to a critical level. The most important organic acids are lactic acid and ketoacids

Buffers



- The two major buffers are bicarbonate and hemoglobin
- Other buffers that play a lesser role include inorganic phosphates, erythrocyte bicarbonate, and albumin
- The placenta also plays a significant role in helping to maintain a bicarbonate pool and buffering the fetus against changes in maternal pH or blood gas status.

Factors affecting fetal acid-base physiology



- Maternal perfusion of the placenta :

- Preeclampsia

- heart disease , chronic renal or pulmonary disease ,chronic hypertension , severe anemia , diabetes mellitus , hypotension

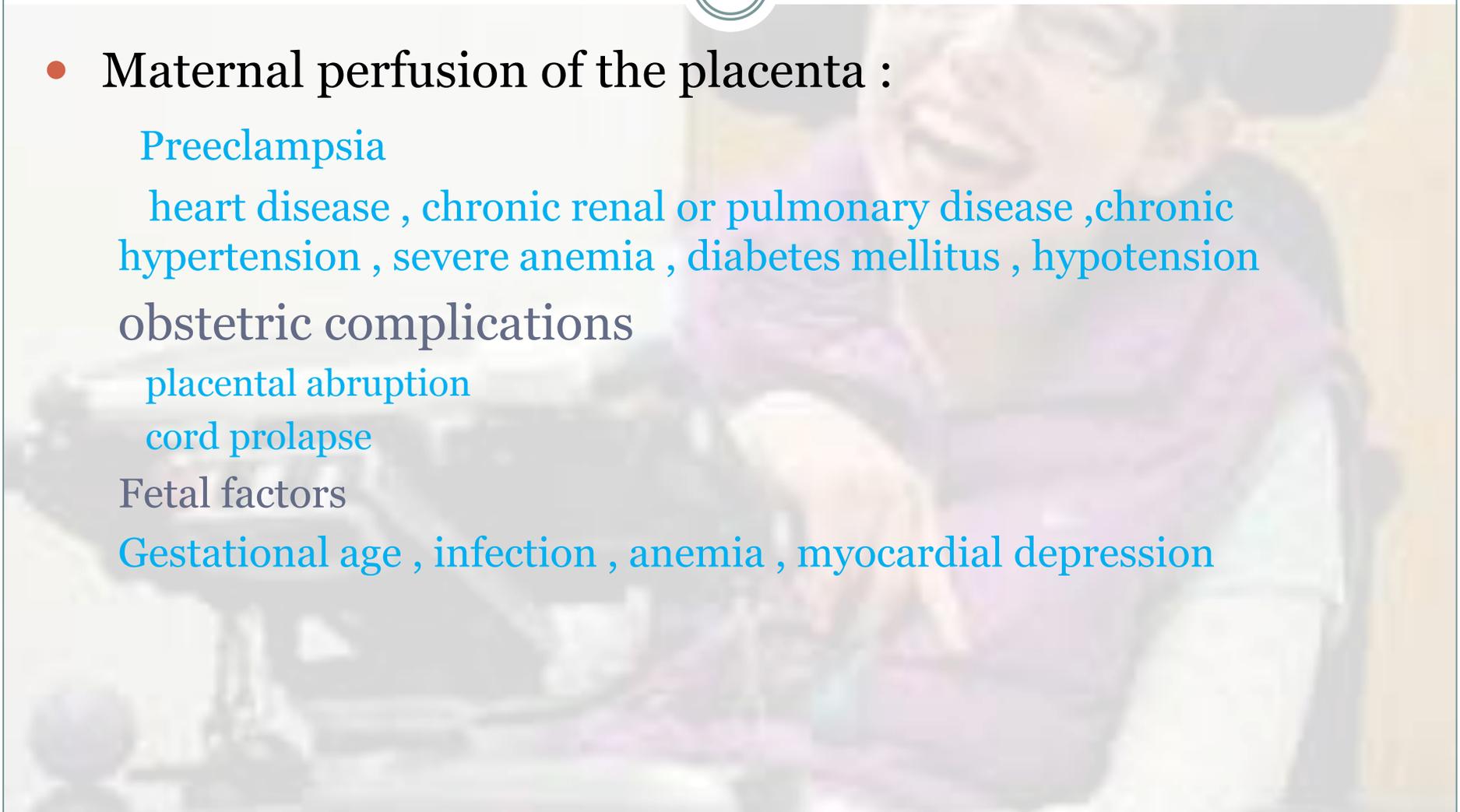
- obstetric complications

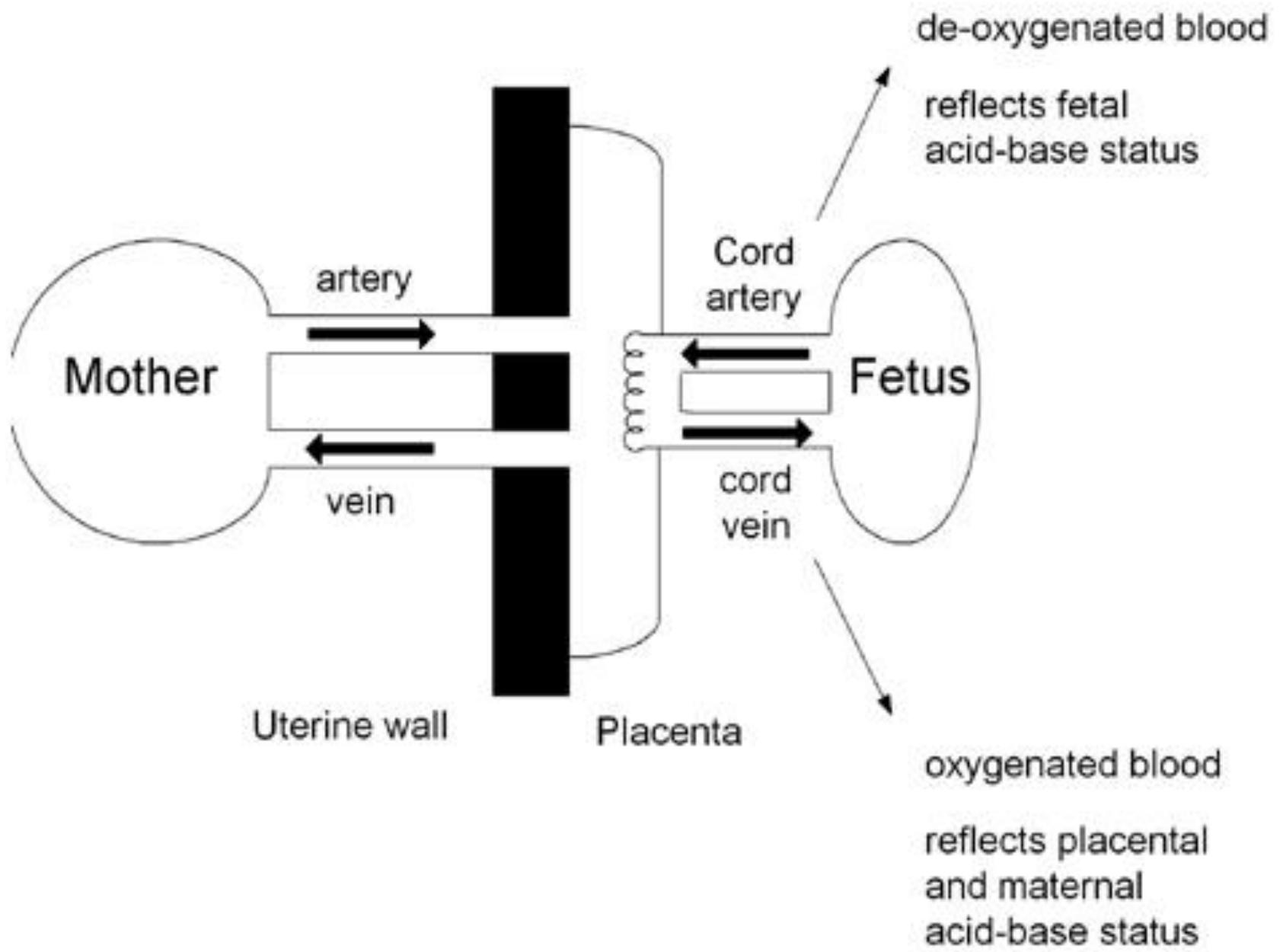
- placental abruption

- cord prolapse

- Fetal factors

- Gestational age , infection , anemia , myocardial depression





INDICATIONS FOR U.VESSELES BLOOD GAS ANALYSIS



- Instrumental or abdominal delivery for suspected fetal compromise
- All non elective cesareans
- A low 5 minute APGAR score
- An abnormal fetal heart rate tracing
- severe Intrauterine growth restriction
- Intrapartum fever
- Multiple pregnancy
- Maternal thyroid dysfunction

Recommendation of ACOG for umbilical cord blood gas sampling



- Double clamp an umbilical cord segment immediately after birth
- Obtain a blood sample with a syringe flushed with heparin.
- A paired sampling of the artery and vein may prevent a dispute over the accuracy of arterial sampling.
