THE ANTENATAL MANAGEMENT OF THE TWIN FETUS

FROM 30 WEEKS GESTATION

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by

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Twin pregnancy is a pregnancy with an increased risk to the individual fetus. The perinatal mortality for reported series varies widely but it is universally greater than that of the singleton pregnancies in the same population group. The perinatal mortality figures for a selection of the larger reported series are shown below:-

AUTHOR	PERINATAL MORTALITY (%)
Gruenwald[1]	5.1
Bender[2]	11.0
Mc Donald[3]	12.5
Patten[4]	12.5

THE FREQUENCY OF TWINNING

The frequency of twinning varies with race and maternal factors such as height, weight, age, parity and socio-economic status.

RACE

The racial variation is great. In western Nigeria it was found by Nylander[5] to be as frequent as 45/1000 births whereas the twinning rate in Europe and the United States is between 10 and 15/1000 (Mc Gillivray et al[6]).

Apart from variation of the twinning rate between racial groups there is an ethnic variation within racial groups. In Nigeria Nylander[7] found a rate variation of 20 to 45/1000 which was related to the ethnic origin of the mothers,

/while Eriksson ....

while Eriksson and Fellman [8] have shown in Finland that some tribes have a higher incidence (16.3/1000) than the rest of the country where the incidence is 10-12/1000.

The variation in the twinning rate with race and ethnic group is a variation in the dizygotic twinning rate and the frequency of monozygotic twinning varies little between population groups [7] [9].

MATERNAL AGE AND PARITY

Maternal age and parity alter the twinning rate. The incidence of twinning increases with maternal age [10] [11] reaching a peak at 35 - 39 years. This increase of rate with age has been recognised by many authors, but Anderson [10] has shown that it is an effect independent of parity. Mac Gillivray et at [12] have postulated that the increase is due to an increase in dizygotic twinning which is in turn related to an increase in ovarian activity producing double ovulation, possibly under hormonal stimulus. They also postulated that the late fall in incidence occurs with exhaustion of the Graafian follicles as the menopause approaches. This must remain as pure hypothesis as they produce no biochemical evidence of increased hypothalamic or ovarian activity.

The increase in twinning rate with parity has been clearly shown [10] [11]. This increased rate with parity is independent of age and there is a gradual and continuous rise in rate with birth order (Anderson [10]).

/MATERNAL HEIGHT ....

MATERNAL HEIGHT AND WEIGHT

Both maternal height and weight have independent effects on twinning rate. Campbell et al[13] found a greater than expected number of tall women with twin pregnancies when compared to singleton pregnancies. They also found this effect of height to be greatest in primigravida.

It has been postulated by Bulmer[14] that poor nutrition reduces the twinning rate, the postulate being based on his finding that there was a fall in the twinning rate in some countries in Europe during the deprivation of war. It is not possible from this evidence to determine whether this effect was due to true nutritional deprivation or a simple reduction in body weight. The relationship to body weight has also been shown by Campbell et al[13] who found that 10% of women having twins were thin as compared to an expected incidence of 25%.

GENERAL FACTORS INFLUENCING PERINATAL MORTALITY

Maternal Age and Parity.

Butler and Alberman[15] in the British Perinatal Mortality Survey showed a relationship between the perinatal mortality of twins and maternal age and parity.

They found that primipara were more likely to lose one or both babies than multipara and although the mortality of all babies was slightly increased in the higher parities this increase did not achieve the level found in primipara. Their

/finding that ....

finding that mothers of less than 30 years of age stood a
1 in 5 chance of losing both their babies may be an inde-
pendant age effect but may also be related to primiparity.

TWIN ZYGOSITY AND SEX

Monochorionic pairs with monochorionic placentae have the
highest death rate and dizygotic twins with separate
placentae have the lowest.

Gruenwald[16] found in his series, that the perinatal mortality
rate of the monochorionic pairs was 7.1% whereas the
dichorionic like sexed pairs had a perinatal mortality rate
of 4.6% and the dichorionic unlike sexed pairs a rate of 3.6%.

In a study of monoamniotic twins Wharton et al[17] found that
the monoamniotic, monochorionic twins were born earlier,
weighed less, had a higher incidence of weight disparity
and a stillbirth rate twice as high as the diamniotic
pairs.   Only one half of the monoamniotic twin pregnancies
resulted in two live babies.

The sex of the pairs has been shown to influence perinatal
mortality rates.   Potter[18] and Klein[19] in large retrospective
series have shown that unlike sexed pairs have a better
chance of survival than like sexed pairs.   This cannot be
solely attributed to the effect of zygosity as Potter[18] and
Barr and Stephenson[20] have both shown that females do better
than males.   This can be clearly seen in Potter's[18] figures
for the perinatal mortality according to sex of the pair:-

/Male / male - 15.9% ......

Male / male	-	15.9%
Male / female	-	14.4%
Female / female	-	11.4%

BIRTH ORDER

Many authors[4][18][21][22] have found that the perinatal loss of the second born twin is at least half as much again as that of the first born, when macerated stillbirths and babies weighing less than 1.0 kg are excluded.   There are only two reported series[23][24] where the perinatal loss of the first born twin was greater than that of the second born and in neither series was the difference significant.

Ferguson[25] compared the perinatal mortality of twins by birth order to that of singletons (21.9/1000) in a series of 1069 multiple gestations.   He found that the perinatal mortality of the first born was 69.6/1000 and that of the second born 115.5/1000, that is an increase in perinatal mortality of second born over first born of 66%.

The increase in perinatal mortality of the second baby is a combination of an increased malpresentation rate and asphyxia. The asphyxia is attributable to a reduced placental circulation as the uterine volume decreases after delivery of the first baby and on occasions actual placental separation occurs. The effect of asphyxia was clearly shown by Mc Donald[3].   In a series of 140 sets of twins where both babies were delivered by the vertex, he found that despite similar presentations the second baby was more often severely asphyxiated than the first baby.

The effect of asphyxia on perinatal mortality is not confined to the intrapartum or immediate neonatal period as Butler and Alberman[15] found that asphyxia not resulting in intrapartum death increased the incidence of hyaline membrane disease. Their finding that this increase was also related in the second baby to delivery intervals of longer than 30 minutes is almost certainly related to asphyxia.

SPECIFIC FACTORS INFLUENCING PERINATAL MORTALITY

THE GESTATION OF DELIVERY

A premature infant is an infant delivered at a gestation at which functional system maturity has not been achieved. The degree of system immaturity is reflected in the requirement for system support following delivery or an absolute inability to survive the extra uterine environment.

Maturation of the various biological systems is related to gestation and in the third trimester of pregnancy the development of adequate alveolar surfactant levels is critical to survival.

Immaturity of the lungs is characterised by the Idiopathic Respiratory Distress Syndrome in the neonate and is related to delivery prior to 37 weeks gestation.

The mean gestation of onset of labour in twins is less than that of singleton pregnancies. Reported series[21][16][27] show a range of 36.7 to 37.4 weeks indicating that the pre-term delivery rate is high with the attendant risk of lung immaturity.

/Robertson ....

Robertson[28] and Dunn[29] found that 50% of twins born five
weeks or more before term do not survive and Sherman and
Lowe[30] found the majority of twin neonatal deaths were in
this same group.

The high pre-term delivery rate remains a problem as little
has been done to reduce this in modern obstetrics.

The effect of bed rest in the early third trimester on
delaying the onset of labour is still in dispute.   Brown
and Dixon[31] and Farrell[32] found that bed rest was beneficial
in this respect but Jeffrey et al[33] in a large series found
no significant difference in the timing of onset of labour
in two matched groups of twins, one rested and one not.

Attempts to delay the onset of spontaneous labour by out
patient administration of an oral beta-sympathomimetic have
been made by Marivate et al[34] and Tamby-Raja[58] et al the
latter authors showed a significant delay in the timing of
onset of labour when the resting pulse rate was maintained
above 100 beats per minute.

There have been no reported studies on the state of the
cervix, endocrine balance or uterine activity in relation
to the onset of pre-term labour in twins.

There is a difference in the pattern of perinatal mortality
in relation to gestation between twins and singletons. Butler
and Alberman[15] using data from the 1958 British Perinatal
Mortality Survey were able to make comparisons of estimated
mortality of first twins, second twins and singletons at
different gestational ages.   In the babies born long before
teer (28 - 32 weeks) the mortality of twins was lower

than that of singletons but in the babies of longer
gestations the trend was reversed.   The mortality rate in
twins, and particularly in second twins of 37 weeks gestation
or more rose steeply as compared with the rate in singletons.
As in singletons they found an optimum time for delivery,
the lowest mortality for first born twins being at 39 weeks
and that for second born twins at 37 to 38 weeks, as compared
with 40 weeks for singletons.   A possible explanation for
this late gestation trend has been put forward by Dunn[29] who
postulates the "post-maturity" in twins appears to commence
at 40 weeks rather than at 42 weeks as in singletons.

BIRTH WEIGHT

In general terms birth weight has an influence on perinatal
mortality.   Potter[18] found that with birth weights of over
2.5 kg, twin mortality was the same as that of singletons
but with birth weights of between 1.0 and 2.5 kg the mortality
of twins was twice as high as singletons.   This same trend
is reflected by the finding of both Farrell[32] and Robertson[28]
that twins of a birthweight of less than 2.5 kg have a fourfold
chance of dying compared to twins weighing more than this.
Farrell[32] also found that the chance of survival increased
with increasing birthweight and he puts the critical level
at 2.0 kg.

In Anderson's[35] series twins weighing less than 1.8 kg
contributed 68% of the total perinatal loss and the babies
weighing less than 1.8 kg had more than 5 times the risk of
being stillborn than those weighing 2.5 kg or more.

INTRAUTERINE GROWTH RETARDATION AND ANTE-PARTUM DEATH

Low birthweight at delivery can be attributed to pre-term delivery, a low growth potential or intrauterine growth retardation. Intrauterine growth retardation is the limitation of fetal growth by factors other than the genetic growth potential of the fetus, resulting in the delivery of a neonate below the 10th centile of weight for gestation. The centile standards used should be those for the population group under study if it can be established that there is no general pathological process affecting the birth weights of that particular group.

Multiple pregnancy with its extra demands on the mother's resources is a frequent cause of intrauterine growth retardation. The was recognised as long ago as 1752 by William Smellie[36] who wrote:

> *"The child that lies next*
> *to the fundus is the*
> *smallest and follows*
> *after the birth of the*
> *other, sometimes dead*
> *and putrified and*
> *sometimes in*
> *an emaciated*
> *condition"*

The stillbirth rate is al least twice as high as in singleton pregnancies varying from 3.5 to 5.5% [18] [29] [35].

Dunn[29] found that intrauterine asphyxia was one of the main causes of death in low birthweight babies of more than 35 weeks gestation and that although it was rare for both babies to die in utero the surviving twin was usually smaller than expected.

In his book on Twins, Bulmer[37] states that *"it seems likely that the fivefold increase in risk of stillbirth in twins, when the infant is less than 1.8 kg, is due to those factors which cause intra-uterine growth retardation rather than low birth weight per se"*.

When intrapartum death occurs with no evidence of trauma the babies dying have been found to be significantly lighter than the surviving co-twin [15][38].

The combination of intrauterine growth retardation and intrapartum asphyxia, which more often affects the second twin[3][39], leads to an increased rate of intrapartum death in the second twin.

Ware's[39] figures show clearly that the second born twin has a greater risk of antepartum death than the first born:-

    First born   -   16.3/1000 antepartum deaths
    Second born   -   37.2/1000 antepartum deaths

The adverse effects of intrauterine growth retardation are not restricted to an increase in antepartum death rate but may effect the early neonate and the developing child.

Robinson[40] has listed the problems of the growth retarded neonate as:-

                    Birth asphyxia
                    Hypoglycaemia
                    Intrapulmonary haemorrhage
                    Polycythaemia

Anoxia and birth asphyxia are known to lead, on occasions, to intracerebral, subarachnoid or intraventricular haemorrhage[41].

Such haemorrhages can of course cause neonatal death but of the infants that survive only 30% are normal and most are severely handicapped both in terms of neurological function and developmental quotients[42].

In a follow up study of 151 children who had symptomatic hypoglycaemia Koivisto et al[48] showed a marked increase in the incidence of permanent brain damage attributable to hypoglycaemia alone.

There is an increased incidence of cerebral palsy in surviving twins. This is probably a combination effect of birth asphyxia and hypoglycaemia. Both Bender[44] and Greenspan et al[45] in an analysis of the delivery of patients with cerebral palsy found that twins, although accounting for only 1.2% of the general population, accounted for 7 to 9% of the patients with cerebral palsy. Illingworth and Woods[46] found like Greenspan et al[45] that the smaller twin was particularly likely to have cerebral palsy. The incidence of cerebral palsy in twins was found by Griffiths[47] to be related to sex and the failure to survive of a co-twin. In a series of 78 twin pregnancies where one or both babies had cerebral palsy, there were 52 cases of normal co-twins, 82 cases of cerebral palsy and 16 stillbirths or noenatal deaths, and in the series there was a much higher than normal proportion of like sexed twins (43%).

There is some dispute as to whether the growth and development of low birth weight twins parallels the growth and development of singletons of the same weight and gestation. According to Drillien[48] low birthweight singletons tend to make up their deficiencies in height and weight by two years of age unless

/there is chronic ....

there is chronic illness or poor social conditions but twins of less than 2.0 kg, even when brought up under the most favourable conditions, never make up their initial growth handicap. On the other hand Naeye[49] found in his series that there was an accelerated rate of growth following delivery in twins and that they reached the median level for singletons by 12 months although he did not specifically consider twins weighing less than 2.0 kg as did Drillien.

Whilst the neonatal and childhood growth patterns of twins are in dispute there is much evidence that the developmental quotients of twins do not achieve the levels found in singletons.

Drillien[50] in a longitudinal study on the mental development of prematurely and maturely born babies found that low birthweight had an effect on developmental quotients up to the age of two years and that these quotients fell steadily with decreasing birthweight, the low birthweight twins having consistently lower scores than singletons.

Churchill and Henderson[51] found in their series that the mean intelligence quotient of twins was 8 points below that of singletons and that the fact they were small at birth was an important factor in retarding their mental and social development, though they did not differentiate between low birthweight from pre-term delivery and low birthweight from intrauterine growth retardation.

The causation of intrauterine growth retardation in twins is not clear. Morris et al[52] postulated that it is due to

/inadequate utero-placental

inadequate utero-placental perfusion as a result of their experiments measuring uterine wall perfusion with ^{24}Na Cl where they found a diminished perfusion in twins in late pregnancy as compared to singletons. This experimental hypothesis is supported by Walker and Turnbull's[53] finding that the cord haemoglobin concentration of twins was consistently higher than that of singletons, a probable effect of chronic hypoxia.

The theory of "crowding of the uterus" as a cause of growth retardation in twins, originally put forward by Mc Keown and Record[27] and supported by Daw and Walker[54], is compatible with the theory of reduced utero-placental perfusion if one postulates that the flow capacity of the uterine arteries is insufficient in some twin pregnancies to maintain the full growth potential of both babies.

