

Neonatal hypothermia and hypo-glycaemia are also more common in this type of infant and result from reduced body fat and glycogen stores. Both of these conditions, if untreated, can lead to increased mortality and neurological damage

Reduced supply of amino acids in utero can impair immune function, increasing the risk of infection in the newborn.

Increased risk of chronic diseases such as coronary heart disease, stroke, hypertension and non-insulin-dependent diabetes in adulthood.

## Case History

19-year-old is admitted to the labour ward at 38 weeks' gestation. She was seen at 12 weeks' gestation and had a scan at that time that confirmed her gestational age. She admitted to smoking 20 cigarettes per day. Abdominal examination shows the fetus is in cephalic presentation. The SFH measurement is 30 cm. Vaginal examination confirms that the cervix is 8 cm dilated. Which complications are such severely growth-restricted infants particularly at risk?

Intrauterine growth restriction (IUGR) due to uteroplacental insufficiency results in a placenta that is unable to provide adequate nutrients and oxygen to the fetus.

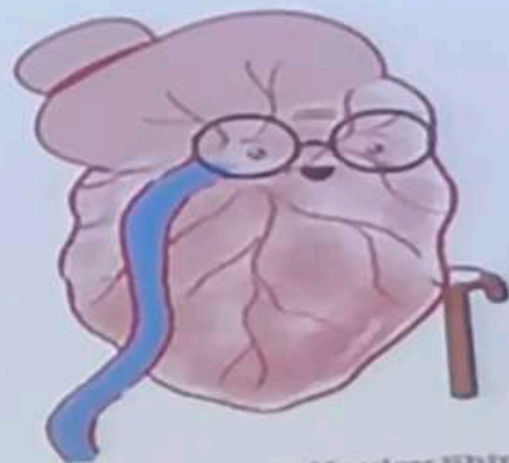


Illustration by Hayley Shing

These growth-restricted babies have an increased risk of hypertension and chronic kidney disease later in life.



# Impaired placental transfer

Placental infarction secondary to the maternal chronic conditions .

Acute premature separation as in placental abruption .

Recurrent bleeding from the placenta (antepartum haemorrhage) can, over time, compromise placental function, leading to poor fetal growth



# Placental influences

Normal placental development and function from early pregnancy is key to ensuring that the fetus receives adequate oxygen and nutrients from the mother.

Placental insufficiency occurs when there is inadequate transfer of nutrients and oxygen across the placenta to the fetus.

It can be due to poor maternal uterine artery blood flow, a thicker placental trophoblast barrier and/or abnormal fetus villous development.

# Chronic disease

Chronic maternal disease may restrict fetal growth.

Such diseases are largely those that affect placental function or result in maternal hypoxia.

Conditions include hypertension (essential or secondary to renal disease) and lung or cardiac conditions (cystic fibrosis, cyanotic heart disease).

Hypertension can lead to placental infarction that impairs its function.

Maternal thrombophilia can also result in placental thrombosis and infarction.

Alcohol crosses the placenta and has a dose-related effect up to 500 g reduction in birth weight, along with other anomalies occurring in women who drink heavily (two drinks per day).

Cocaine use is associated with spontaneous preterm birth, low birth weight and small head circumference.

Placental abruption is associated with cigarette smoking and use of recreational drugs such as cocaine.



## Behavioural influences

Smoking, alcohol and recreational drug use all associated with reduced fetal growth and birth weight.

Babies born to mothers who smoke during pregnancy deliver babies up to 300 g lighter than non-smoking mothers.

This effect may be through toxins, for example carbon monoxide, or vascular effects on the uteroplacental circulation.

Stopping smoking, even in pregnancy, can lead to increased birth weight



# Maternal influences

## Physiological influences

Heavier and taller mothers tend to have bigger babies and certain ethnic groups lighter babies

Parity with increasing parity being associated with increased birthweight.

In older women ,increased risk of chromosomal abnormalities and maternal disease, for example hypertension, lead to lower birthweights.

Teenage pregnancy is also associated with FGR.

# Infection

Infection has been implicated in FGR, particularly rubella, cytomegalovirus, Toxoplasma and syphilis

When fetus is found to be very small on ultrasound measurement (for example EFW less than the 5th centile for gestational age), it is common to test the maternal blood for antibodies to these infections.