- If the neonate appears vigorous, then the clamped cord segment can be discarded.
 - The cord segment is appropriate for sampling anytime within 60 minutes from birth
 - Blood is appropriate for analysis anytime within 60 minutes from sampling

Time of sampling



PH decreases 0.05 at 30 min

PH decreases 0.087 at 60 min

PH decreases 0.12 at 90

In clamped cord







Warning! It is easy to contaminate the sample with ambient air! So, if you see bubbles in the liquid, discard it and try again



NO BUBBLES of O₂



Cord blood normal values



	Venous cord blood	Arterial cord blood
PH	7.25-7.45	7.18-7.38
PCO ₂ (mmHG)	26.8-49.2	32.2-65.8
PO ₂ (mmHG)	17.2-40.8	5.6-30.8
HCO ₃	15.8-24.2	17-27
BASE EXCESS	0 - -8	0 - -8



Umbilical cord blood gas recommended in all high-risk deliveries including:

- Intrapartum fever (>100.4)
- Cesarean section for fetal compromise
- Severe growth restriction
- Abnormal FHR tracing
- 5-minute Apgar score <7
- Multifetal gestation





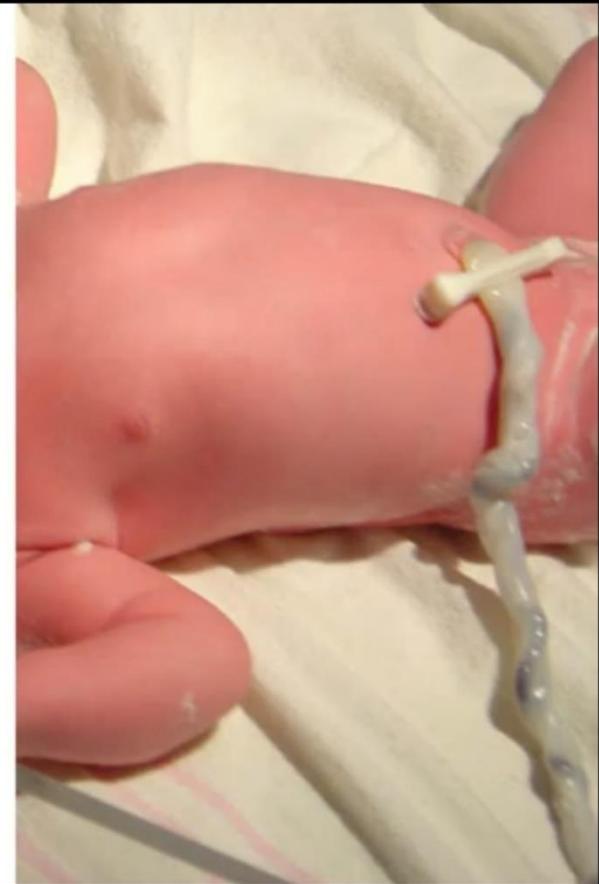
For optimal cord blood gas interpretation...

- Section of umbilical cord clamped on each end to isolate from the placenta
- Samples drawn soon after birth
- Use a separate 1 mL heparinized syringe for each vessel, and, as soon as the blood is drawn, place the specimen on ice and send it to respiratory therapy for analysis.





- Umbilical artery
 - Smaller vessel
 - Should be drawn first
 - Insert needle superficially. Don't poke through the artery and into the vein
- Umbilical vein
 - Larger vessel
 - Should be drawn after the artery