Placentation may also play a part in growth deprivation of the babies. Most twins show a subnormal rate of growth in the third trimester[49][55]but the deviation is greatest in monozygotic monochorionic pairs[16].

The diagnosis of single or dual growth retardation in a twin pregnancy is complicated by the problem of identification of the individual fetus. The only reported work is the use of ultrasonically measured biparietal diameters in terms of the difference between them[56][59].

/SUMMARY ....

SUMMARY

The predilection of twin pregnancies to delivery of low birthweight neonates leads to a marked increase in perinatal mortality and morbidity.

When low birthweight is due to pre-term delivery neonatal biological system immaturity, particularly of the lungs, may occur and lead to neonatal mortality and morbidity.

Low birthweight from intrauterine growth retardation is common in twins and leads to an increased incidence of ante and intrapartum death, neonatal mortality and morbidity and may have an effect on subsequent mental and physical development.

THE PROBLEM

In addition to the recognised problems in twins of immaturity and fetal growth retardation there are specific problems related to King Edward VIII Hospital, Durban.

The total number of deliveries under the supervision of the hospital is 28,000 per annum, which with a twinning rate of 1 in 38 pregnancies results in approximately 750 twin deliveries per year.

Few of the patients have personal transport and the public transport facilities are poor, particularly at night. Consequently when a twin labour commences the time delay to hospital admission can have disasterous effects on the outcome of labour.

The medical services near where most of the patients live are inadequate for twin delivery in that there are no facilities for intensive care of the neonate and the staffing is by trained midwives with no medical officer cover. In many instances there are no facilities anywhere near the patients home.

Contracted pelves are prevalent in this population group. The mean antero-posterior brim measurement of women who achieve a vaginal delivery is 10.3 centimeters[57].

In a retrospective study by the author of the twin deliveries of babies of over 0.8 kg in the years 1975 and 1976 at King Edward VIII Hospital, the perinatal mortality was found to be 274 out of 1686 babies (16.8%). The commonest identifiable causes of death were fresh stillbirths (5.9%) and neonatal deaths of babies weighing less than 2.0 kg (8.5%).

THE AIMS

1. To determine a method or methods of predicting pre-term labour in twin pregnancy.
2. To evaluate the method of diagnosis of single or dual fetal growth retardation and consequently the prediction of many of the antepartum deaths.
3. To elucidate the correct timing of delivery in normal twin pregnancy and in twin pregnancy where fetal growth retardation is occurring.

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CHAPTER II

THE SERIES

MATERIAL

METHOD

Clinical, Biochemical and Ultrasonic Assessment

Results Analysis and Statistics

RESULTS

The perinatal Mortality

Maternal Height

Maternal Age

Parity

The gestation of onset of labour

The method of delivery

Birthweight for gestation

Birthweight and neonatal sex

Plasma oestriol levels

Placental lactogen levels

DISCUSSION

CONCLUSION

In this chapter the general results of the series in terms of epidemiology, gestation of onset of labour and fetal outcome are discussed and compared with similar parameters from other series.

From these comparisons showing the similarity between this series and other reported series the conclusion will be made that any significant findings, in terms of the aims stated in Chapter I, will be valid not only for this population but for twins in general.

MATERIAL

All diagnosed twin pregnancies in King Edward VIII Hospital and the surrounding polyclinics were referred to the Special Twin Clinic held once a week.

The patients are all African blacks, among whom the hospital twinning rate is 26.3/1000 deliveries.

The criteria for inclusion in the study were:-

1. The patient had been assessed on at least 3 occasions on the basis of:

   a) Weekly attendance at the twin clinic.
   b) Hospitalization for at least two weeks for whatever reason, or
   c) A combination of both.

2. The patient was under 36 weeks by gestational age.

/METHODOLOGY ....

METHODOLOGY

THE FIRST VISIT

At the first attendance at the Twin Clinic the patient's age, parity, obstetric, medical and menstrual history were carefully obtained and recorded.

Their heights were measured in centimetres and their weights in kilograms. The blood pressure was taken in the lateral recumbent position and the urine checked for the presence of protein, glucose and blood using a reagent stick.

They were then subjected to a full general examination including the mucosal colouration, thyroid and breast palpation and examination of the cardiovascular and respiratory systems.

The abdomen was examined, the height of the uterine fundus was assessed clinically as was the lie and presentation of each fetus. Confirmation of life of at least one fetus was made by simple auscultation.

ABDOMINAL GIRTH

This was measured with a standard tape measure taking the minimal girth in centimetres at the umbilicus at full expiration.

CERVICAL ASSESSMENT

A vaginal examination was performed and the cervix uteri was assessed in terms of length of canal in centimetres and

/dilation of the ....

dilation of the internal cervical os in centimetres. The adjudgment of centimetres was made by pre-measuring the middle finger of the right hand. When the internal os was closed the thickness of the lower segment was assessed by pressure against the presenting part and summated with the length of the ecto-cervix.

The result was then expressed as the CERVICAL SCORE [1]. This is the length of the cervix in centimetres minus the dilation of the internal cervical os in centimetres. For example a cervix 3 centimetres long with a closed internal os has a score of PLUS 3 and a cervix 1 centimetre long with the internal os 3 centimetres dilated has a score of MINUS 2.

The advantage of this form of assessment over the Bishop Score is that observor error is minimised.

ARRANGEMENTS FOR SUBSEQUENT VISITS

The necessity for weekly attendance was impressed on each patient as was the fact they would be subjected to vaginal examination, blood tests weekly and ultrasonic examination every 2 weeks.

Blood was then taken for plasma oestriol and placental lactogen assay and arrangements made for ultrasonic assessment on the morning of the next visit prior to attendance at the clinic. Hospitalized patients had the investigations performed on the same day of the week as the clinic patients.

PLASMA OESTRIOL ASSAY

Plasma oestriol was measured by radioimmunoassay by the following method using the radiochemical centre, oestriol R.I.A. Kit, code IM.82. Samples of serum or plasma are incubated with an enzyme solution containing a mixture of glucoronidase and sulphatase enzymes. The conjugates of oestriol in the samples are hydrolysed during the incubation and free oestriol is released.

The total amount of oestriol, including that liberated by hydrolysis is then determined in aliquots of the hydrolysed samples by radioimmunoassay. Oestriol is allowed to compete with ^{125}I - labelled oestriol for the binding sites on a specific anti-oestriol antibody.

The amount of ^{125}I - labelled oestriol which is bound by the antibody is inversely proportional to the concentration of unlabelled oestriol in the samples. The antibody bound ^{125}I - labelled oestriol is separated by precipitation with an ammonium sulphate solution.

After centrifugation and removal of the supernatant solution, the radioactivity in the precipitated fraction is measured in a gamma counter. The concentration of oestriol in the unknown samples is then estimated by interpolation from a dose response curve prepared using standard sera.

The laboratory control error against known standards was less than 6%.

/PLACENTAL LACTOGEN ....

PLACENTAL LACTOGEN ASSAY

Placental lactogen was measured by radioimmunoassay in a similar manner to plasma oestriol (using the radiochemical centre, H.P.L. immunoassay kit, code I.M. 68). The hydrolyzing procedure is not necessary and the antibody bound component is precipitated with ethanol.

The laboratory control error against known standards was less than 6%.

BIPARIETAL DIAMETER MEASUREMENT

This measurement was carried out in the Radio Physics Department under the auspices of the Department of Radiology. The apparatus is the, "KRETZ Combisin 2", with grey scale using 2.5 megaherz.

The patient is made comfortable in the supine position and the abdomen painted with olive oil, a fetal head is identified with the scanning probe by visualizing the B scale oscilloscope image. The scanning probe is then angulated until a midline echo of at least one third of the antero-posterior diameter of the head is seen, the echo pattern is checked on the A scale and the biparietal diameter read off on the automatic readout in millimetres.

The external topography of the situation of the first head is noted and the second head sought. Once located the biparietal diameter is measured as above. If there is marked fetal movement during this process the whole procedure is repeated.

Where there is a discrepancy in size of heads the twin
with the larger head is denoted "A" and the twin with the
smaller head "B" irrespective of position in utero.

This procedure is repeated every two weeks.

SUBSEQUENT WEEKLY VISITS OR IN-PATIENT ASSESSMENTS

Weight and girth are measured as is the state of the cervix
in terms of length of canal and dilation of the internal
os in centimetres (vide supra).   Specimens are taken for
plasma oestriol and placental lactogen assay.

UTERINE SENSITIVITY TESTING

A solution containing 6 milliunits of oxytocin is made up
by adding 6 units of oxytocin to 1 litre of normal saline.

Exactly 10 millilitres of this solution are drawn up into
a graduated syringe.

The patient is made comfortable in the lateral recumbent
position.   The external tocography transducer is placed
on the abdomen and linked to the graphic recorder.

A butterfly cannula is inserted into a vein on the dorsum
of the hand.

One millilitre of this made up solution is infused over a
timed 1 minute period with an interval of exactly 4 minutes
before 2 millilitres is infused over a period of a minute
again followed by 4 minute interval.   This procedure is
repeated with 3 and 4 millilitres.

A POSITIVE response is recorded when a palpable uncomfortable uterine contraction is sustained for 30 seconds or more. This, on all occasions in the study, was reflected on the tocograph by an increase in amplitude and duration of existing uterine activity or a deflection from the baseline when the uterus was quiescent. Infusion was discontinued when a positive response was illicited.

When there was no uterine response to the maximum bolus of 4 millilitres of solution (24 milliunits) the result was recorded as a positive response at greater than 24 milliunits.

The dosage schedule was chosen arbitrarily in view of the dosage required at the standard oxytocin challenge test used in the hospital.

THE CHOICE OF METHOD OF DELIVERY

The selection of the method of delivery was made at the first or second antenatal assessment.

The policy practised was to allow vaginal delivery if the following criteria were fulfilled:-

1. The first twin was presenting by the cephalus.
2. The antero-posterior diameter of the pelvis was greater than 10.5 centimetres assessed clinically in multipara and radiologically in primipara.
3. There was no evidence of fetal distress i.e. meconium staining of the liquor or fetal heart rate abnormality of the first twin judged by continuous monitoring using an internal scalp electrode.

Four patients were delivered electively for severe hypertensive states (detailed later) the remainder were, as policy, allowed to go into spontaneous labour.

NEONATAL ASSESSMENT

Immediately following post-delivery resuscitation, the neonates were weighed to the nearest 50 grams. A full Dubowitz assessment of gestational age was carried out on all surviving infants 24 - 36 hours following delivery. The assessor was a trained paediatric Registrar and the author checked every second set of twins. On only two occasions was there a discrepancy between the assessor's findings and the author's assessment and for these babies a third assessment was carried out and the gestation was taken as that of the agreeing pair of examiners.

At the time of Dubowitz assessment a careful measurement of biparietal diameters was made using graduated calipers. Where there was a difference in actual or ultrasonically measured biparietal diameters of greater than 3 mm in a pair of twins the head circumferences were measured in centimetres.

Head circumferences were also measured when there was a weight disparity of greater than 500 grams in a pair of twins.

/RESULTS ....

RESULTS ANALYSIS AND STATISTICS

For analysis purposes the following groups of twin pregnancies were compared:-

1. Pre-term labour with term labour.

2. Pregnancies where one or both twins were growth retarded with pregnancies where neither twin was growth retarded.

3. Pregnancies where the combined weight of the twins was equal to or less than the mean combined weight for gestation for the series with pregnancies where the combined weight was greater than this mean.

The difference between the distribution of a particular finding between two groups was statistically analysed by using Chi squared 2 x 2 contingency tables with Yates' modification for continuity.

The difference between two means was assessed by using the students "T" test.

Probability results were assigned using standard probability tables. Significance was taken as a p value of <0.05 and trends taken as p values of <0.1 but >0.5.

In assessing the most important variables discriminant analysis was carried out on a Univac 1100 by assessing the linear combinations of independent variables that best distinguished between cases in the categories of the dependent variables.

RESULTS

The study period was from the 1st March 1977 to the 31st March 1978.

During this period 196 sets of twins entered the study. Sixty-four sets were eventually excluded because the time from entering the study to delivery was less than two weeks or the gestational age on entering the study was greater than 36 weeks as calculated from the neonatal Dubowitz score.

This leaves a series TOTAL of 132 sets of twins.

THE PERINATAL MORTALITY

There were 12 perinatal deaths out of 264 infants delivered giving a PERINATAL MORTALITY of 4.6%.

The perinatal mortality of the 393 sets of twins delivered in the hospital in the study period (infants weighing over 0.8 kg) was 81 out of 786 babies - 10.3%.

The breakdown of the perinatal mortality in the series is shown in Table I.

TABLE I

THE PERINATAL DEATHS

MACERATED STILLBIRTHS			SURVIVING CO-TWIN
Female 0.45 kg	31 weeks		(Female, 1.65 kg)
Female 0.30 kg	37 weeks		(Female, 2.90 kg)

FRESH STILLBIRTHS (Includes early maceration)			SURVIVING CO-TWIN
Female 1.55 kg	31 weeks	- placenta praevia	(No survivor)
Male 1.6 kg	31 weeks	- placental abruption	(No survivor)
Male 1.5 kg	31 weeks	- placental abruption	(No survivor)

Male	1.5	kg	37 weeks		(Female,	2.95	kg)
Male	2.2	kg	37 weeks		(Female,	3.5	kg)
Male	2.1	kg	38 weeks		(Male,	2.2	kg)
Female	2.1	kg	38 weeks		(Female,	2.5	kg)

NEONATAL DEATHS

Female	1.45	kg	31 weeks - placenta praevia	(No survivor)
Male	1.9	kg	33 weeks - I.R.D.S.	(Male, 1.75 kg)
Female	2.75	kg	40 weeks - birth trauma	(Female, 2.5 kg)

MATERNAL HEIGHT

The mean height of the twin mother was 157.35 centimetres whereas the mean height of 1500 women over the age of 17 years in the local population is 154 centimetres[2].

The distribution of height of the mother is shown in Figure 1 (tabulated data in Appendix 1).   Ninety-three of the 132 mothers (70%) were between 154 and 161 centimetres tall as compared to 51% of singleton mothers.