The results are then compared with samples taken at booking antenatal care to determine if the mother has an acute infection.

# Epigenetic

External influences such as diet, stress and exposure to things like cigarette smoking may potentially affect DNA methylation patterns, leading to effects that are caused by an environment or lifestyle.

Emerging evidence shows that genes that are paternally expressed promote fetal growth, whereas maternally expressed genes suppress growth.

# Epigenetic

Epigenetics is the study of how behaviors and environment cause changes that affect the way the genes work.

Unlike genetic changes, epigenetic changes are reversible and do not change DNA sequence, but they can change how body reads a DNA sequence.

Epigenetic changes plays a role in determining fetal size.



# Fetal influences

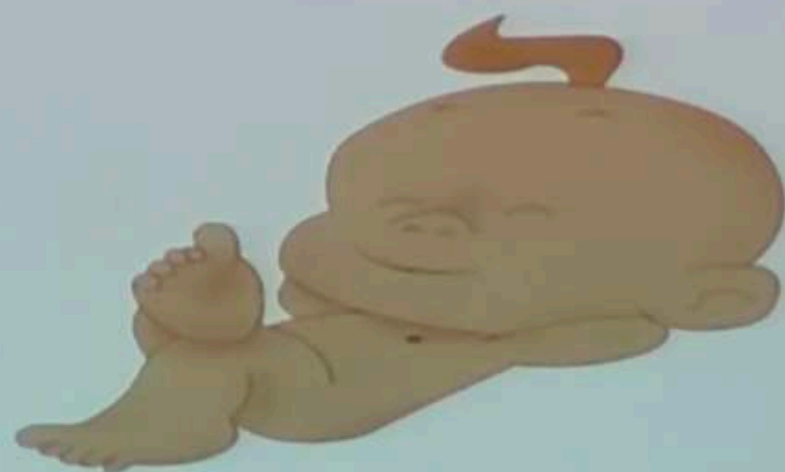
Genetic:

Has significant role in determining fetal size.

FGR is seen in fetuses with chromosomal defects such as the trisomies, 13 (Patau's syndrome) ,18 (Edward's syndrome), in trisomy 21 (Down's syndrome).

The other genetic influence is fetal sex, with slightly greater birthweights in males.

Fetal hyperinsulinaemia, which occurs in association with maternal diabetes mellitus when maternal glycaemic control is suboptimal, results in fetal macrosomia.



This leads to complications such as late stillbirth, shoulder dystocia and neonatal hypoglycaemia.

Other factors important in determining fetal growth include fetal hormones that affect the metabolic rate, growth of tissues and maturation of individual organs.

Insulin-like growth factors (IGFs) coordinate a precise and orderly increase in growth throughout late gestation.

Insulin and thyroxine (T4) are required through late gestation to ensure appropriate growth in normal and adverse nutritional circumstances.

# Determinants of fetal growth and birth weight.

Multifactorial.

Natural growth potential of the fetus depends on the fetal genome and epigenome, but also by the intrauterine environment that is influenced by both maternal and placental factors.

The ultimate birthweight is the result of the interaction between the fetus and the maternal uterine environment.

Fetal growth is dependent on adequate delivery to, and transfer of nutrients and oxygen across, the placenta, which relies on appropriate maternal nutrition and placental perfusion.



Birthweight is within the normal range for gestation (above the 10th centile) they still may have failed to reach their full growth potential. Detecting these fetuses is even more difficult than identification of the small growth-restricted fetus.



**Crisis! Inflation! No jobs!**  
**I think I am going to stay here.**

One challenge is to recognize potentially small fetuses, to identify those that are 'small and healthy' and those that are 'small and unhealthy'.

Interventions to deliver the growth-restricted fetuses early from the intrauterine environment may improve outcome.

It is important to note, however, that not all growth-restricted fetuses are SGA

# Complications

Asphyxia,

Hypothermia,

Hypoglycemia,

Polycythemia.

Necrotizing enterocolitis.

Infection.

Hypoxic-ischaemic encephalopathy (HIE).

Stillbirth.

The accuracy of identifying abnormal fetal growth obviously hinges on the accuracy of EFW.