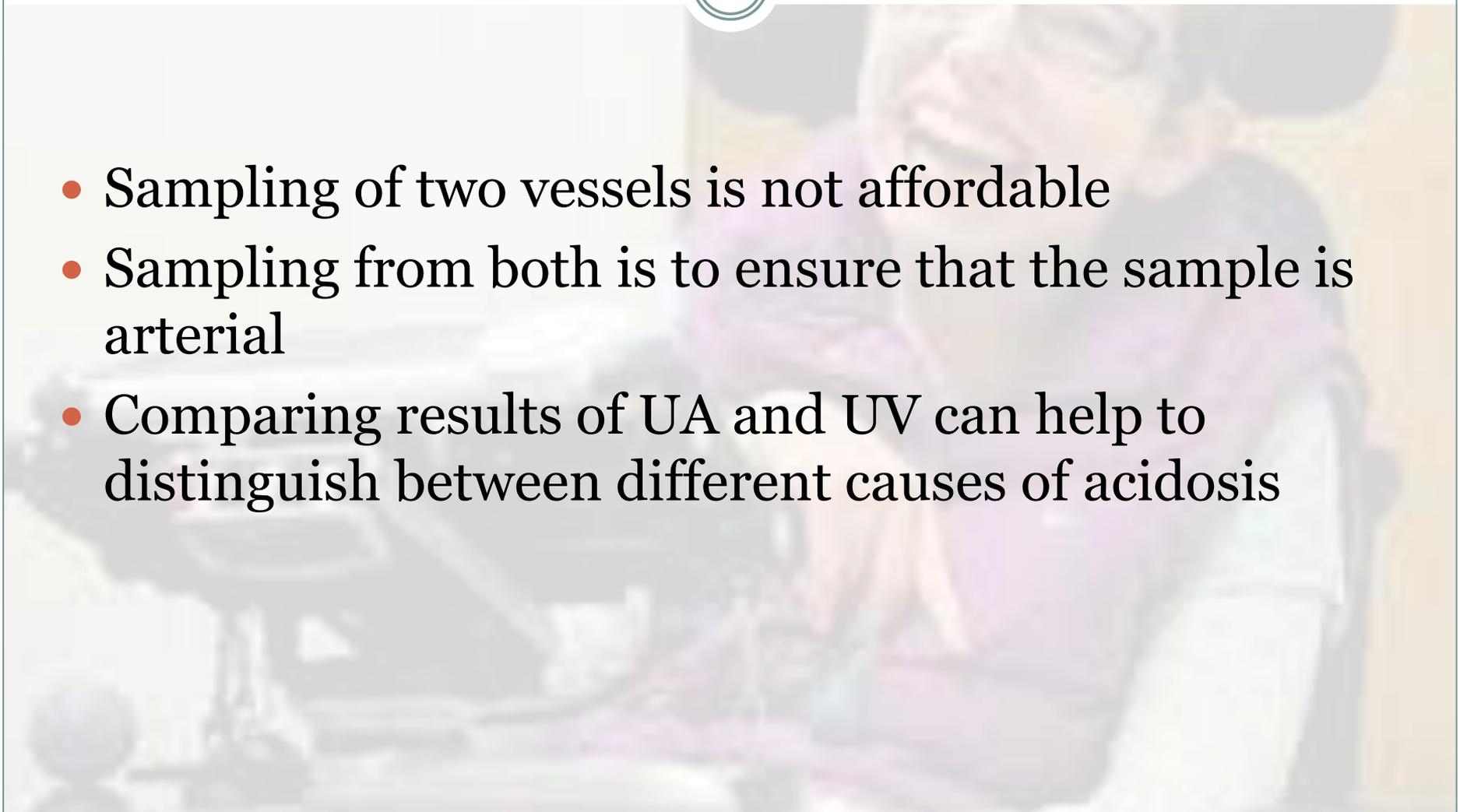
It is important to sample both arterial and venous blood. Especially if the infant is depressed at birth.



Sampling from Artery , Vein or both?



- Sampling of two vessels is not affordable
- Sampling from both is to ensure that the sample is arterial
- Comparing results of UA and UV can help to distinguish between different causes of acidosis



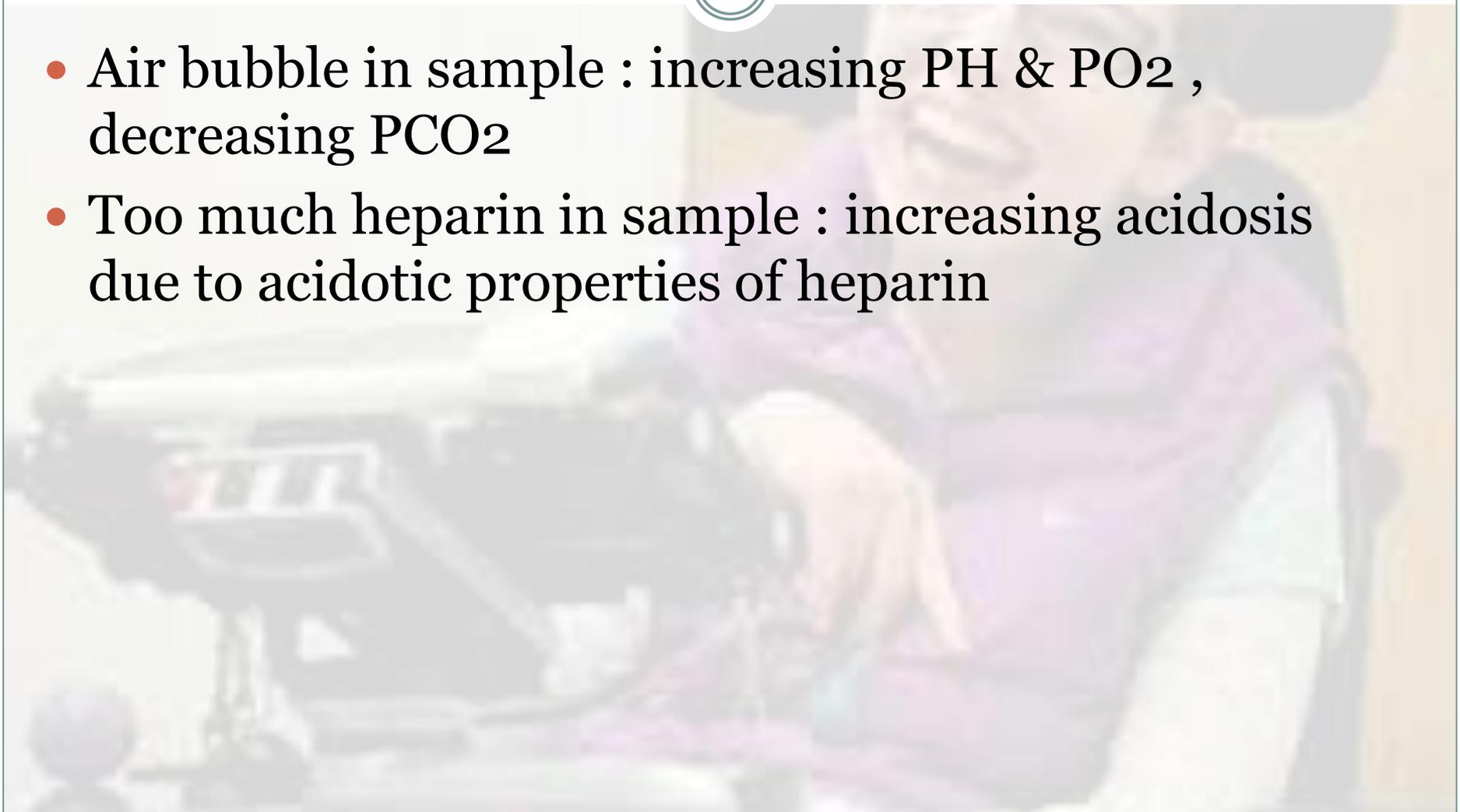
Cord blood samples



- pH should be at least 0.02 units and unit less in artery than vein
- pCO₂ should be at least 4 mmHG higher in the artery
- If reported pao₂ is >31 mmHG it is highly likely to be venous sample



- Air bubble in sample : increasing PH & PO₂ , decreasing PCO₂
- Too much heparin in sample : increasing acidosis due to acidotic properties of heparin