Fig. 1

THE HEIGHT DISTRIBUTION OF THE MOTHERS OF THE TWINS COMPARED
TO THE MOTHERS OF SINGLETONS
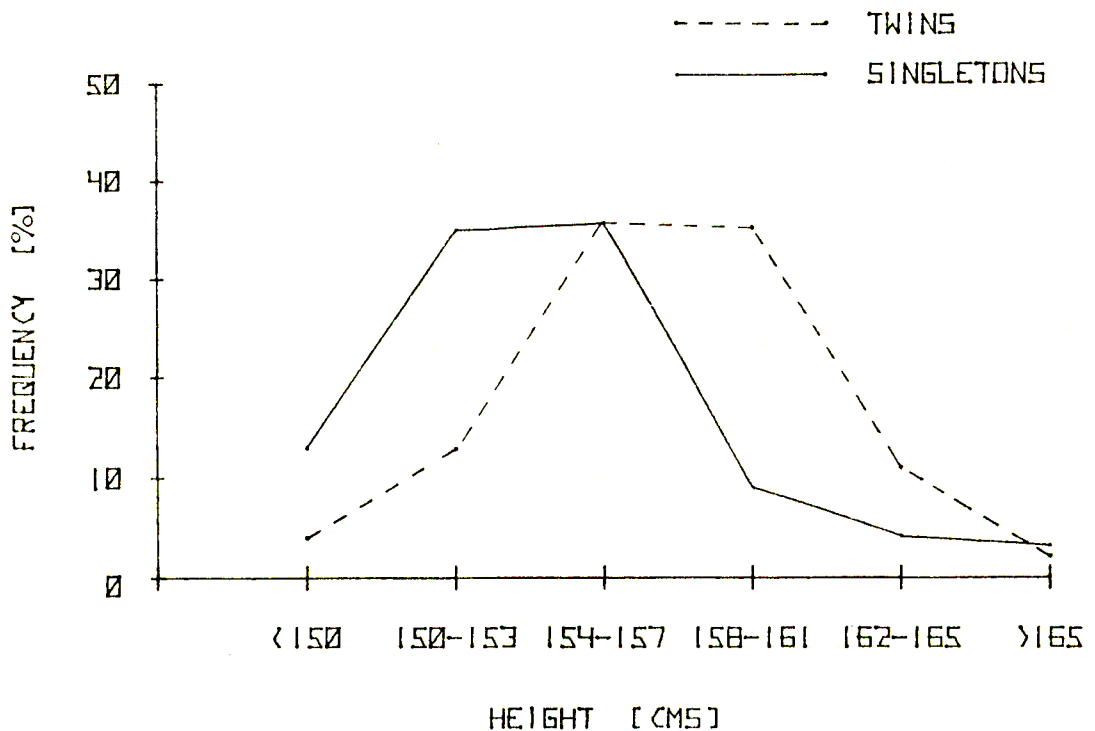
MATERNAL AGE

The mean age of the twin mothers was 26.7 years whereas
the mean age of the mothers of 575 consecutive live born
singletons of over 0.8 kg in weight was 23.12 years. The
age distribution of the twin mothers is compared to the
age distribution of the mothers of singletons in Figure 2
(tabulated data in Appendix I).   There was a significantly
smaller number of women under the age of 20 years having
twin pregnancies (8%) as compared to singleton pregnancies
(31%) (p = <0,001).   Thirty-seven percent of the mothers
of twins were between 20 and 35 years as were 37% of the
mothers having singleton pregnancies.   Fifty-five percent
of the twin mothers were over the age of 35 years but only
31% of the mothers having singleton pregnancies (p = <0,001).

Fig. 2

MATERNAL AGE OF THE TWINS COMPARED TO MATERNAL AGE OF
SINGLETONS
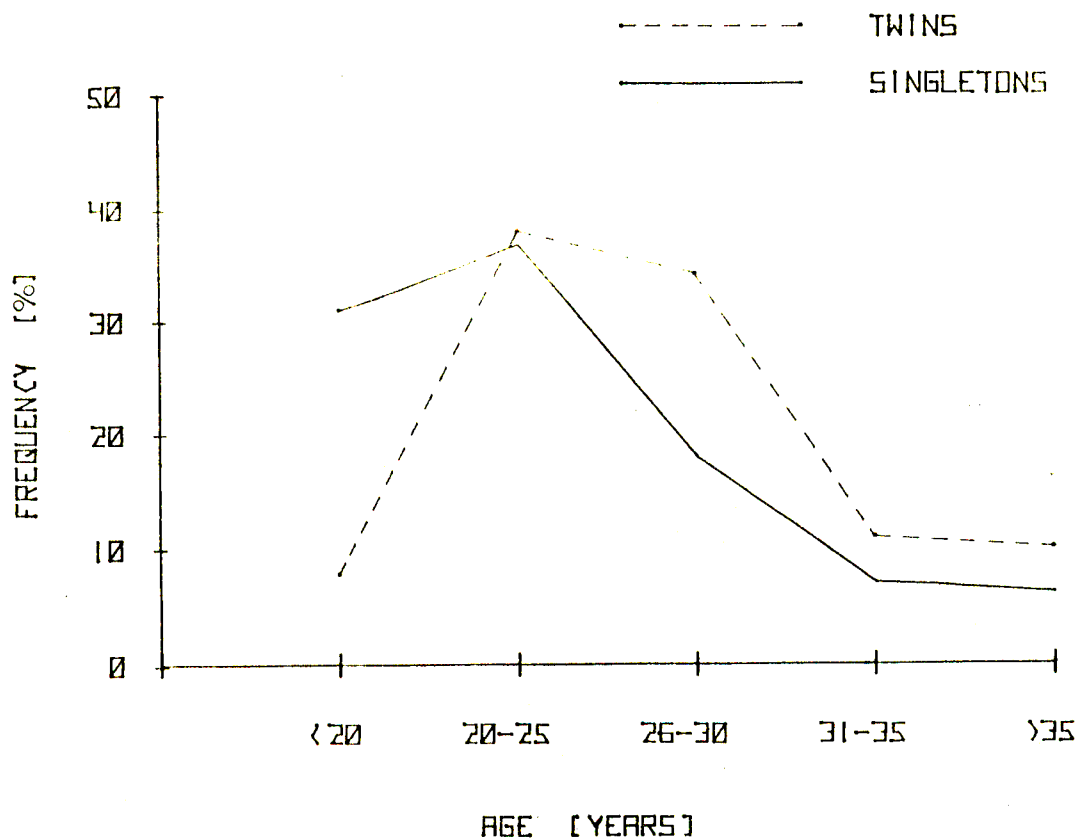
PARITY

The mean parity of the twin mothers was 2.90 whereas the mean parity of the mothers of 575 consecutive live born singleton pregnancies of over 0.8 kg was 1.68 (p = <0,001).

The comparison between the parity of the twin mothers and the mothers of singletons is shown in Figure 3 (tabulated data in Appendix I). Significantly fewer of the twin mothers were primiparous (11%) when compared to the mothers of singletons (34%) (p = <0,001).

Fifty-seven percent of the twin mothers were of parity 1 to 3 inclusive as were 52% of the mothers of singleton pregnancies.

Thirty-two percent of the twin mothers were of a parity of more than 3 compared to 12% of the mothers of singletons (p = <0,001).

Fig. 3

THE PARITY OF THE TWIN MOTHERS COMPARED TO THE PARITY OF THE MOTHERS OF SINGLETONS
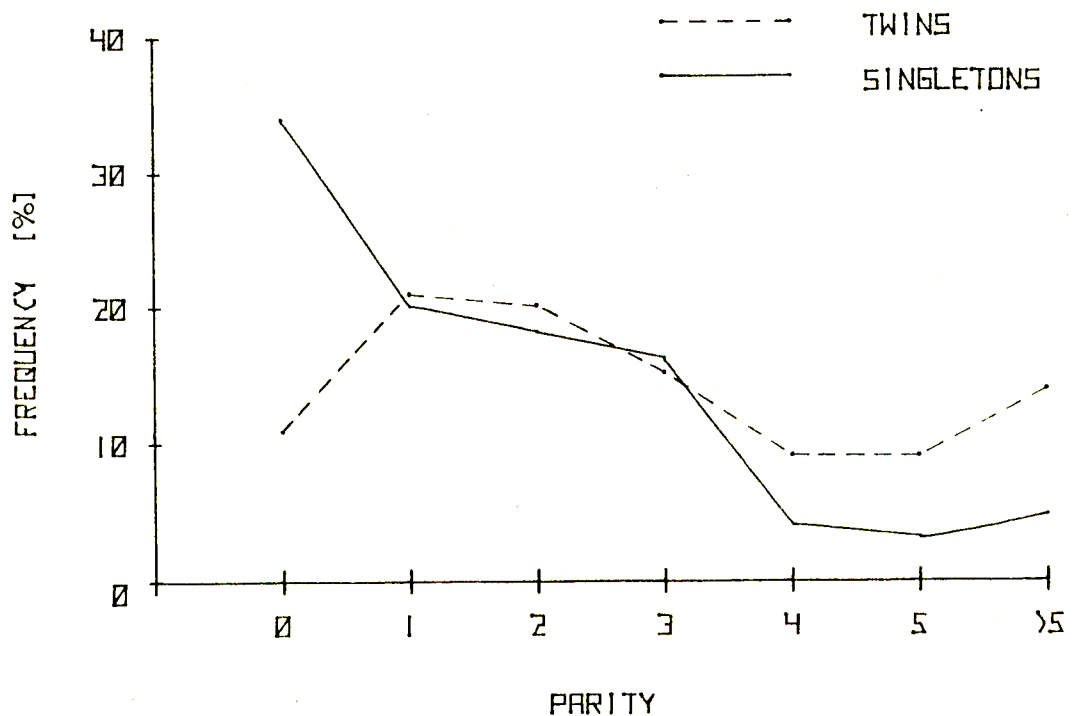
THE GESTATION OF ONSET OF SPONTANEOUS LABOUR

The mean gestation of onset of labour in the twins was
36.85 weeks whereas the mean gestation of onset of
spontaneous labour of 1892 consecutive live born singletons
assessed by Dubowitz was 38.51 weeks (p = <0,0005).   The
comparison between the 2 groups is shown in Figure 4
(tabulated data in Appendix I).

The tendency to earlier spontaneous labour in the twin
pregnancies can be clearly seen.   Fifty-five percent of
twin pregnancies went into labour between 37 and 39 weeks
gestation whereas a similar percentage of singleton pregnancies
(52%) went into labour from 39 to 41 weeks gestation.   The
median value for the twins was 37 weeks and for the singletons
was 40 weeks.

Fig. 4

THE GESTATION OF ONSET OF LABOUR IN THE TWINS COMPARED TO
SINGLETONS
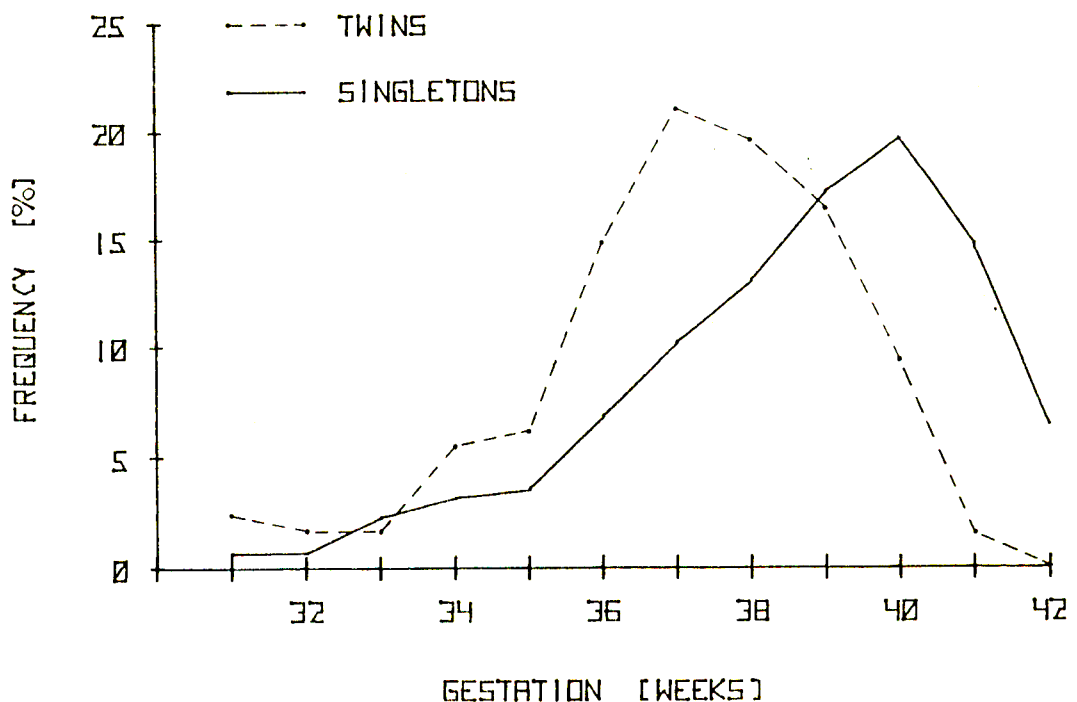
Spontaneous labour before 37 weeks occurred in 32% of the twin pregnancies and 19% of the singleton pregnancies. (Appendix I).

THE METHOD OF DELIVERY

The policy for choice of method of delivery is detailed earlier in this chapter.

The patients that delivered the first twins as a breech were all admitted in advanced active stage of labour with the breech at or just above the level of the ischial spines and the time interval from admission to delivery was too short to allow caesarean section to be performed. The mode of delivery is shown in Table II.

T A B L E   II

VAGINAL DELIVERIES   —   (TOTAL 73)

	Number Of Deliveries
Vertex vertex	38
Vertex breech	24
Breech vertex	7
Breech breech	4
Total vertex deliveries	106
Total breech deliveries	38
Vacuum extractions : First Twin	4
Second Twin	5
Breech extractions of the second twin	3

CAESAREAN SECTIONS IN LABOUR   -   (TOTAL 55)

	Number of Patients
Breech presentation of first twin	28
Previous caesarean section	9
Cephalo pelvic disproportion	8
Fetal distress	3
Severe hypertension in labour	1
Retained second twin	3
Placental praevia bleeding	1
Malpresentation of first twin	3

THE ELECTIVE DELIVERIES   -   (TOTAL 4)

Indication	Gestation (weeks)	Method of Delivery
Hypertension	36	Induction and vaginal delivery.
Hypertension	36	Induction and vaginal delivery.
Hypertension	36	Caeasrean section.
Hypertension	38	Caesarean section.