An ideal definition of FGR should take into account the growth potential of the fetus, current fetal size, fetal and placental health, and, if available, fetal growth velocity.





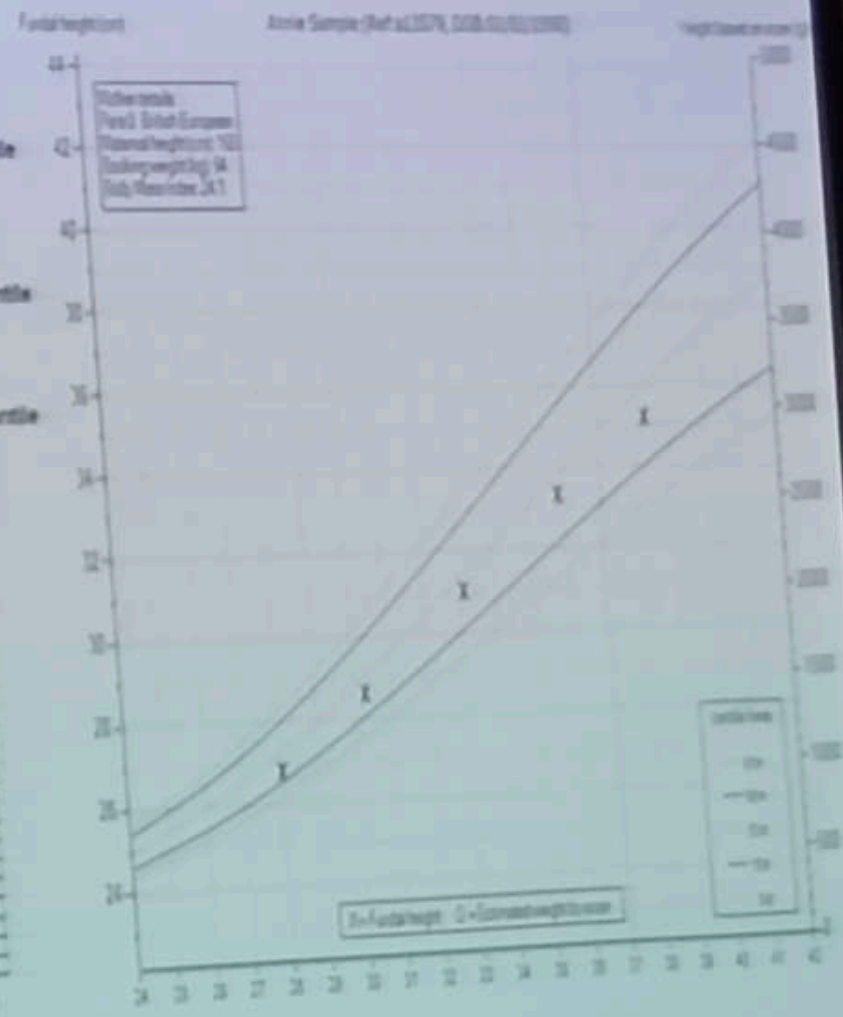
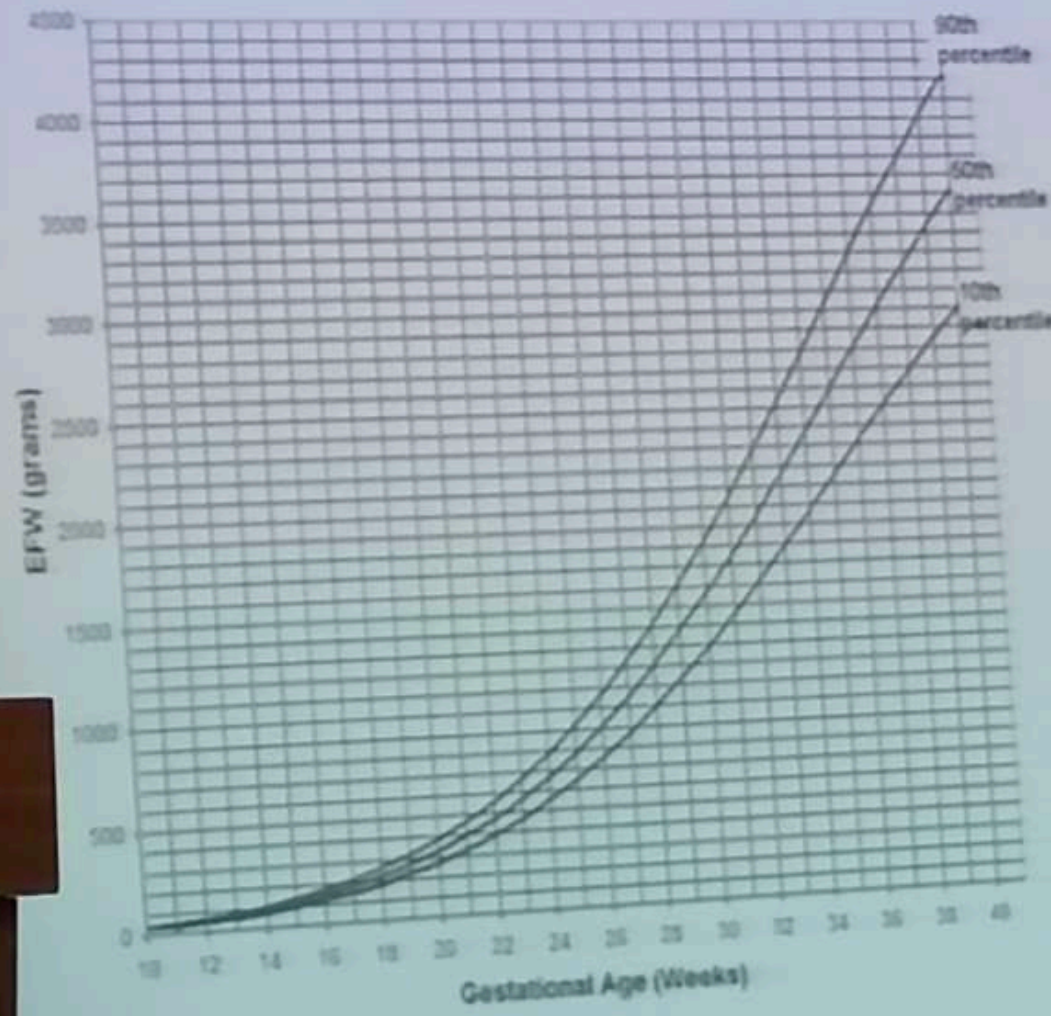
A fetus that is less than the 10th centile is described as being small for gestational age (SGA) .