Umbilical artery sampling with delay cord clamping

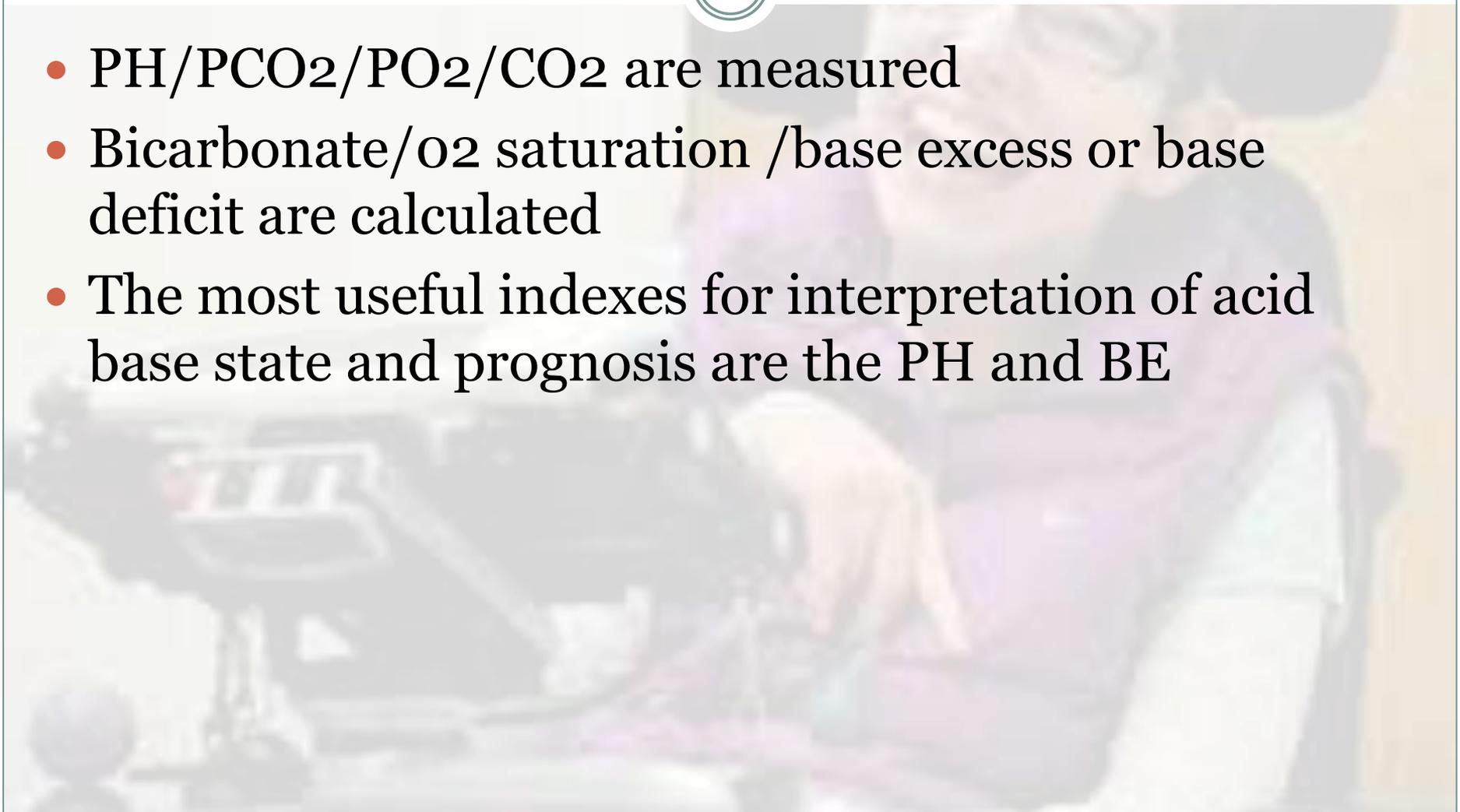


- Delayed cord clamping : decreasing PH , BE ,HCO₃ , increasing lactate & PCO₂ (hidden acidosis)
- DCC is not indicated for non vigorous babies
- Sampling from pulsating UA and UV unclamped cord (with expert staff)
- DCC up to 2 min have no or little effect

Test results



- PH/PCO₂/PO₂/CO₂ are measured
- Bicarbonate/O₂ saturation /base excess or base deficit are calculated
- The most useful indexes for interpretation of acid base state and prognosis are the PH and BE



Test results



- Risk of low PH(<7) :3.7/1000 live births
- Majority of newborn with umbilical artery PH less than 7 have uncomplicated neonatal course
- In one study : 93 neonate with PH < 7
- 97.8% : no HIE
- 89.2% : not need CPR

What is damaging acidosis



- Acidosis is well tolerated by the fetus without sequela until it becomes very severe
- Serious adverse sequela in the newborn period are unusual with umbilical cord PH greater than 7 or BE less acidotic than -12
- Infants with cord PH above 7 have no adverse effect of acidosis on cognitive function