CAESAREAN SECTION RATE 57 out of 132 (43.2%)

THE BIRTHWEIGHT OF SINGLETONS

In order to establish birthweight for gestation for the population group 2000 consecutive live born singleton pregnancies were assessed in terms of birthweight and gestational age as calculated from Dubowitz scoring. The results are shown in Figure 5 (tabulated data in Appendix I) and compared with Lubchenco's[3] figures and those of Gairdner and Pearson[4]. The correlation coefficients for the smoothed centiles are:-

10th centile - 0.97

50th centile - 0,99

90th centile - 0,99

Fig. 5

BIRTHWEIGHT FOR GESTATION, 2OOO CONSECUTIVE LIVE BORN
SINGLETONS
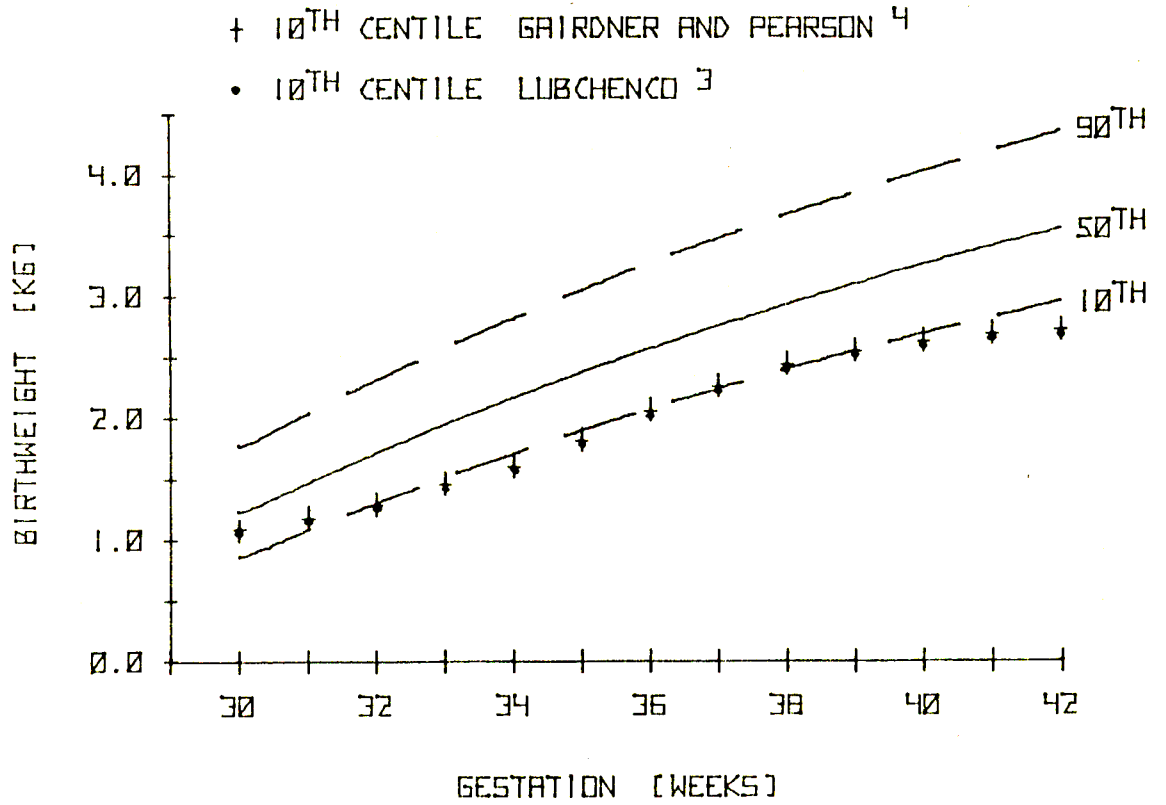
THE BIRTHWEIGHT OF THE TWINS

The mean birthweights of the larger twin and the smaller
twin are shown in comparison to the birthweight chart
for the population groups in Figure 6.   (tabulated data
in Appendix I).

/Figure 6 ....

Fig. 6

THE BIRTHWEIGHTS OF THE TWINS COMPARED TO SINGLETON STANDARDS

† THE LARGER TWIN

• THE SMALLER TWIN
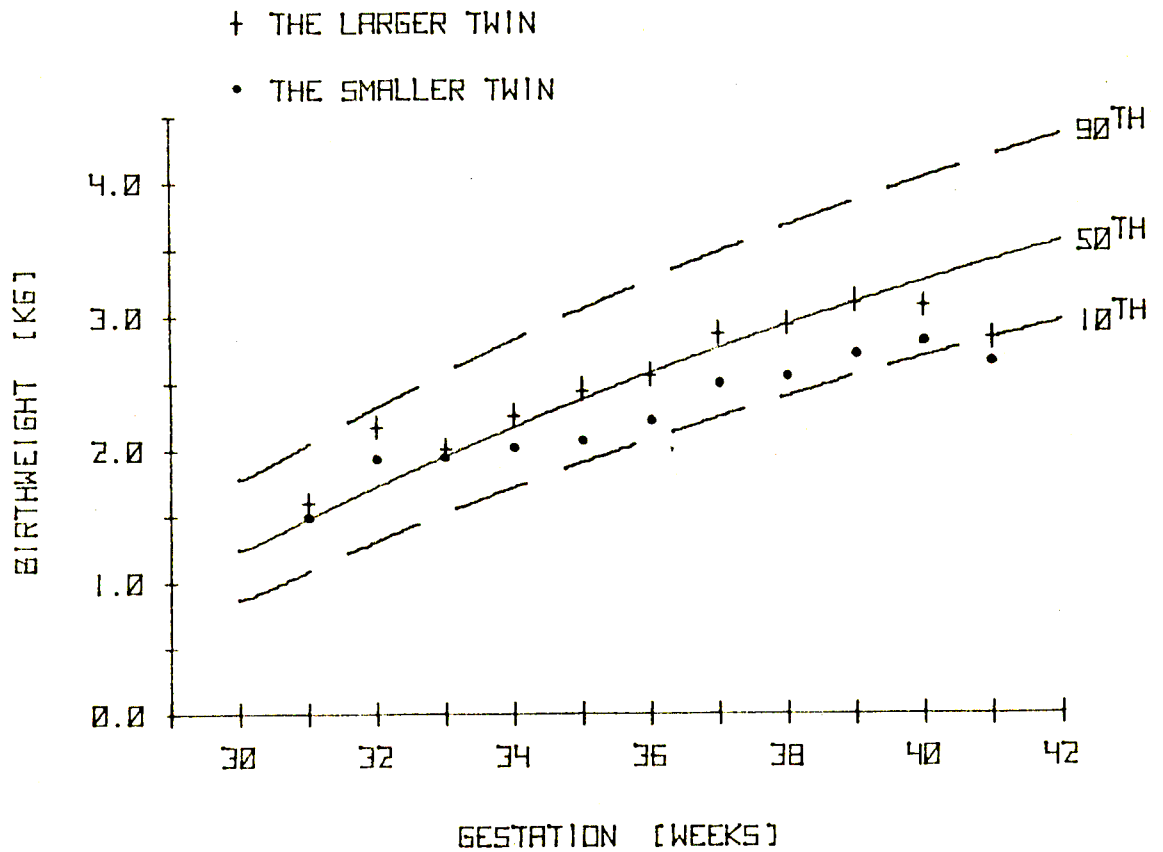
SEX AND ZYGOSITY

The sex of the infant pairs is shown in Table III.

T A B L E III

SEX	NUMBER OF PAIRS
Male / Male	42
Female / Female	35
Male / Female	55
	132

/Using Weinberg's .....

Using Weinberg's rule, that is the number of monozygotic
pairs is the total number of pairs less twice the number
of unlike pairs, there were 22 monozygotic pairs.

If the incidence of twinning in this population group is
26.3 per 1000 (see earlier in this chapter) the incidence
of monozygotic twinning is 4.4 per 1000.

The combined birth weight of the pairs according to sex
is shown in Table IV.

T A B L E   IV

THE COMBINED WEIGHT ACCORDING TO SEX

Sex	Mean combined birthweight (kg) $\pm$ 2 S.D.
Male / Male	5.255 $\pm$ 1.78
Female / Female	5.10 $\pm$ 1.61
Male / Female	5.267 $\pm$ 1.84
Like sexed pairs	5.178 $\pm$ 1.70

(Excludes the 2 pregnancies with a fetus papyraceous).

The weight disparity according to the sex of the pairs
is shown in Table V.

T A B L E   V

WEIGHT DISPARITY ACCORDING TO SEX

Sex	Mean weight disparity (kg) $\pm$ 2 S.D.
Male / Male	0.33 $\pm$ 0.54
Female / Female	0.26 $\pm$ 0.51
Male / Female	0.38 $\pm$ 0.69
Like sexed pairs	0.30 $\pm$ 0.53

(Excludes the 2 pregnancies with a fetus papyraceous).

The weight disparity of over 0.5 kg according to sex is shown in Table VI.

T A B L E   VI

WEIGHT DISPARITY OF OVER 0.5 KG ACCORDING TO SEX

Sex	Incidence
Male / Male	9 out of 42 (21%)
Female / Female	2 out of 33 (6%)
Male / Female	15 out of 55 (27%)
Like sexed pairs	11 out of 74 (14.9%)

(Excludes the 2 pregnancies with a fetus papyraceous).

PLASMA OESTRIOL AND PLACENTAL LACTOGEN

Plasma oestriol and placental lactogen results were allocated to gestation at the time of assay according to the gestation of the neonates as assessed by Dubowitz scoring. Where the gestation of assay was not allocated to an exact week it was allocated to the nearest full week below.

PLASMA OESTRIOL

The results for plasma oestriol calculated from a total of 478 assays are shown in Figure 6 (tabulated data in Appendix I). The correlation coefficients for the smoothed centiles were as follows:-

10th centile - 0.98
50th centile - 0.98
90th centile - 0.93

Fig. 7

THE PLASMA OESTRIOL VALUES OF THE TWINS
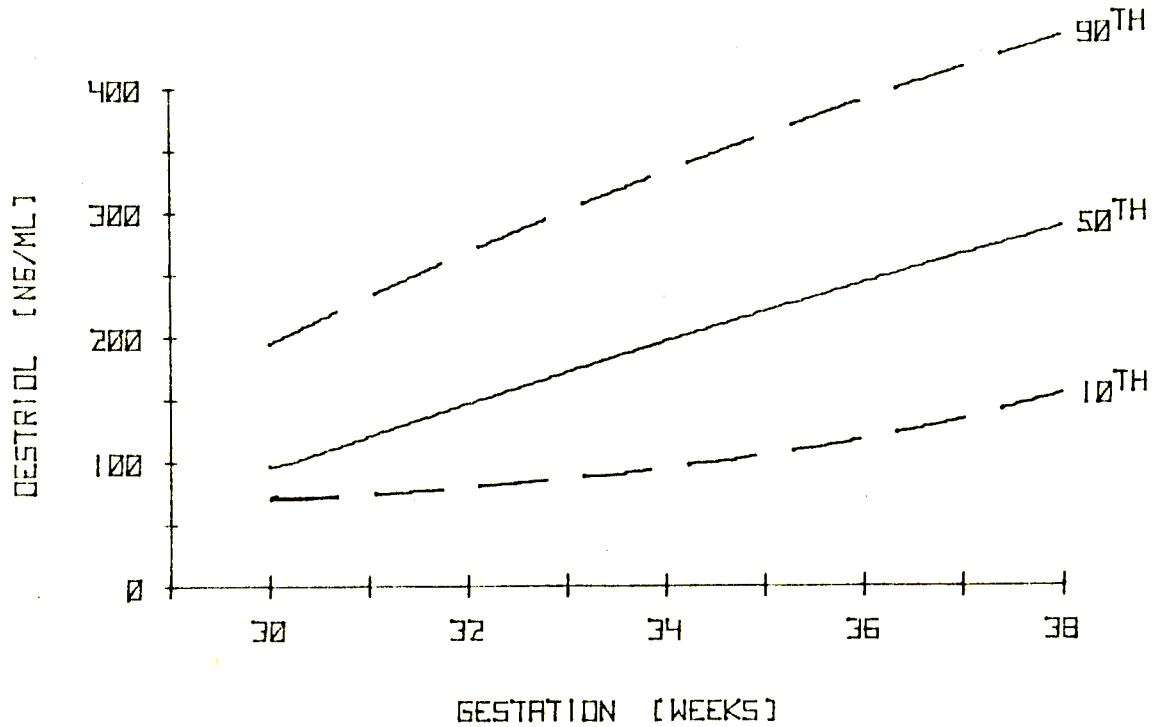
PLACENTAL LACTOGEN

The results for placental lactogen calculated from 491

results are shown in Figure 7 (tabulated in Appendix I).

The correlation coefficients of the smoothed centiles

were as follows:-

10th centile - 0.76

50th centile - 0.95

90th centile - 0.85

Fig. 8

THE PLACENTAL LACTOGEN LEVELS OF THE TWINS
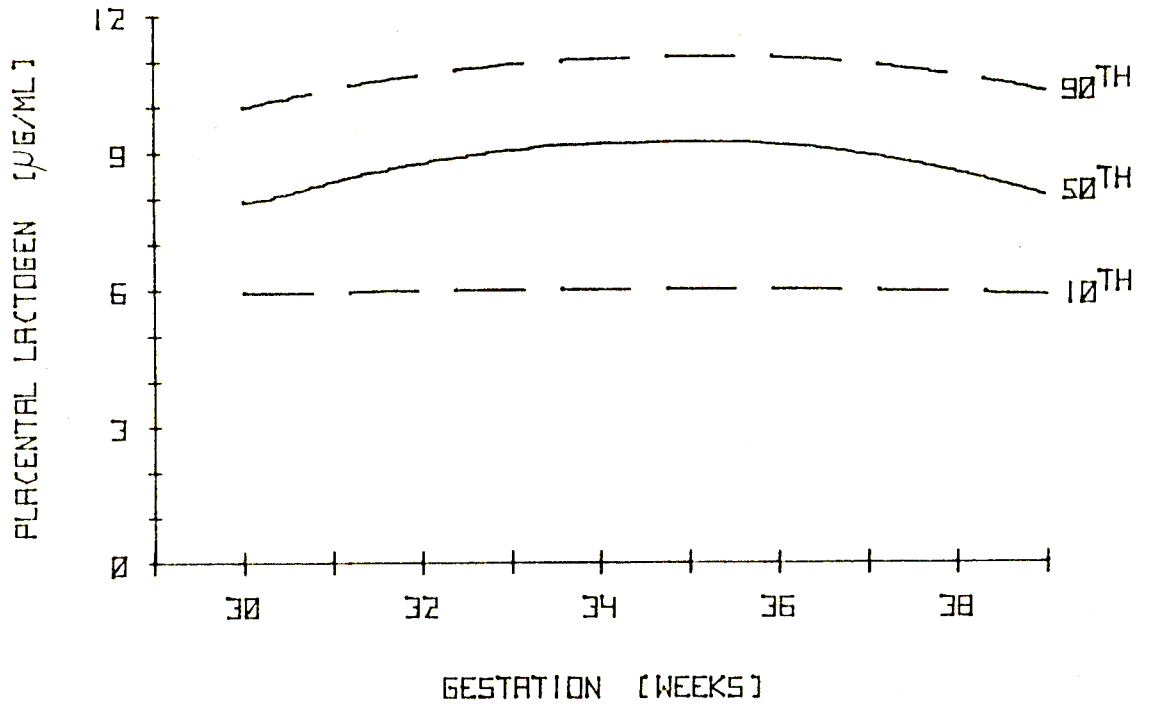
DISCUSSION

In discussion of this series of 132 twin pregnancies

reference is made to the literature in order to show

the epidemiological similarity of the twin pregnancies

in this population group with other reported series.

/MATERNAL HEIGHT ....

MATERNAL HEIGHT

There is a distinct difference between the mean height of the twin mothers and the mean height of singleton mothers of the same population group. This concurs with Anderson's[5] finding that there was an increase in twinning rate with height in Aberdeen and also the finding of Campbell D.M. et al[6] that there was a greater number of tall women than expected having twin pregnancies when compared to singleton pregnancies.

Because of the small number (14) of primigravid patients in this series no attempt has been made to confirm their finding that the effect of height was maximal in primigravida.

MATERNAL AGE

The increase in twinning rate with age has been reported frequently[5] [7] [8] [9] [10] Anderson[5] found that there was an increase in twinning rate with age to a peak between 35 and 39 years. He also found that this increase was independent of the parity effect.

The significant difference between the age of the twin mother in this series compared to their singleton counterparts is shown clearly in Figure 2 where the effect is most apparent under the age of 20 years and over the age of 25 years.