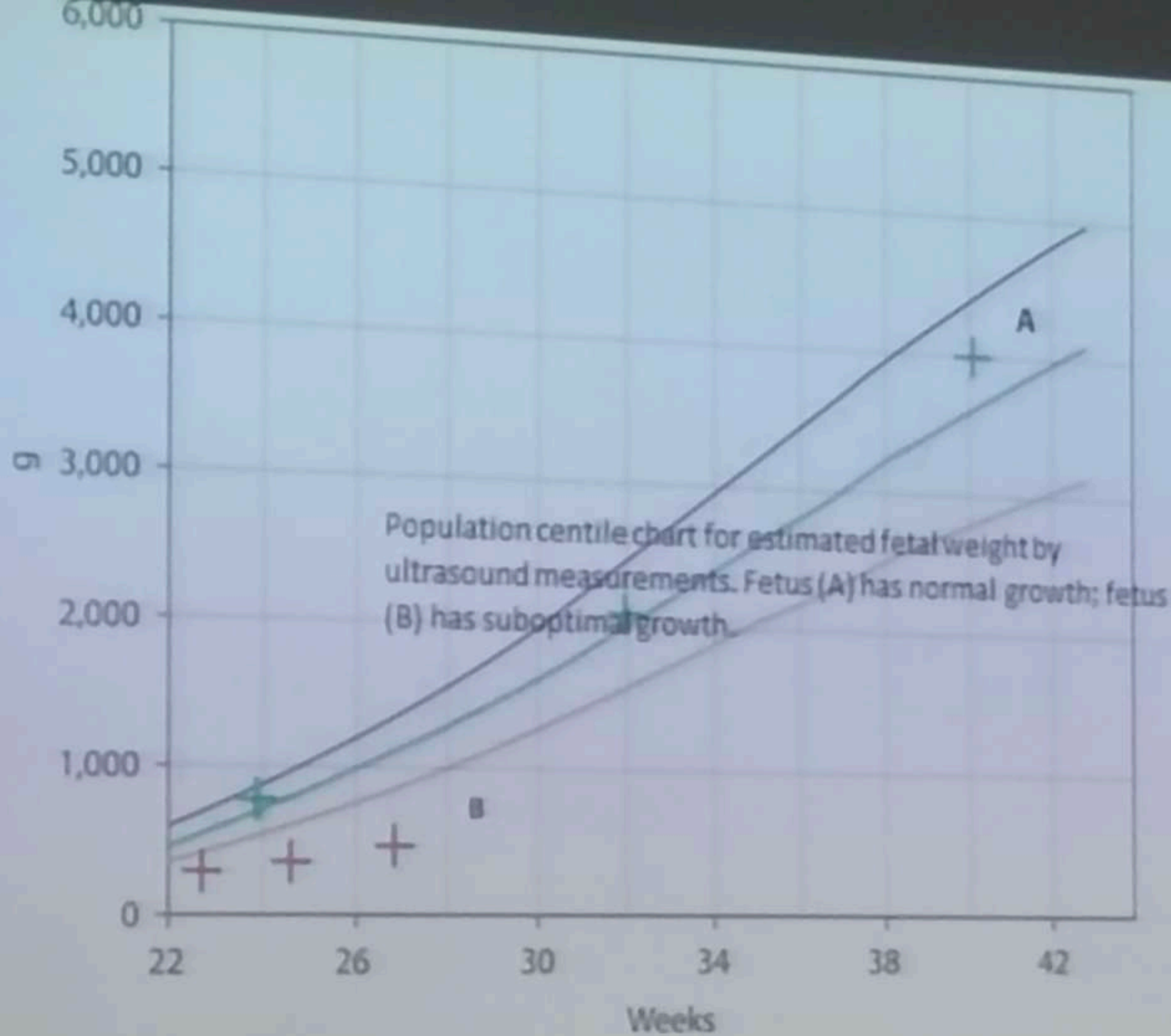
An SGA fetus may be constitutionally small, in other words their growth potential was reached but were destined to be that small.