damaging acidosis

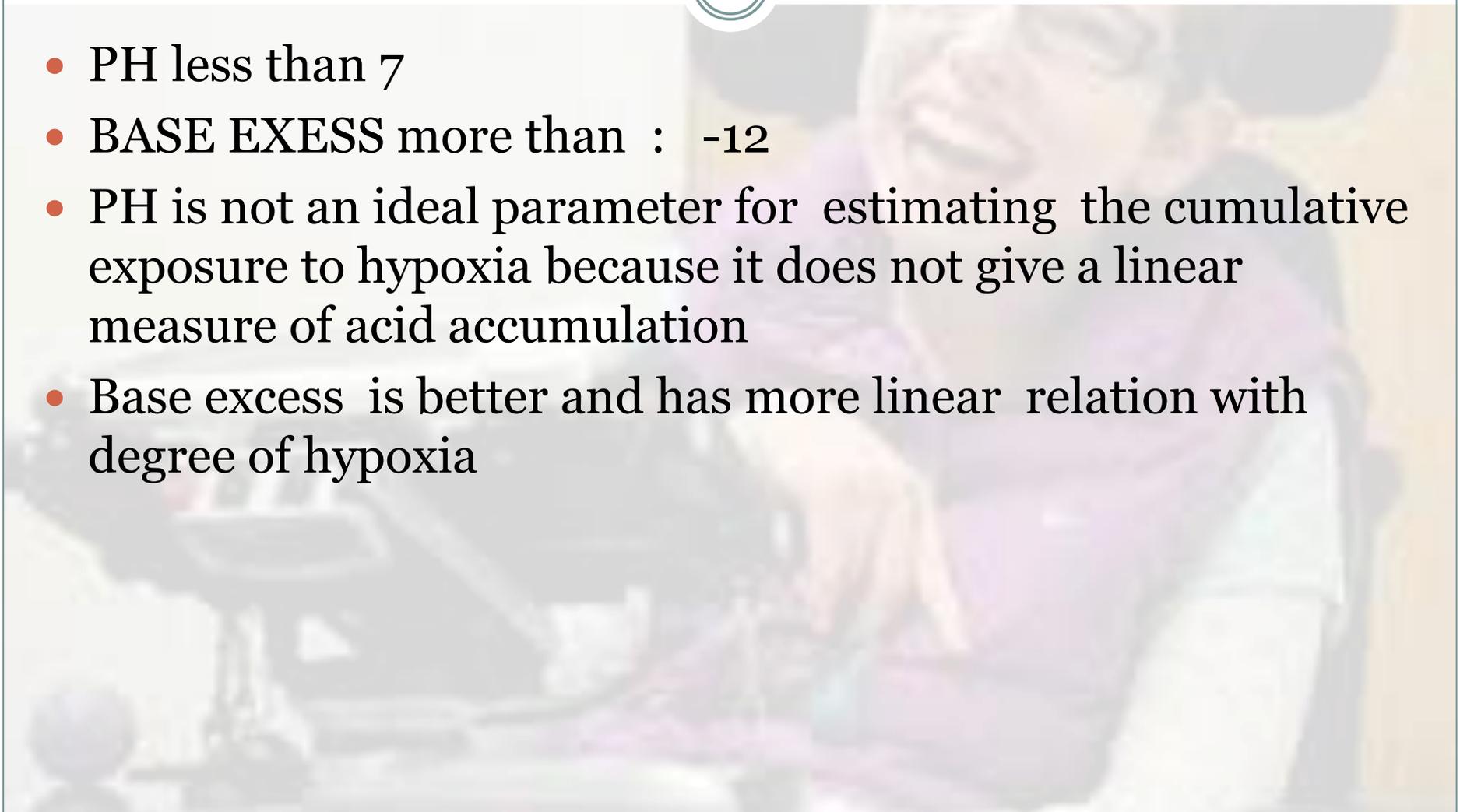


Once severe acidosis is present, the likelihood of adverse sequelae rises sharply with worsening acidosis. Goodwin et al found that HIE occurred in 12% of infants with cord pH <7.0, 33% with cord pH <6.9, 60% with cord pH <6.8, and 80% with cord pH <6.7

damaging acidosis



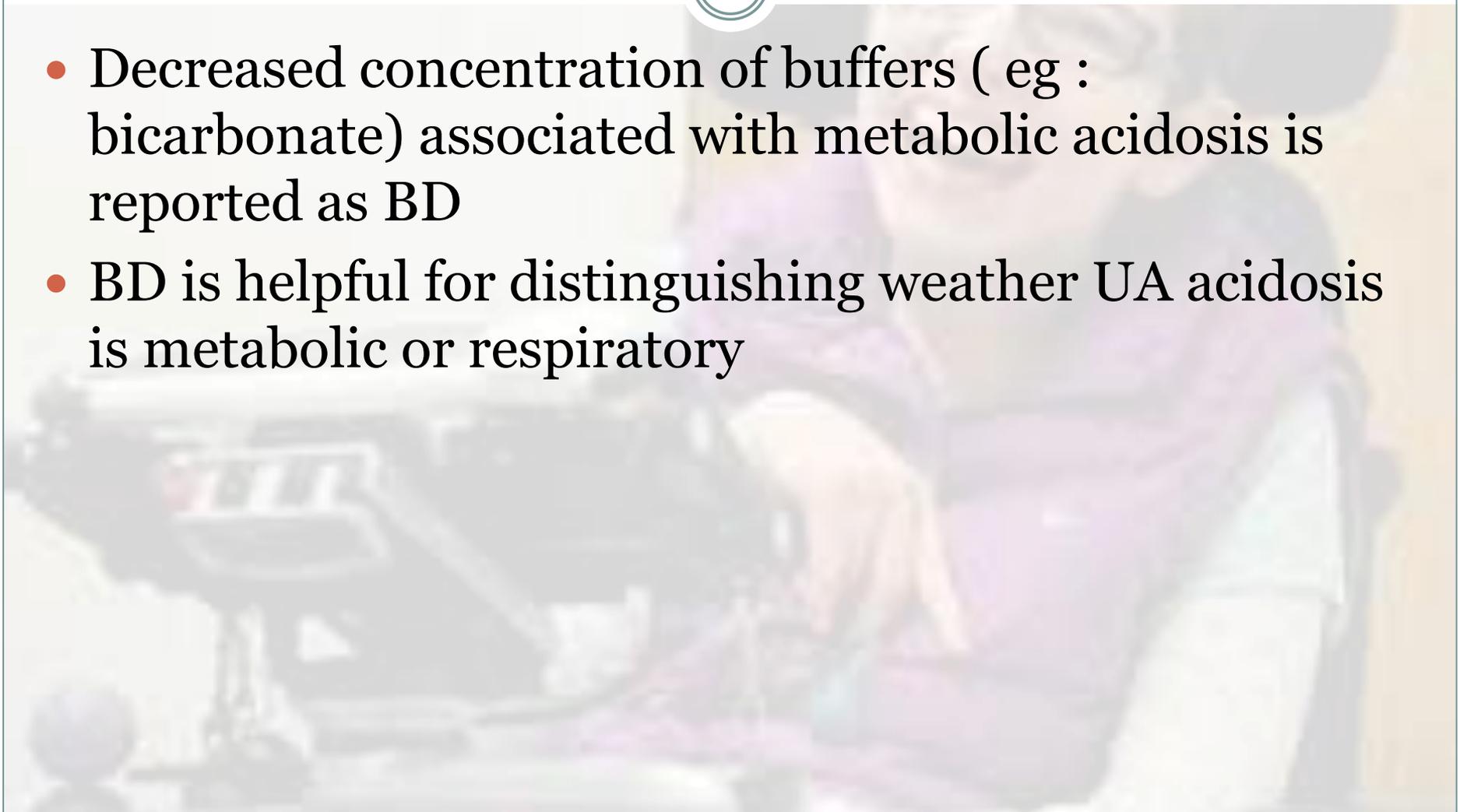
- PH less than 7
- BASE EXCESS more than : -12
- PH is not an ideal parameter for estimating the cumulative exposure to hypoxia because it does not give a linear measure of acid accumulation
- Base excess is better and has more linear relation with degree of hypoxia



BASE DEFICIT(BASE EXCESS)