PARITY

The increase in twinning rate with parity has been well
documented[5] [7] [8] [9] [10] and Anderson[5] found that this effect
was independent of maternal age with a continuous gradual
rise of twinning incidence with birth order.   In this
series there is a significant difference between the
parity of the twin mothers and their singleton counterparts.
This difference is clearly seen in Figure 3 where the
effects of parity are most notable in the primiparous
patients and the patients of a parity of 4 or more.

THE GESTATION OF ONSET OF LABOUR

The dissimilarity between the distribution of timing of
onset of spontaneous labour according to gestation between
the twins and singletons can be seen in Figure 4.   There
is a sharp rise in the frequency of onset of labour in twins
from 35 weeks gestation to a peak at 37 weeks, whereas the
rise from 35 weeks in singleton pregnancies is more gradual
to a peak at 40 weeks.   No twins in the series were
gestationally aged as more than 41 weeks whereas 6% of
the singleton pregnancies were more than 41 weeks gestation
at the time of spontaneous labour and delivery.

The mean gestation of onset of spontaneous labour in the
series was 36.85 weeks.   This falls within the range quoted
by various authors:

/AUTHORS ....

AUTHORS	MEAN GESTATION (WEEKS)
Mc Keown and Record[11]	37.37
Karn[12]	36.73
Guttmacher and Kohl[13]	36.85
Butler and Alberman[14]	37.71

BIRTHWEIGHT

SINGLETONS

The difference between the birthweight centiles of this population group and those found by Lubchenco et al[3] and Gairdner and Pearson[4] are shown in Figure 5. The 10th centile of the birthweights for the population group under study are not significantly different to Gairdner and Pearson's or Lubchenco's figures until after 40 weeks when there is a trend for Lubchenco's figures becoming slightly less than the authors.

THE BIRTHWEIGHT OF THE TWINS

The mean birthweights for the larger twin and the smaller twin are compared to the authors figures for singleton birthweights in Figure 6. The larger twin appears to grow normally until 36 to 37 weeks gestation when the growth rate falls below the mean, whereas the smaller twin falls below the mean from 34 to 35 weeks gestation.

The diminished rate of growth of the twin fetus in the third trimester of pregnancy is well documented although there are differing opinions as to the timing of the

/deviation ......

deviation.   McKeown and Record[17] state that fetal growth
is independent of litter size until about the 30th week
of gestation after which multiple fetuses show an increasing
weight deficit.   Gruenwald[15] found that prior to 37 weeks
gestation twins of opposite sex conform to singleton
standards but monochorionic twins show the deviation at
an earlier stage.   A more extreme view is held by Daw
and Walker[16] who state that little or no growth of the
twin fetus occurs from 34 to 40 weeks gestation.

SEX AND ZYGOSITY

The sex distribution of the infant pairs is shown in Table
III.   The calculated monozygotic twinning rate in this
series of 4.4/1000 closely agrees with the finding that
the frequency of monozygotic twinning varies little
between populations and is 3-4/1000[17] [18] .

The slightly higher number of male/male pairs than female/
female pairs in the series is similar to the findings of
Bulmer[19].

The series supports the findings of Potter[20] and Klein[21]
that unlike sex pairs have a better chance of survival
than like sexed pairs as can be seen in Table I.   In 7
of the 9 pregnancies in which one or both infants died
the twins were of like sex.

No significant difference could be found between like
sexed twins and unlike sexed twins in either mean combined
weight at delivery or degree of weight disparity (Tables

IV and V), though a weight disparity of more than 0.5 kg was more common in unlike sexed twins (Table VI).

PLASMA OESTRIOL AND PLACENTAL LACTOGEN

The values for plasma oestriol and placental lactogen for the twins in the series have been established. These will be referred to in relation to values for singletons and the one reported series of plasma oestriol values in twins in later chapters.

CONCLUSIONS

The epidemiological findings in this series are very similar to the findings of the many series referred to in the text.

Because of this similarity the author infers that valid conclusions can be derived from studies undertaken on this series in terms of the aims as stated in the introductory chapter.

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CHAPTER III

THE PREDICTION OF PRE-TERM LABOUR AND THE TIMING OF ONSET OF LABOUR

INTRODUCTION

CONSIDERATIONS

Age Parity and Height

Weight and Abdominal Girth

Changes in weight and Girth

Presentation of the first twin

Plasma Oestriol and Placental Lactogen

Neonatal Weight for Gestation

Sex of the Infants

The Cervix and changes in the Cervix

Uterine Sensitivity to Oxytocin

DISCUSSION

CONCLUSION

INTRODUCTION

The problems associated with pre-term delivery (delivery before 37 weeks gestation) have been considered in Chapter I. The dimension of the problem in twin pregnancy is highlighted by the incidence of pre-term labour and delivery in this series (32.5%).

The approach to the problem of prediction of pre-term labour and the timing of onset of labour in twins is outlined below:

Comparisons are made between the pre-term labour and delivery group and the group labouring at term using the following parameters:-

a. Age, parity and height.
b. Final actual weight and girth.
c. Incremental changes in weight and girth.
d. Presentation of the leading fetus.
e. Profiles of plasma oestriol and placental lactogen.

In all the above comparisons the three elective pre-term deliveries are excluded.

The total number of twin pregnancies considered was 42 patients in the pre-term labour group and 87 patients in the term labour group.

The cervix and uterine sensitivity to oxytocin are considered by comparing the undermentioned static states, changes or response with impending labour.

a. The length and change in length of the cervix.
b. The dilation and change in dilation of the cervix.
c. The cervical score and change in cervical score.

/d. Uterine response .

d. Uterine response to oxytocin infusion (uterine sensitivity).

e. The inter relationship between uterine sensitivity and cervical score.

In these comparisons the 4 elective deliveries are excluded leaving 42 patients in the pre-term labour group and 86 patients in the group labouring at term.

The results will then be discussed as will the value of the results and an hypothesis on causation of pre-term labour in twins.

The material and methodology are considered in Chapter II.

RESULTS

The incidence of pre-term labour and delivery was 42 out of 129 patients - 32.5%.

MATERNAL AGE AND THE TIMING OF ONSET OF LABOUR

For comparison purposes the patients have been divided into 5 year age groups as follows:-

Less than 20 years
20 to 25 years
26 to 30 years
31 to 35 years
More than 35 years

The range was 17 to 45 years. The only difference that could be found was between the group under 20 years old which had a 60% incidence of pre-term labour compared to

an incidence of 30.25% in all patients 20 years of age or
more.   This is shown in Figure 1 (tabulated data in
appendix II).   The difference was not statistically
significant but indicates a trend.

Fig. 1

MATERNAL   AGE   AND   PRE-TERM   OR   TERM   LABOUR

FREQUENCY %
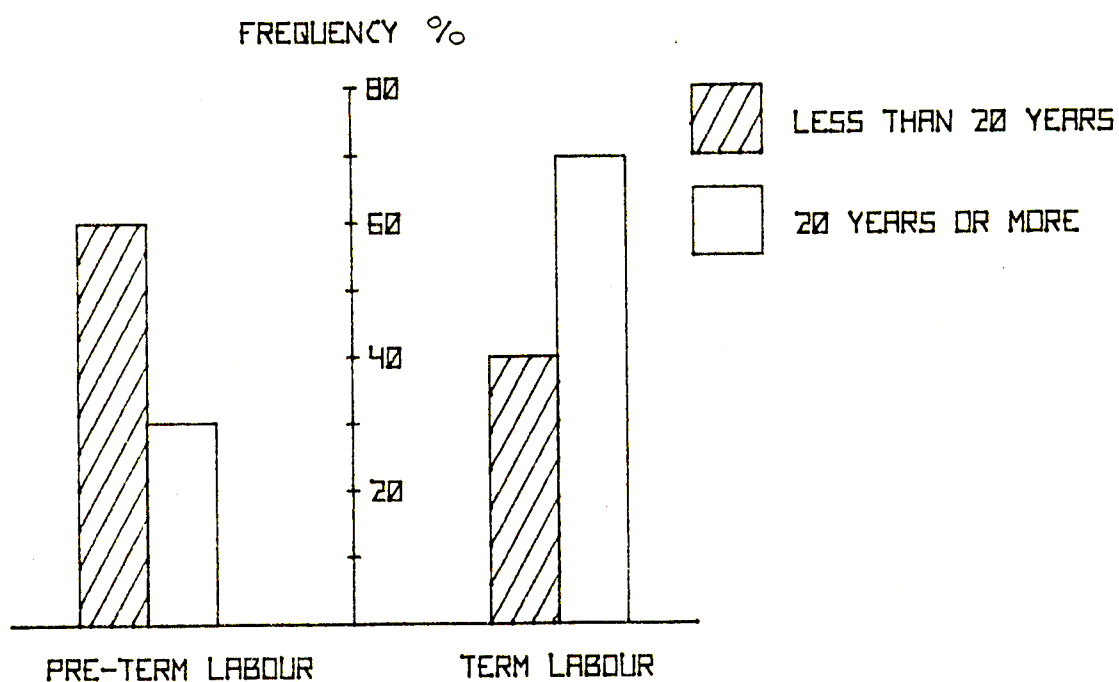
Four of the six patients under 20 years of age in the
pre-term labour group were also primiparous.

PARITY AND THE TIMING OF ONSET OF LABOUR

The patients were grouped according to actual parity

except for a group with a parity of more than 5.

There is an apparent trend of a reducing incidence of

pre-term labour with increasing parity.   Primiparous

patients had a greater incidence of pre-term labour

(57%) compared to all other parities (31.8%)   and

particularly when compared to women of a parity greater
than 4 (23.3%) (p = <0.1 = >0.5).   This trend is shown
in Figure 2 (tabulated data in appendix II).

Fig. 2

PARITY   AND   PRE-TERM   OR   TERM   LABOUR

FREQUENCY %

PARITY AND PRE-TERM OR TERM LABOUR chart
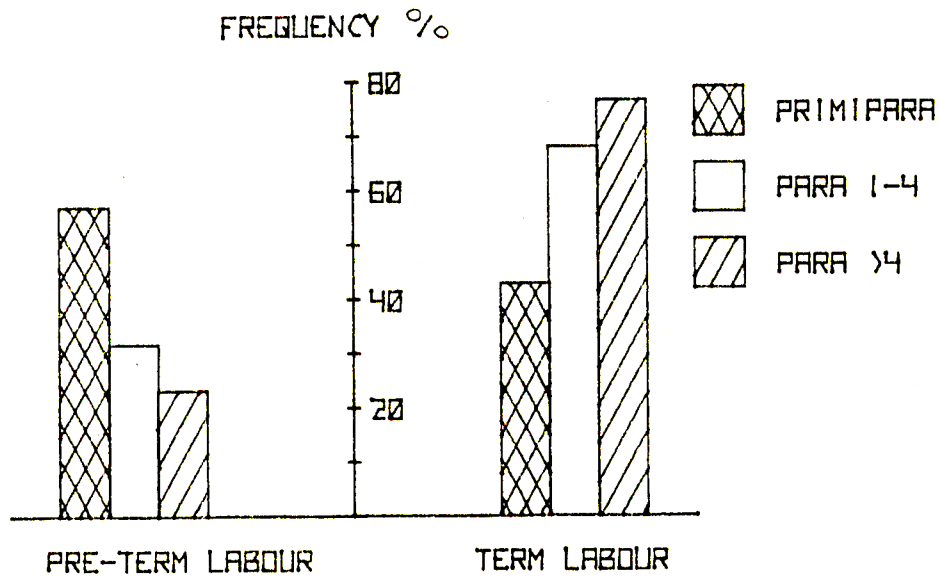
Four of the eight primiparous patients in the pre-term
labour group were also under 20 years of age.

MATERNAL HEIGHT AND THE TIMING OF ONSET OF LABOUR
For comparison purposes the patients were divided into
groups according to height as follows:-

                    Less than 150 cm
                    150 to 153 cm
                    154 to 157 cm
                    158 to 161 cm
                    162 to 165 cm
                    More than 165 cm

The range was 145 to 168 cm.

/The only apparent .

The only apparent difference between the pre-term labour group and the term labour group was the lowered incidence of pre-term labour in the tall women over 161 cms (18.75%) as compared to the women measuring 161 cm or less (34.5%). This is shown diagrammatically in Figure 3 (tabulated data in appendix II). The difference between the height groups did not achieve statistical significance.

Fig. 3

MATERNAL HEIGHT AND PRE-TERM OR TERM LABOUR

FREQUENCY %
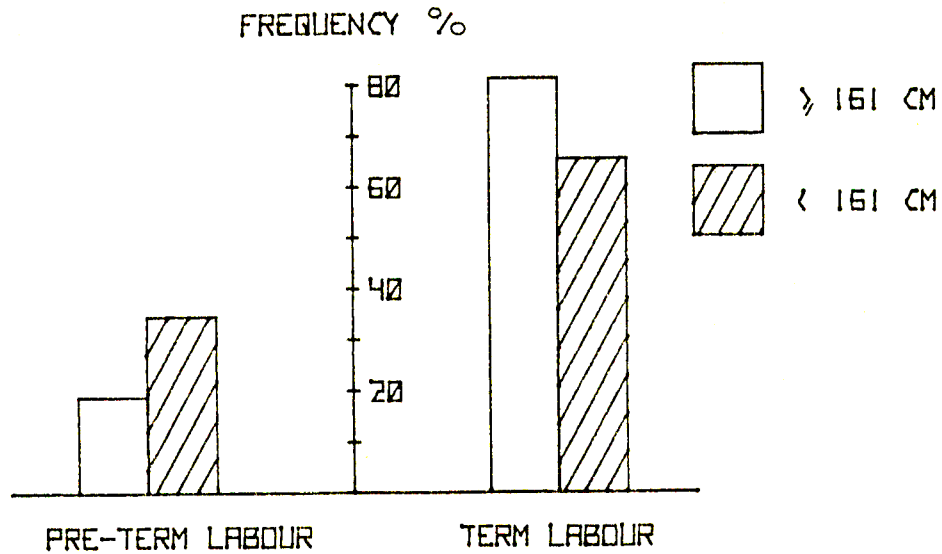
INCREMENTAL WEIGHT CHANGE AND THE TIMING OF ONSET OF LABOUR

In order to determine whether weight change in the two weekly assessments prior to spontaneous labour would have any benefit in predicting those patients who would go into pre-term labour comparison was made in terms of incremental weight change in the two groups. The patients were divided into weight change groups according to average increment of weight change over the three assessments prior to the onset of labour as follows:

/Loss of weight ....

Loss of weight equal to or more than 0.5 kg/week

Loss of between 0.5 and 0 kg/week

Static weight

Gain of weight of less than 0.5 kg/week

Gain of weight of 0.5 to 1.0 kg/week

Gain of weight of more than 1.0 kg/week

There was no significant difference in the distribution of incremental weight change patterns in the two groups (tabulated data in appendix II).

FINAL ACTUAL WEIGHT AND THE TIMING OF ONSET OF LABOUR

The patients body weight prior to pregnancy could not be established with any degree of accuracy on any occasion. In order to determine the effect of obesity on the incidence of pre-term labour the actual final measured weight was corrected very simply for height by calculation of the height to weight ratio. Thus low values reflect obesity and high values low body weight. It is appreciated that this calculation might reflect either a. obesity, or b. excessive weight gain in pregnancy.