Many fetuses that are SGA, however, have failed to reach their full growth potential, a condition called fetal growth restriction (FGR).

FGR is associated with a significant increased risk of perinatal morbidity and mortality.

# Estimated Fetal Weight (Hadlock 1991)







Normal fetal size at birth varies significantly by race/ethnicity, sex, parity, and maternal size, as well as other genetic and physiological factors.

A given fetal size may be considered normal for a short, thin woman but may reflect FGR for a tall, large woman.

The average weight of fetuses born preterm is lower than the average weight of fetuses of the same gestational age who remain in utero.

Fetal growth has to be followed for many weeks.



Fetal size can be assessed antenatally in two ways,

Externally by using a tape measure to assess the uterine size from the superior edge of the pubic symphysis to the uterine fundus (symphysis-fundal height [SFH] measurement).

Ultrasound to measure specific parts of the fetus and then calculating the estimated fetal weight (EFW) .

The fetal size is described in terms of its size for gestational age and is presented on centile charts.

# Fetal grow



Fetal growth and the eventual weight of the fetus at birth are important not only for the immediate health of the neonate but also for the long-term health of the adult.

Reduced fetal growth is strongly associated with a number of chronic conditions later in life.

These chronic conditions include coronary heart disease, stroke, diabetes and hypertension.

# Normal Fetal Growth

Normal fetal growth is a critical component of a healthy pregnancy and influences the long-term health of the offspring.

Intrauterine growth restriction is one of the most common and complex problems in obstetrics.

Currently, estimated fetal weight (EFW) or birthweight below the 10th percentile of certain reference at a given gestational week is commonly defined as small for gestational age (SGA).

EFW or birthweight  $< 5$ th or  $< 3$ rd percentiles are also used.



# LEARNING OBJECTIVES

To understand that fetal growth and birthweight .

They are important determinants of immediate neonatal health and long-term adult health.

To understand the fetal, maternal and placental factors that affect fetal growth .

An understanding of normal development, growth and maturation is important for understanding the complications that may arise in pregnancy and for the neonate.