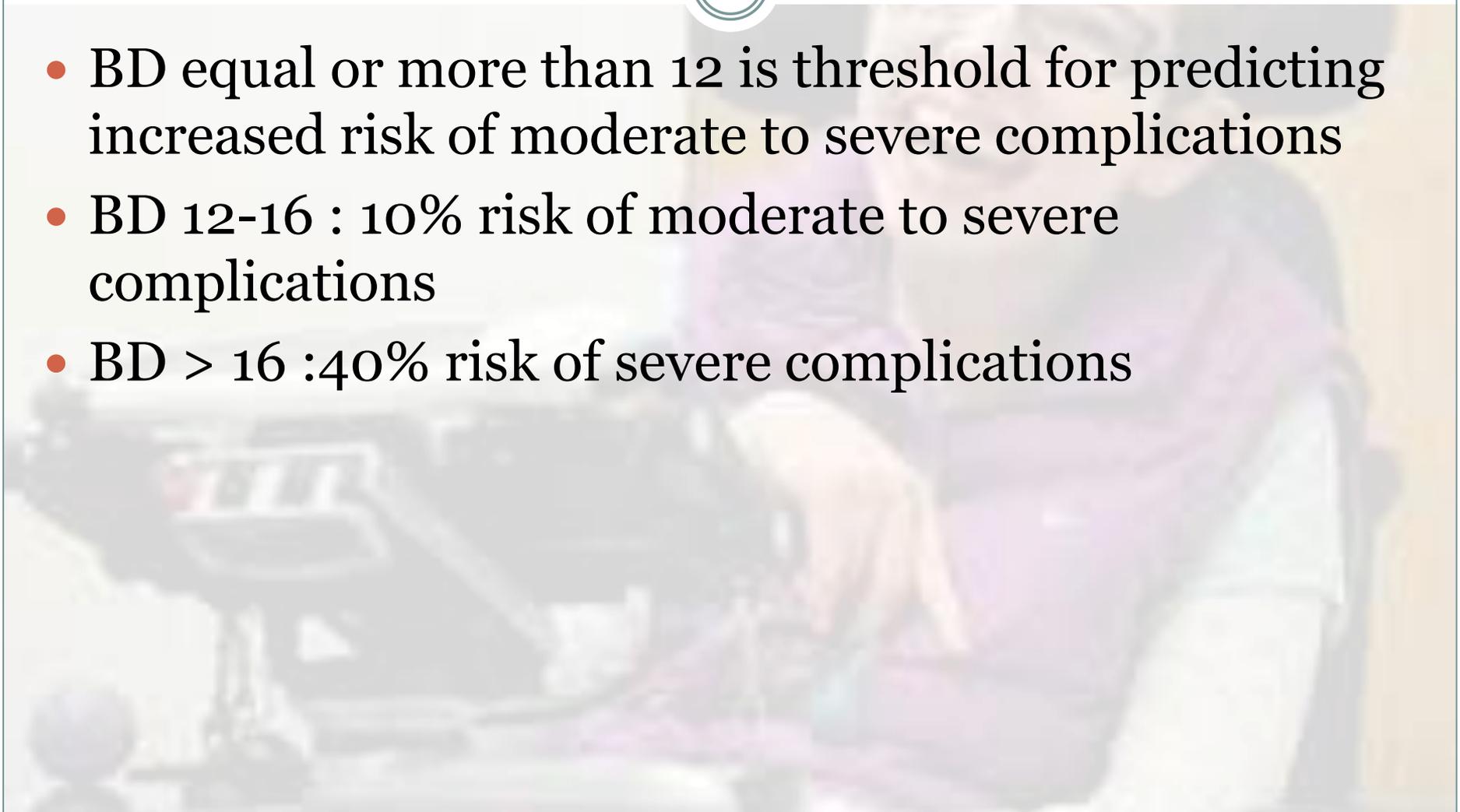
- Decreased concentration of buffers (eg : bicarbonate) associated with metabolic acidosis is reported as BD
- BD is helpful for distinguishing whether UA acidosis is metabolic or respiratory



BASE DEFICIT(BASE EXCESS)



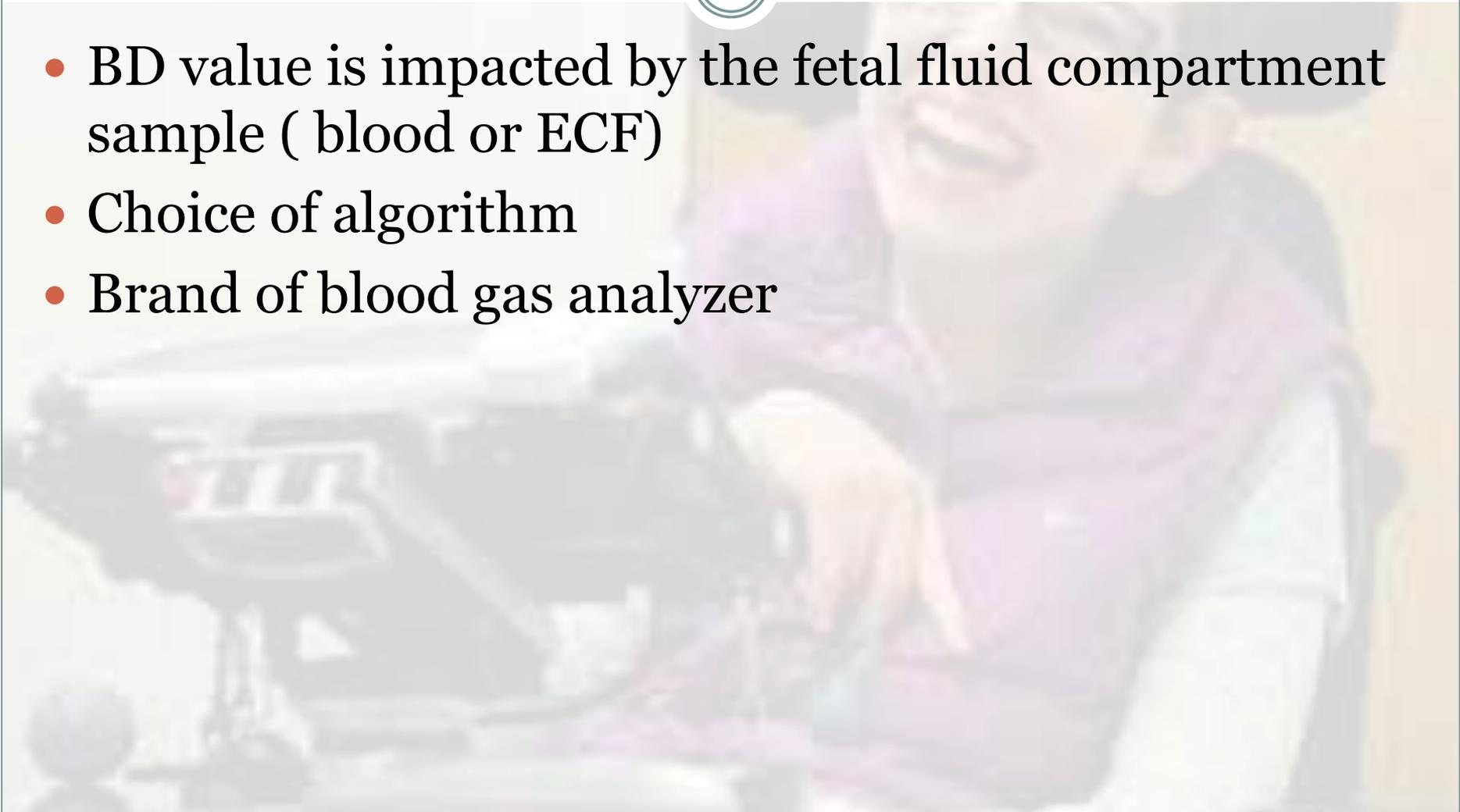
- BD equal or more than 12 is threshold for predicting increased risk of moderate to severe complications
- BD 12-16 : 10% risk of moderate to severe complications
- BD > 16 :40% risk of severe complications



BASE DEFICIT(BASE EXCESS)