The patients were then grouped according to height / weight ratio as follows:-

           1.5   to 1.750
           1.751 to 2.0
           2.001 to 2.25
           2.251 to 2.5
           2.501 to 2.75
           More than 2.75

The range was 1.503 to 3.310.

It was apparent that obese patients whether primarily obese

/or obese due ....

or obese due to excessive weight gain in pregnancy (height and weight ratio <2.0) were less likely to go into pre-term labour (p = <0.1 = >0.5).   This is shown in Figure 4 (tablulated data in appendix II).

Fig. 4

FINAL HEIGHT TO WEIGHT RATIO AND PRE-TERM OR TERM LABOUR
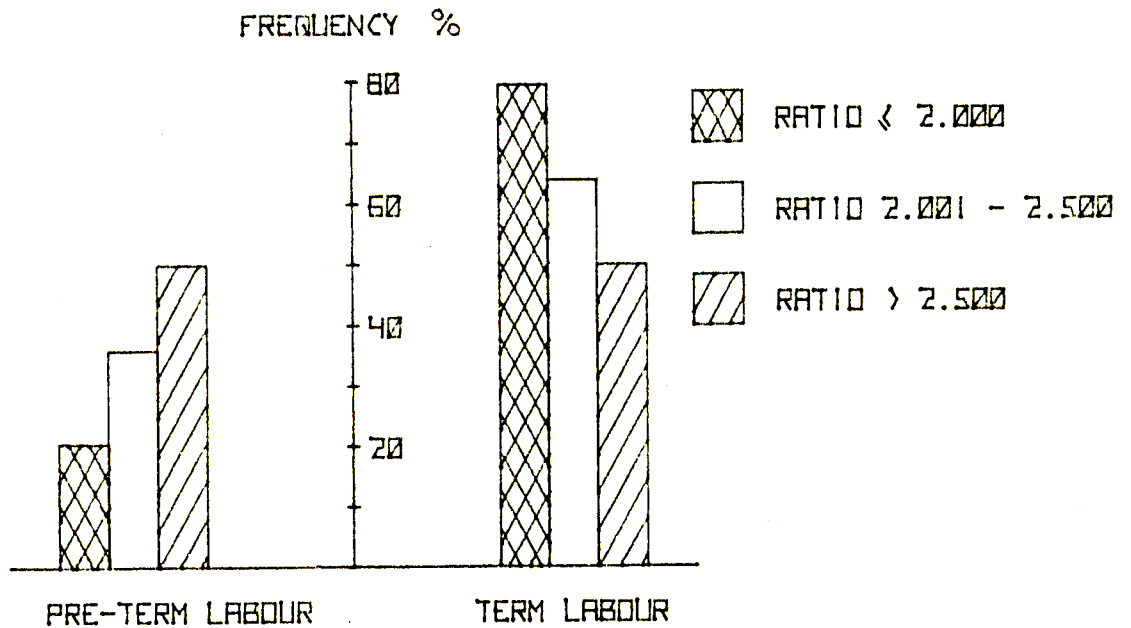
INCREMENTAL GIRTH CHANGE AND THE TIMING OF ONSET OF LABOUR

In order to determine whether there was a difference in the weekly increment of girth change in the two groups the average increment over the 3 assessments prior to labour was calculated and the patients divided into the following groups.

> Losing more than 1 cm / week
> Losing 1 cm or less / week
> Static
> Gaining less than 1 cm / week
> Gaining from 1 to 2 cm / week
> Gaining more than 2 cm / week

/There was no ....

There was no difference in the distribution of increment of girth change preceding labour in the two groups (tabulated data in appendix II).

FINAL ACTUAL GIRTH AND TIMING OF ONSET OF LABOUR

In order to determine whether actual girth achieved had any relation to pre-term labour on the timing of onset of labour the patients were divided into groups. Each of the eight groups had a final actual girth within a 5 cm range from 80 cm to more than 120 cms.

As would be expected the group labouring before term had a smaller girth on average than the group labouring at term, Figure 5 (tabulated data in appendix II), for clarity the groupings are summated to 10 cm.

Fig. 5

FINAL ACTUAL GIRTH IN THE PRE-TERM AND TERM LABOUR GROUPS
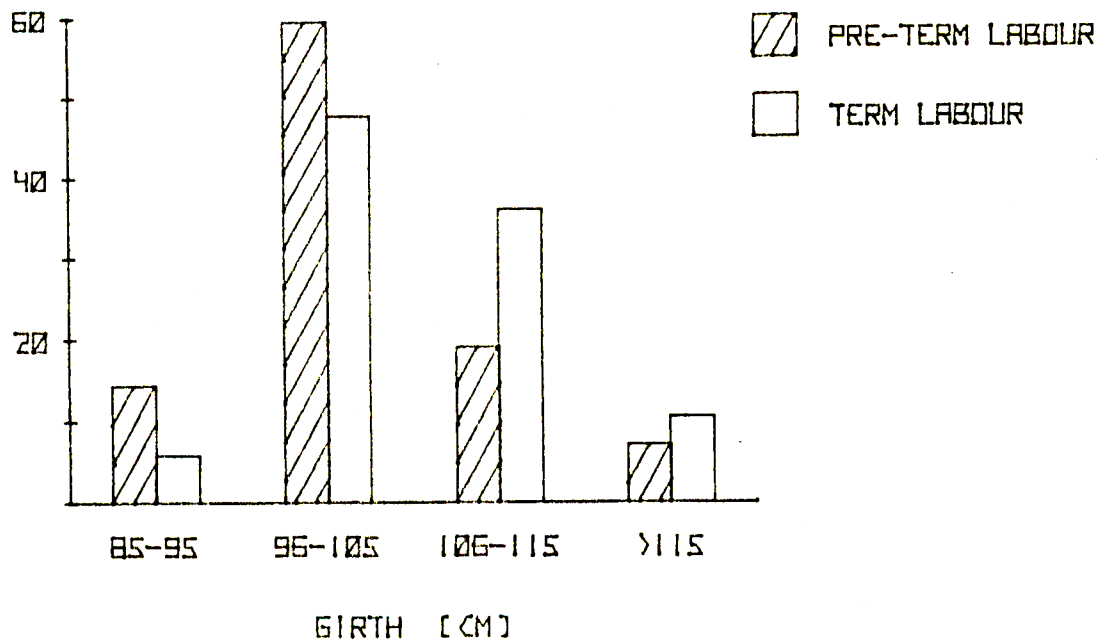
/ When considering ....

When considering the 5 cm groups the median value for each
group or patients prior to labour was 101 to 105 cms.

FINAL ACTUAL GIRTH CORRECTED FOR WEIGHT AND THE TIMING OF
ONSET OF LABOUR

Simple actual girth measurement is a summation of uterine
circumference and maternal soft tissue at the position of
measuring.   The main variable in maternal soft tissue is
fat and in an attempt to correct the girth for obesity the
product of the height : weight ratio and final actual girth
was considered in relation to the pre-term labour group and
the group labouring at term.

This relationahip is shown in Figure 6 (tabulated data in
appendix II) only 11.9% (5 out of 42) in the pre-term labour
group and 10.5% 9 out of 86) in the term labour group had
a product value of 200 or less at the assessment preceding
the onset of labour.

Fig. 6

THE PRODUCT OF THE HEIGHT TO WEIGHT RATIO AND PRE-TERM
OR TERM LABOUR
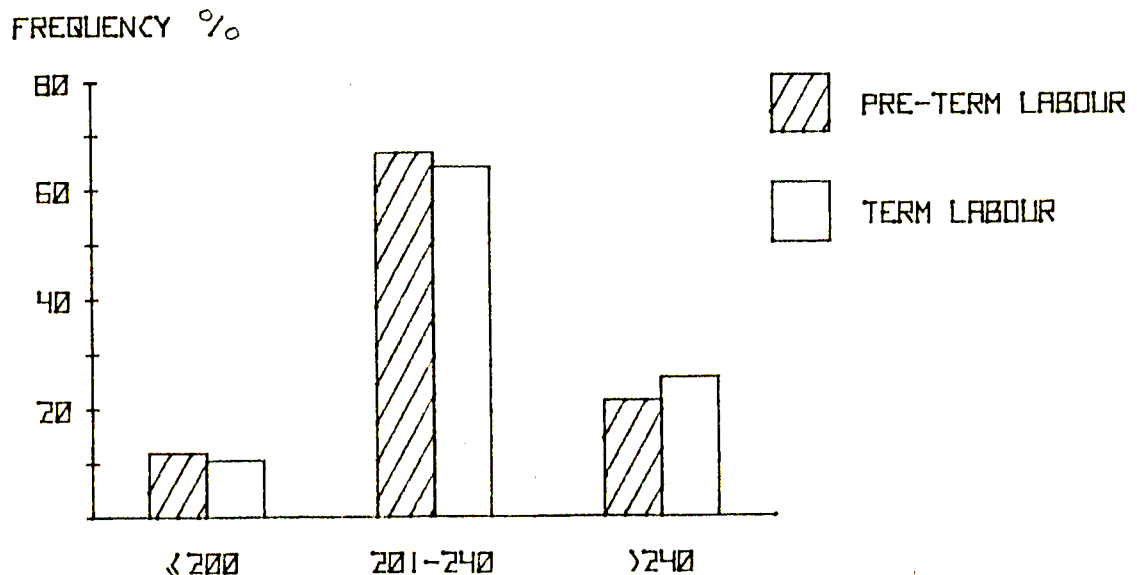
It would appear that few patients go into spontaneous labour before the product of height / weight ratio and actual girth exceeds 200. All of the patients with a product of less than 200 within 7 days of labour were obese the highest height to weight ratio being 2.025 the remainder were less than 2.0.

THE PRESENTATION OF THE LEADING TWIN AND THE TIMING OF ONSET OF LABOUR

No difference could be found between the pre-term labour group and the group labouring at term in respect of the presentation of the leading twin (Table I).

TABLE I

THE PRESENTATION OF THE LEADING TWIN AND THE TIMING OF ONSET OF LABOUR

PRESENTATION	PRE-TERM LABOUR	TERM LABOUR
Cephalic	28 (66.6%)	57 (65.5%)
Other	14 (33.3%)	30 (34.5%)

PLASMA OESTRIOL AND PRE-TERM LABOUR

The plasma oestriol values for the pre-term labour group were analysed in terms of centiles and the 50th centile curve superimposed on the values of plasma oestriol previously established for all the twins in the series (Chapter II).

The difference between the two sets of values can be seen in Figure 7 (tabulated data in appendix II).

Fig. 7

PLASMA OESTRIOL VALUES IN THE PRE-TERM LABOUR GROUP
COMPARED TO THE VALUES FOR ALL THE TWINS
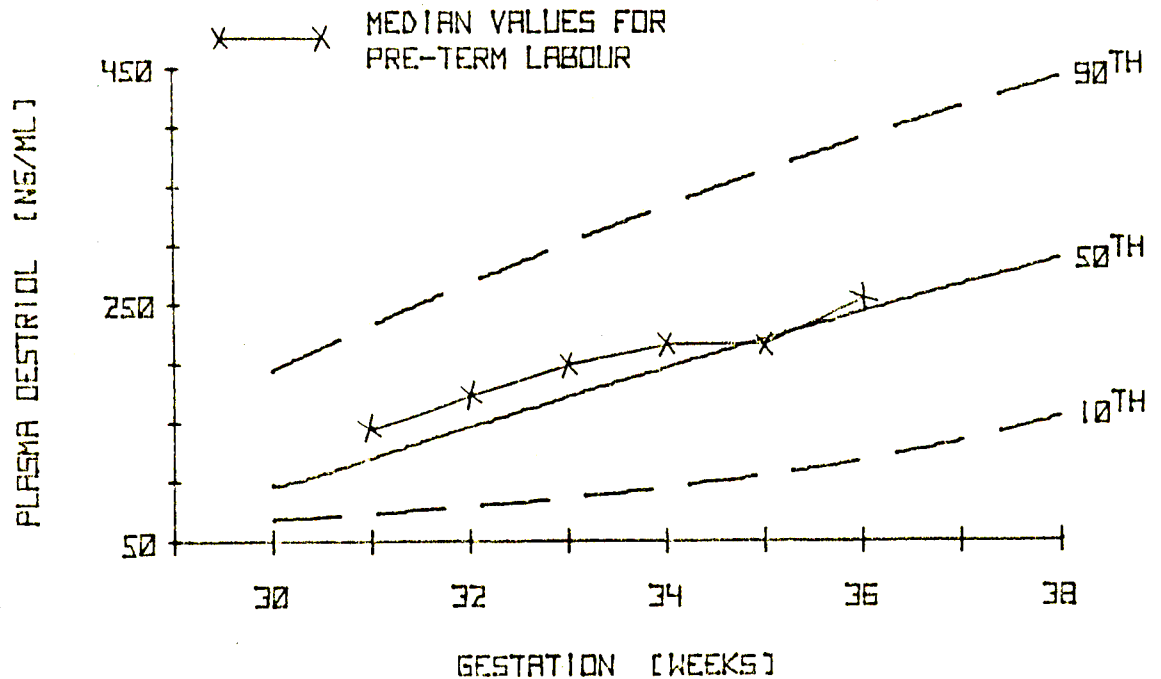
The median values for the pre-term labour group is significantly
higher (p = <0.005) than the 50th centile for all the twins.

The total number of assays in the pre-term labour group was
129 and the distribution of these according to gestation
can be seen in appendix II.

PLACENTAL LACTOGEN AND PRE-TERM LABOUR

The 50th centile values of placental lactogen levels for
the pre-term labour group are compared to those for all
the pregnancies in Figure 8 (tabulated data in appendix II).

There is no difference between the two groups at any
gestation to 36 weeks.

Fig. 8

PLACENTAL LACTOGEN VALUES IN THE PRE-TERM LABOUR GROUP
COMPARED TO THOSE FOR ALL THE TWINS
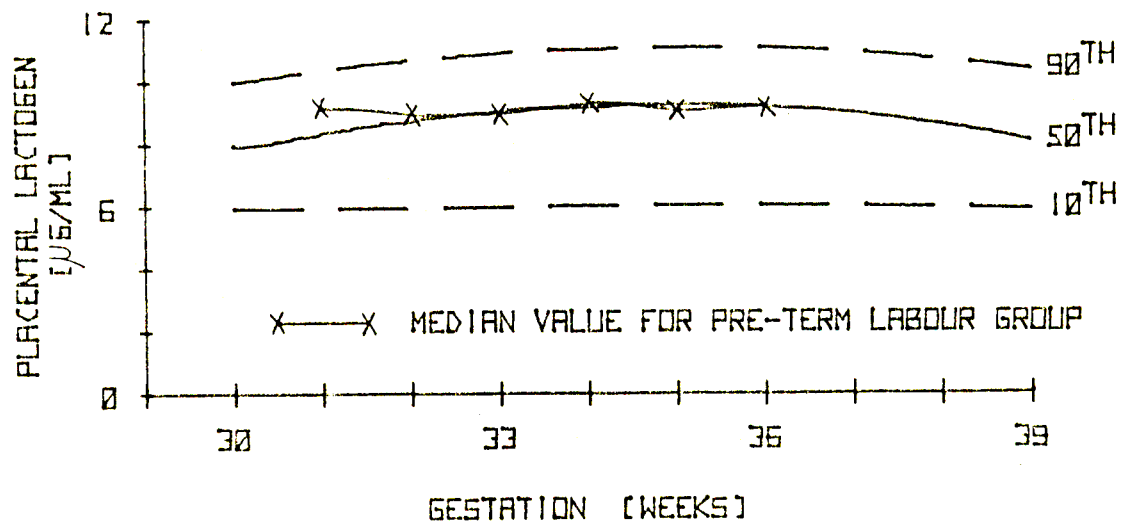
NEONATAL WEIGHT FOR GESTATIONAL AGE AND THE TIMING OF

ONSET OF LABOUR

It is possible that chronic deprivation of one or both

twins may precipitate early spontaneous labour.