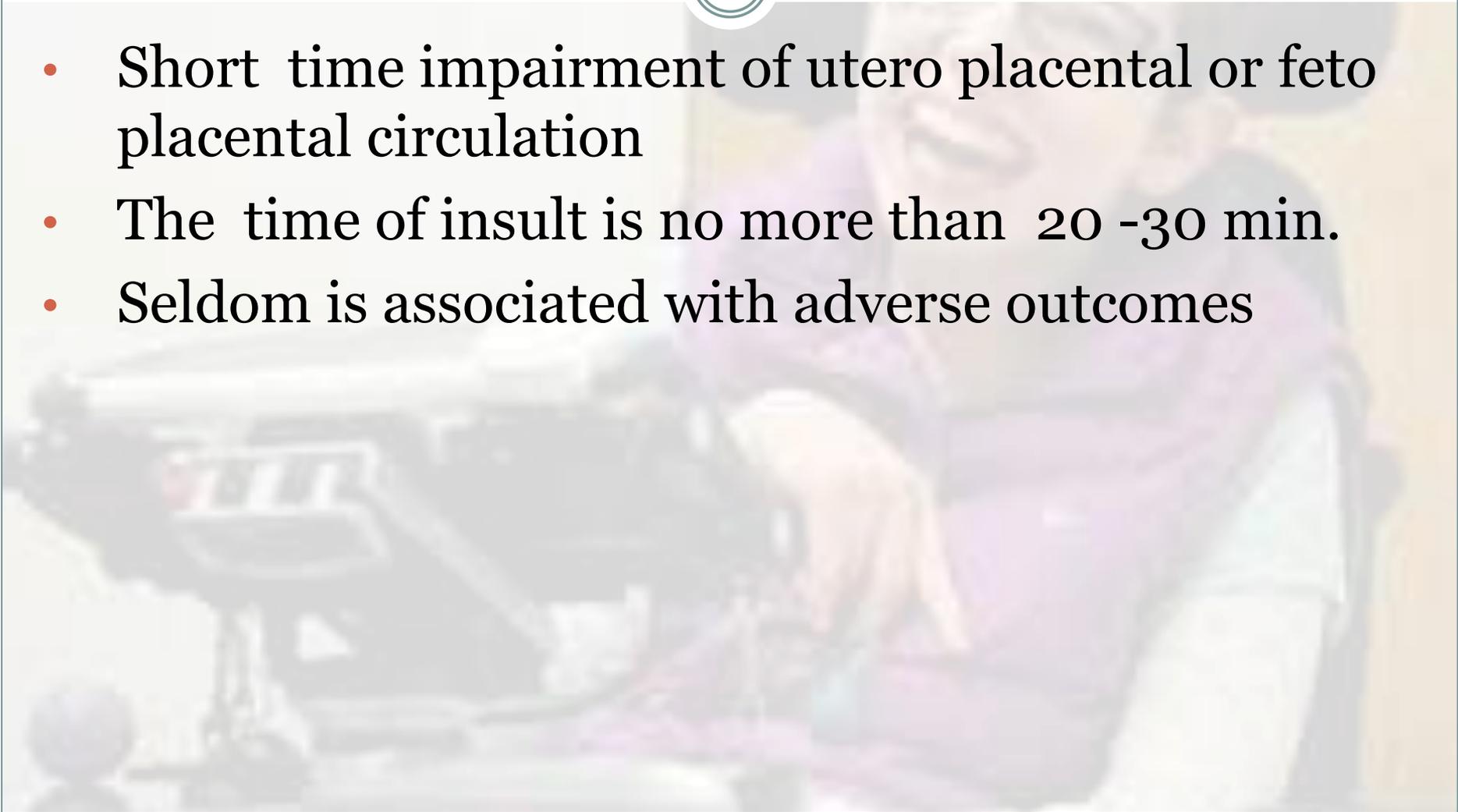
- BD value is impacted by the fetal fluid compartment sample (blood or ECF)
- Choice of algorithm
- Brand of blood gas analyzer



Isolated fetal respiratory acidosis



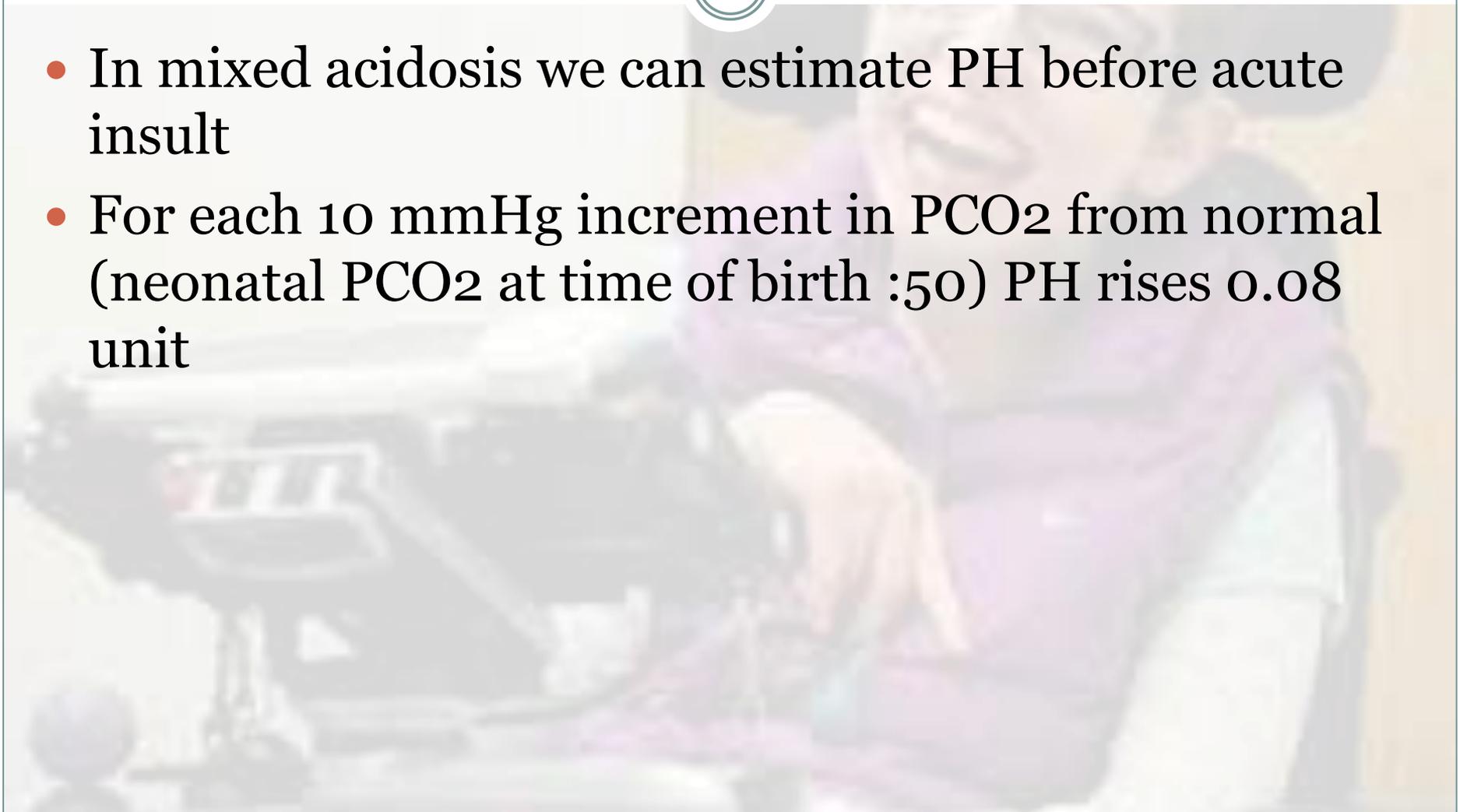
- Short time impairment of utero placental or feto placental circulation
- The time of insult is no more than 20 -30 min.
- Seldom is associated with adverse outcomes



THIS IS NOT TRUE:



- In mixed acidosis we can estimate PH before acute insult
- For each 10 mmHg increment in PCO₂ from normal (neonatal PCO₂ at time of birth :50) PH rises 0.08 unit



Other factors which influence cord blood values



- Prolonged second stage of labor
- Second twin
- Uterine hyperstimulation
- Regional anesthesia :spinal block



Effect of labor



- Normal second stage of labor changed BE 1mmol/l/hr
- Moderate to severe variable FHR deceleration changed BE 1mmol/l/30min
- Late or atypical variable deceleration : 1mmole/l/6-15 min
- Acute uterine rapture with fetal bradycardia changed BE 1mmol/l/2-3 min



- Chorioamnionitis , with or without funisitis does not appear to influence cord blood pH
- Although placental infection is associated with cerebral palsy in both term and preterm infants, the mechanism appears to be largely independent of hypoxiaaischaemia.

Restriction of cord blood flow



. Both umbilical arterial and venous gases could then be normal despite severe intrapartum asphyxia.

Fetal death with normal cord gases could also occur with fetal cardiac arrest . In cases of intrapartum stillbirth and in infants who are in very poor condition at birth and who require considerable resuscitation, normal cord venous and arterial pH do not therefore exclude acute intrapartum asphyxia. A blood gas sample taken from the infant soon after birth would be expected to show marked acidosis if there had been cord obstruction. (reperfusion acidosis)

Restriction of cord blood flow



- **If the obstruction to the umbilical vessels was sudden and complete and this persisted until the moment of delivery or until fetal death then the cord gases sampled at birth would give a snapshot of the fetal acid–base balance prior to the obstruction**

Short or long lasting hypoxia



- High BD in artery and normal BD in vein – short lasting hypoxia

E.g Art pH 7.01 Vein pH 7.27

CO₂ 8.82 5.14

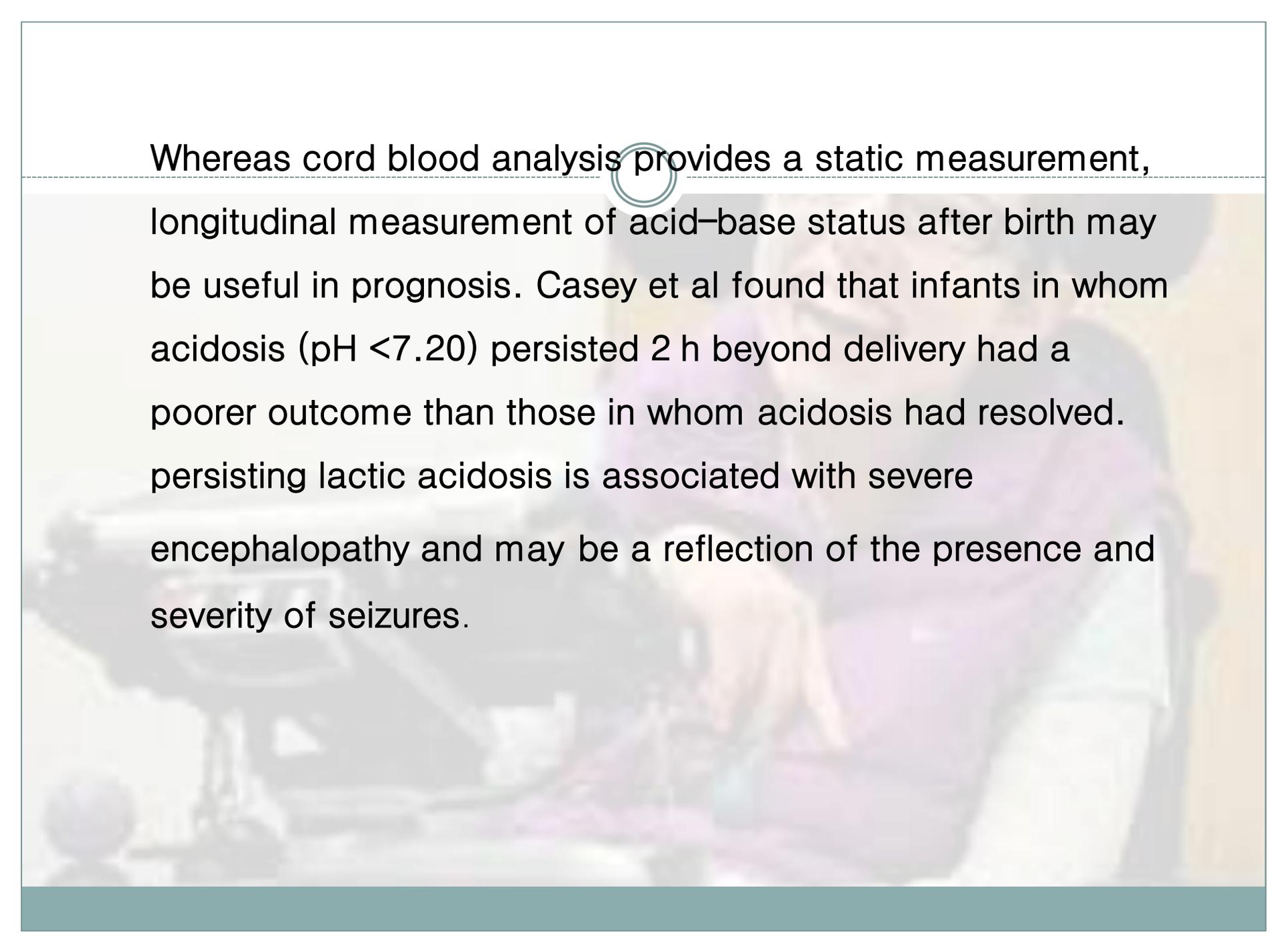
BD 12.8 8.0

- High BD in artery and vein – long lasting hypoxia

E.g. Art pH 7.01 Vein pH 7.12

CO₂ 8.82 6.65

BD 12.8 11.5



Whereas cord blood analysis provides a static measurement, longitudinal measurement of acid–base status after birth may be useful in prognosis. Casey et al found that infants in whom acidosis (pH <7.20) persisted 2 h beyond delivery had a poorer outcome than those in whom acidosis had resolved. persisting lactic acidosis is associated with severe encephalopathy and may be a reflection of the presence and severity of seizures.



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- arterial to venous differences are small where there is impairment of the maternal perfusion of the placenta, such as in cases of abruption
- In a comparative study between infants born after cord prolapse and those born after placental abruption, Johnson et al observed venoarterial differences in pH of up to 0.3 units, and showed that a difference greater than 0.15 units could be used to differentiate reliably between the two.

CORD BLOOD LACTATE



- lactate measured in umbilical cord blood samples is almost entirely fetal in origin.

correlate with both pH and base excess.

Routine assessment of cord blood lactate is not recommended given the poor predictive value of newborn long term outcome