For comparison purposes the pregnancy incidence of intra-

uterine growth retardation between the pre-term labour group

and the group labouring at term is shown in Table II.

TABLE II

INTRA-UTERINE GROWTH RETARDATION AND THE TIMING OF ONSET
OF LABOUR

	PREGNANCY INCIDENCE INTRA-UTERINE GROWTH RETARDATION
Pre-term labour	8 out of 42 (19.0%)
Term labour	29 out of 86 (33.7%)

(Excludes the two pregnancies with a fetus papyraceous.

/THE SEX OF ....

THE SEX OF THE NEONATES AND PRE-TERM LABOUR

The distribution of sex of the neonatal pairs was no

different in the pre-term labour group from the group

labouring at term (Table III).

TABLE III

SEX OF THE PAIR AND THE TIMING OF ONSET OF LABOUR

SEX	PRE-TERM LABOUR	TERM LABOUR
Male / male	14	27
Female / female	11	24
Male / female	17 (40.5%)	36 (41.3%)
Like sexed	25 (59.5%)	52 (58.7%)

THE CERVIX

In assessing changes of the cervix prior to labour the

following terminology is used:-

Week 0 - the last assessment before labour (within 7 days).

Week 1 - the penultimate assessment.

Week 2 - the weekly assessment prior to the penultimate
assessment.

THE CERVICAL CANAL LENGTH AND CHANGES IN LENGTH PRECEDING
SPONTANEOUS LABOUR

Comparison was made between the pre-term labour group and

the term labour group in terms of cervical canal length

within 7 days of the onset of labour (Table IV).

TABLE IV

THE LENGTH OF THE CERVICAL CANAL PRECEDING SPONTANEOUS
LABOUR (WITHIN 7 DAYS)

LENGTH (CM)	PRE-TERM LABOUR	TERM LABOUR	ALL LABOURS
3	11 (26%)	15 (17%)	26
2	20 (48%)	44 (51%)	64
1	11 (26%)	22 (26%)	33
0	-	5 (6%)	5

There is no significant difference in distribution between
the two groups.

The changes in cervical length prior to the onset of both
pre-term labour and term labour are shown in Figure 9
(tabulated data in appendix II).

Fig. 9

THE CHANGE IN CERVICAL LENGTH PRECEDING LABOUR EXPRESSED
AS PERCENTAGE SHOWING CHANGE
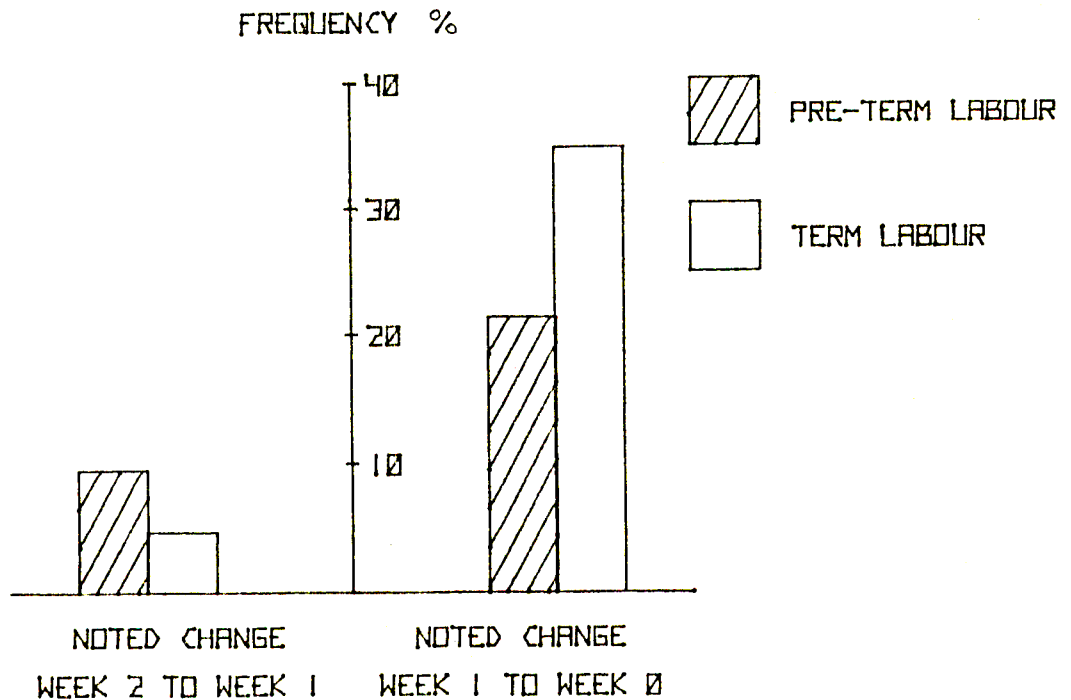
It is apparent that a change in cervical length of 1 cm or less occurs more frequently (30.5%) in the 7 to 14 days before the onset of labour than in the 14 to 21 days prior to the onset of labour (6.25%) (p = <0.001). This change occurs less frequently in the pre-term labour group (21%) than the group labouring at term (34.5%) but this difference is not statistically significant.

THE CERVICAL DILATION AND CHANGES IN CERVICAL DILATION PRECEDING THE ONSET OF LABOUR

Comparison was made between the pre-term labour group and the term labour group in terms of dilation of the internal cervical os within 7 days of the onset of labour (Table V).

TABLE V

THE DILATION OF THE INTERNAL CERVICAL OS PRECEDING THE
ONSET OF LABOUR (WITHIN 7 DAYS)

DILATION (CM)	PRE-TERM LABOUR	TERM LABOUR	ALL LABOURS
3 or more	7 (16.7%)	23 (26.7%)	30
2	8 (19.0%)	23 (26.7%)	31
1	12 (28.6%)	18 (21.0%)	30
0	15 (35.7%)	22 (25.6%)	37

There is no significant difference in the distribution between the two groups.

The change in cervical dilation prior to the onset of both pre-term and term labour are shown in figure 10 (tabulated data in appendix II).

Fig. 10

CHANGE IN CERVICAL DILATION PRECEDING LABOUR EXPRESSED AS PERCENTAGE SHOWING CHANGE
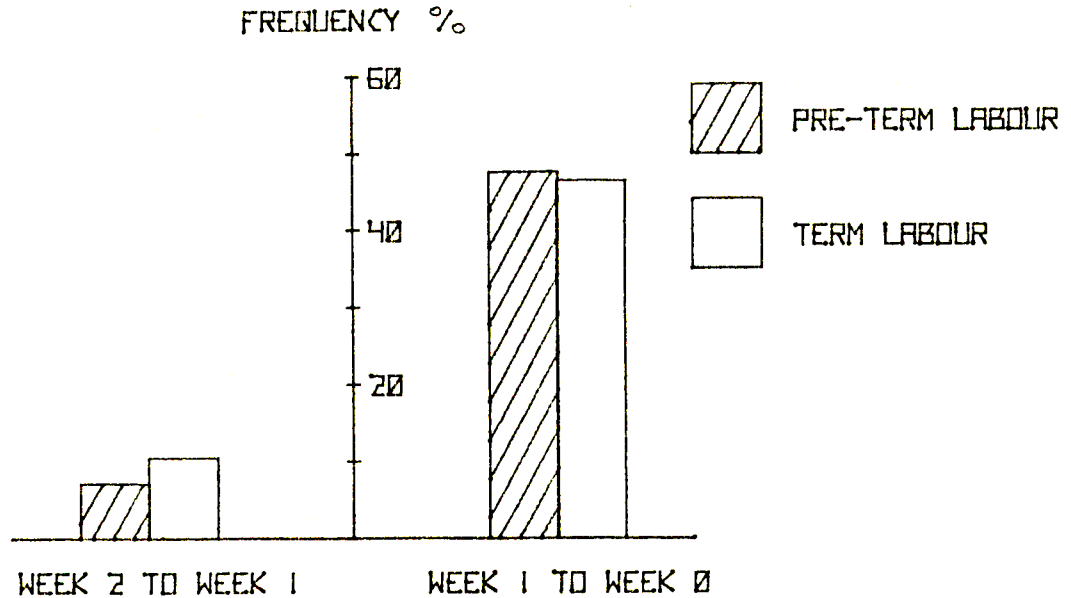
There was no significant difference in the incidence of change in cervical dilation in the 21 days prior to the onset of labour between the two groups.

It is apparent that a greater number of patients (46.7%) show a change in cervical dilation within the 14 days preceding labour than the number that show a change in the 14 to 21 days preceding labour (9.4%) (p = <0.001).

THE CERVICAL SCORE AND CHANGES IN CERVICAL SCORE PRECEDING THE ONSET OF LABOUR

The cervical score (see Chapter II) assessed within 7 days of the onset of labour is shown in Table VI (full tabulated data in appendix II).

TABLE VI

THE CERVICAL SCORE (LENGTH LESS DILATION) PRECEDING THE
ONSET OF LABOUR (WITHIN 7 DAYS)

CERVICAL SCORE	PRE-TERM LABOUR	TERM LABOUR	ALL LABOURS
1 or more	23	38	61
0 or less	19	48	67

There is no significant difference in the score distribution
between the two groups.   Sixty seven of the 128 patients
(52.34%) had a score of 0 or less at the last visit preceding
labour.

In order to determine whether the finding of a cervical score
of 0 or less had any predictive value the scores found at all
visits other than the final visit were analysed.   Table VII
(full tabulated data in appendix II).

TABLE VII

THE CERVICAL SCORE FOUND AT ALL ASSESSMENTS OTHER THAN
THE FINAL ASSESSMENT (TOTAL 519)

CERVICAL SCORE	PRE-TERM LABOUR	TERM LABOUR	ALL LABOURS
1 or more	148	315	463
0 or less	8	48	56

There is no significant difference between the pre-term
labour group and the term labour group.

On only 56 out of 514 occasions (10.8%) was the cervical
score found to be 0 or less and spontaneous labour did not
occur in the subsequent week.   The difference between the
incidence of a finding of a cervical score of 0 or less and
labour within 7 days compared to the same finding in patients
that did not labour within 7 days is highly significant
($p = <0.001$).

Fig. 11

THE INCIDENCE OF A CERVICAL SCORE OF O OR LESS WITHIN
7   DAYS OF LABOUR AND MORE THAN 7 DAYS FROM LABOUR

FREQUENCY %

MORE THAN 7 DAYS   WITHIN 7 DAYS
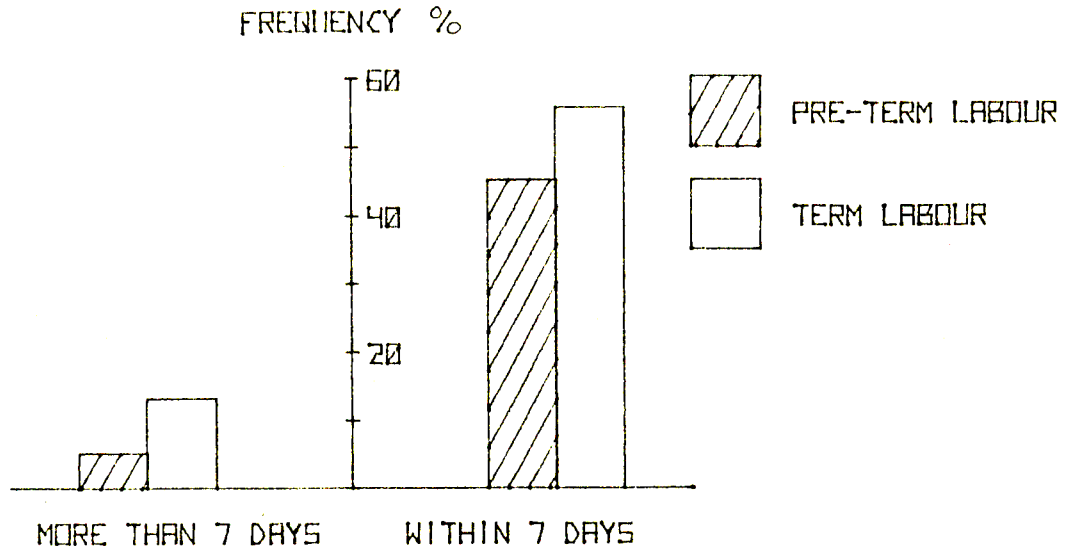
The change in cervical score between weekly assessments
7 - 14 days before the onset of labour and 14 - 21 days
before the onset of labour is shown in Figure 12 (tabulated
data in appendix II).   The difference in incidence of a
cervical score change is highly significant (p = <0.001).

Fig. 12

CHANGE IN CERVICAL SCORE PRECEDING LABOUR EXPRESSED AS
PERCENTAGE SHOWING CHANGE

FREQUENCY %

WEEK 2 TO WEEK 1   WEEK 1 TO WEEK 0
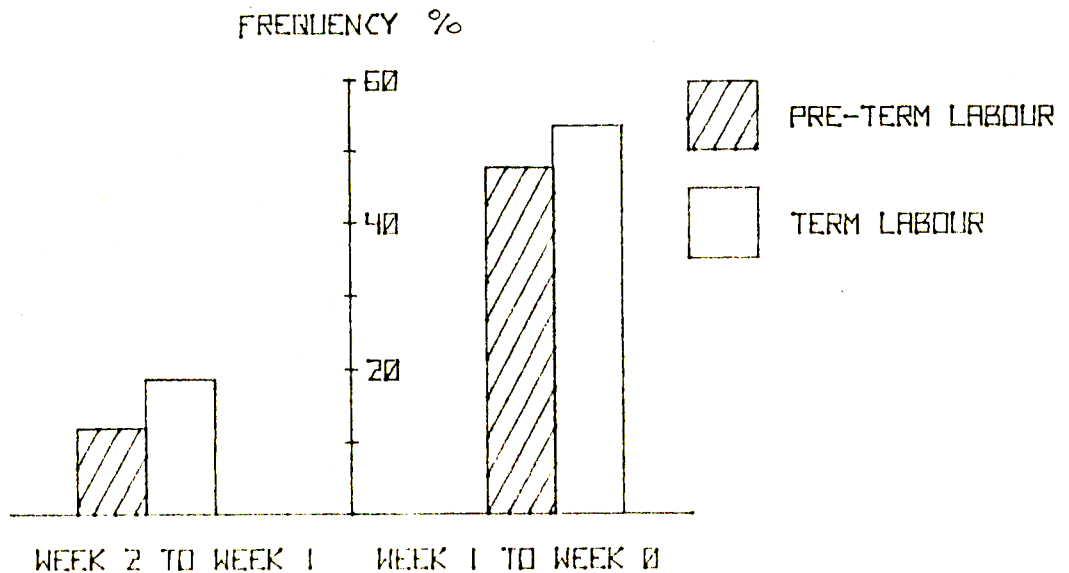
/There is no ....

There is no significant difference in the frequency of change of cervical score preceding labour between the pre-term labour group and the term labour group.

The cervical score and its changes were analysed in primiparous patients (appendix II).

Four out of the 14 (28.6%) had a score of 0 or less within 7 days of the onset of labour compared to 52% of all the patients.

A change of cervical score of 1 or more was seen in 5 out of the 14 patients 7 to 14 days before the onset of labour (35.7%) compared to 52% of all patients.

THE TIME RELATIONSHIP BETWEEN A NOTED CHANGE IN CERVICAL SCORE PRECEDING LABOUR AND THE ACTUAL ONSET OF LABOUR

In an attempt to determine whether the rapidity of change in the state of the cervix was the reason for the failure to predict all impending labours the time interval from noted change to onset of labour was analysed Table IX (full tabulated data in appendix II).

TABLE IX

THE TIME INTERVAL FROM NOTED CERVICAL SCORE CHANGE AND ACTUAL ONSET OF LABOUR

TIME INTERVALS (DAYS)	NUMBER OF PATIENTS
0 to 3	30 (45.5%)
4 to 7	36 (54.5%)

This showed approximately as many labours occurring within 3

days of noted change as 4 to 7 days from noted changes.

THE PREDICTION OF IMPENDING LABOUR ON BASIS OF CERVICAL SCORE

The prediction of impending labour using the cervical score

in individual patients is shown in Table X, XI and XII.

TABLE X

THE PREDICTIVE VALUE OF THE FINDING OF A CERVICAL SCORE
OF O OR A CHANGE IN CERVICAL SCORE IN THE INDIVIDUAL PATIENT

Labour within 7 days	- 36
Labour in 7-14 days	- 41
False positive predictions	- 26
Not predicted	- 25

In 26 patients (20.3%) the prediction of labour in the

subsequent 14 days would have been falsely positive.

Using these criteria labour would not have been predicted

in 25 patients (19.5%).

TABLE XI

THE PREDICTIVE VALUE OF THE FINDING OF A CERVICAL SCORE OF

O OR A CHANGE IN CERVICAL SCORE OF 2 POINTS OR MORE

Labour within 7 days	- 33
Labour in 7-14 days	- 20
False positive predictions	- 15
Not predicted	- 60

In 15 patients (11.7%) the prediction of labour within 14

days would have been falsely positive and in 60 patients

(46.9%) labour would not have been predicted using these

criteria.

TABLE XII

THE PREDICTIVE VALUE OF THE FINDING OF A CERVICAL SCORE OF
O OR A CHANGE IN CERVICAL SCORE IN THE PRE-TERM LABOUR GROUP

Labour within 7 days   - 14
Labour   in 7-14 days   - 15
False positive predictions   -   1
Not predicted   - 12

In 12 (28.6%) patients in the pre-term labour group labour
within 14 days would not have been predicted using these
criteria.   Of these 12 patients 5 were primipara.   When
multipara only are considered in only 7 out of 34 patients
(20.5%) would pre-term labour not have been predicted and
the false positive prediction rate would have been 1 out of
34 patients (2.9%).

UTERINE SENSITIVITY TO OXYTOCIN

The methodology for this test is fully described in Chapter II.

Fifty patients under 36 weeks by gestation with confirmation
by ultrasonic biparietal diameter measurement underwent
uterine sensitivity testing.   The test was repeated on a
second occasion two weeks later on 5 of the patients.

None of the patients went into labour in the 48 hours
following this test.

A positive response was recorded when an uncomfortable
uterine contraction was palpably sustained for 30 seconds
or more.   This on all occasions was shown on the tocograph
by an increase in amplitude of pre-existing uterine activity
or deflection from the baseline in a quiescent uterus.

The results are shown in Figure 13 (tabulated data in appendix
II) where the frequency of occurrence of spontaneous labour
within 14 days of testing is compared between a positive
response to a bolus of 18 milliunits or less and 24
milliunits or more.

Fig. 13

POSITIVE UTERINE RESPONSE TO BOLUS OF OXYTOCIN AND LABOUR WITHIN 14 DAYS

FREQUENCY %

POSITIVE AT ⟩24   POSITIVE AT ⟨18

LABOUR WITHIN 14 DAYS

NOT LABOURING WITHIN 14 DAYS
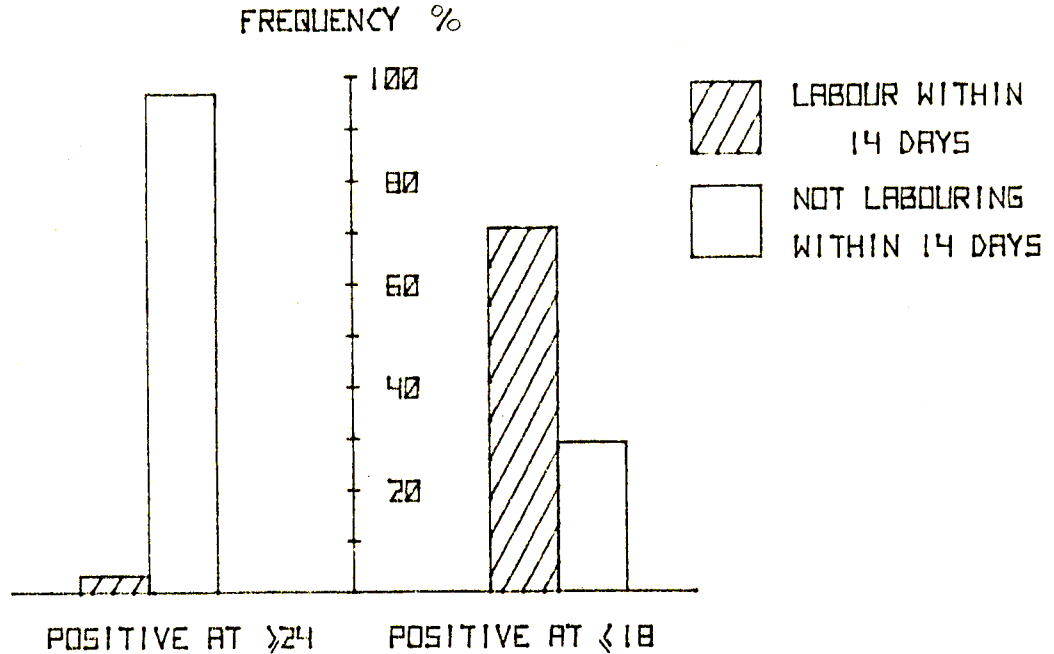
There were 7 false positive results (29%) and only 1 false negative result (3.2%) (p = <0.001).

THE RELATIONSHIP BETWEEN THE CERVICAL SCORE AND UTERINE SENSITIVITY

The distribution of the cervical score at the time of testing is shown in Table IX.

TABLE XIII

THE CERVICAL SCORE AT UTERINE SENSITIVITY TESTING

CERVICAL SCORE	POSITIVE AT 18 MU OR LESS	POSITIVE AT 24 MU OR MORE
3	–	3
2	3	10
1	7	13
0	7	4
Minus 1	1	1

The expected tendency of lower cervical scores in the group with a positive response at 18 mu or less is observed.

The 1 false negative result was in a patient with a cervical score of 0 and of the false positive results only 1 had a

/score of 0 ....

score of 0 the remainder had higher scores.

DISCUSSION

The prediction of the timing of onset of labour in twin pregnancies be it pre-term or term, would have a number of major advantages particularly in the circumstances at King Edward VIII Hospital where because of transport problems the patients have great difficulty in getting to the hospital when in labour.

Hospitalization from diagnosis would overcome the transport and communications problems. The impracticality of such a policy is shown by already over crowded ante-natal wards where patients regularly have to sleep on "floor beds" because of the full bed occupancy.   In addition there is the financial problem of the cost of admitted patients for prolonged periods of time.

The prediction of impending term labour may therefore reduce the risk of unattended and unmonitored twin labour and delivery with all the associated hazards.   The prediction of impending pre-term labour has the additional advantages of allowing assessment of fetal maturity, the potential ability to accelerate fetal lung maturity, the potential ability to inhibit labour and immediate neonatal care for babies that are possibly both premature and growth retarded.

Biological system immaturity, particularly the lungs, is associated with pre-term delivery and is a major contributary cause to the high perinatal mortality in twins particularly when delivery occurs at less than 35 weeks gestation[1,2,3].

Both Robertson[1] and Dunn[2] found that approximately 50% of twins born 5 or more weeks before term do not survive.

Little has been achieved in reducing the pre-term delivery rate.   There is still dispute about the advantage of bed rest in this respect, in 1939 Hirst[4] claimed that bed rest, preferably in hospital, from the 36th week onwards prolonged the average length of twin pregnancy to 38 weeks and Law[5] thought that there was a slight prolongation of pregnancy. Neither Dunn[6] or Jonas[7] could find evidence of prolongation of pregnancy - a view supported by a more recent large study by Jeffrey et al[8].

None of the studies on the effect of bed rest have been large enough to establish accurate matched control groups in terms of sex and zygosity of the babies, maternal height and weight and socio-economic status.

The true effect of bed rest on delaying the timing of onset of labour is not clear though the present evidence suggests there is no such effect.

The advent of the purer beta-sympathomimetics with their known tocolytic activity has led to 2 reported trials with orally administered drugs[9] [10] and at least in the second of these two trials by Tamby-Raja et al[10] there was a significant prolongation of gestation in twins using salbutamol in a dosage sufficient to raise the pulse rate above 100 beats per minute.

From the above evidence it would seem that prediction of impending pre-term labour could therefore lead to delaying the onset of labour.

When labour is destined to occur at under 37 weeks gestation hospitalization has the following advantages:-

1. Amniocentesis can be performed to assess lung surfactant levels and consequently assess the maturity status of the fetal lungs.   Spellacy et al[11] have suggested that the procedure is necessary only on one sac if the weight difference of the twins is less than 0.6 kg. (the assessment of weight difference is considered in a later chapter).
   If immaturity of the lungs is demonstrated attempts can be made to induce lung maturity with parentenal or oral glucocorticoids[12].

2. The patient will be placed in an environment where full labour monitoring and analgesia can be commenced early in labour and there are facilities for immediate neonatal resuscitation and care.

The above advantage also applies to the prediction of impending labour at term.

THE RESULTS

It is possible that the pre-term labour incidence of 32.5% in this series is falsely low as one of the criteria for

inclusion in the study was 3 assessments at weekly intervals and the mean gestational age at delivery of the 64 patients excluded from the series was 36.1 weeks (author's Dubowitz assessment) as compared to 36.85 weeks for those included in the series. If this is the case, as seems likely, the true incidence of pre-term labour in this population is greater than 32.5% increasing the dimension of the problem.

EPIDEMIOLOGY

In order to define which patients were at greater risk, maternal age, parity, height and weight differences were analysed between the pre-term labour group and the term labour group.

AGE AND PARITY

There was a difference in the incidence of pre-term labour in mothers of under 20 years of age (60%) as compared to mothers 20 years old or more (30.25%) Figure 1.

This difference is also seen with parity as the incidence of pre-term labour in primiparous patients was 57% as compared to 31.8% for all other parities. Figure 2 shows a trend for the incidence of pre-term labour to decrease with increasing parity with the rate lowest (23.3%) in women of a parity greater than 4.

/The high ....

The high incidence of pre-term labour in the group under
20 years of age and the primiparous patients is not totally
interdependent as only 4 out of the 6 patients under 20
were primiparous and only 4 out of the 8 primiparous patients
were less than 20 years old. This suggests that primiparity
has a more marked effect of increasing the incidence of
pre-term labour than a maternal age of less than 20 years.
This is a partial explanation for the findings of Butler
and Alberman[13] that primiparous patients stood a higher
chance of losing one or both their babies (they did not
quantify the risk) and that mothers under the age of 20
had a 1 in 5 chance of losing both their babies.

MATERNAL HEIGHT AND WEIGHT

There was a difference in the incidence of pre-term labour
in women more than 161 cm tall (18.75%) as compared to
women of 161 cm or less (34.5%) Figure 3. The difference
was not significant with the numbers involved but indicates
a possible trend. The effect of obesity on the incidence
of pre-term labour was difficult to establish as an accurate
pre-pregnancy weight was not obtainable. When the final
measured weight was corrected simply for height by calculation
of the height weight ratio it was apparent that the women
that were assessed as obese (height/weight ratio of 2,00 or
less) in the third trimester were less likely to go into
pre-term labour (20.5%) than the less obese mothers (37.7%).
Figure 4 shows an apparent trend of an increasing incidence
of pre-term labour with decreasing obesity.

'It is not clear ...

It is not clear (vide supra) whether this effect due to pre-pregnancy obesity which might reflect nutritional status or weight gain in the first and second trimester.

CLINICAL MEASUREMENTS IN PREGNANCY

GIRTH

When assessing girth as a simple measurement in centimetres the expected tendency for the girth to be lower in the pre-term labour group prior to the onset of labour is shown in Fig. 5. This may reflect the effect of obesity. The majority of all labours occurred when a girth of 96 to 115 cms was achieved (51.6%)

Appreciating that simple girth measurement does not reflect uterine circumference only, but is a summation of that circumference and maternal soft tissue particularly subcutaneous fat the girth was corrected for obesity by calculating the product of the height / weight ratio and girth. It emerged that only 10.9% of patients HAD a product value of 200 or less at the last assessment PRIOR to spontaneous labour. There was no difference in this finding between the pre-term labour groups and the term labour groups (fig. 6).

This finding of a similar product value between the pre-term labour group and the group labouring at term suggests that the uterine circumference is critical to the timing of onset of spontaneous labour in twins.

The product of height to weight ratio and girth has no
value in the prediction of timing of onset of labour in
twin pregnancy.

INCREMENTAL CHANGES IN WEIGHT AND GIRTH

No difference in pattern of incremental change in weight
or girth could be found between the pre-term labour group
and the term labour group and consequently no prognostic
value in terms of prediction of pre-term labour could be
assigned to either measurements.

THE PRESENTATION OF THE LEADING FETUS

No difference could be found between the pre-term labour
group and the term labour group in terms of presentation
of the leading fetus.

This might suggest that degree of application of the
presenting part on the lower uterine segment had no effect
in precipitating labour.

PLASMA OESTRIOL AND PLACENTAL LACTOGEN

The values of plasma oestriol were significantly higher in
the pre-term labour group than the group labouring at
term (Fig. 7) whereas the values of placental lactogen were
the same in the two groups (Fig.8).   Plasma oestriol is a
measure of both placental production of 17 hydroxy-
pregnenolone and fetal conversion of this steroid in adrenal

/gland and liver ....

gland and liver to 16 alpha hydroxy dehydroepiandrosterone sulphate. Therefore high plasma oestriol reflects indirectly the metabolic activity of the fetal adrenal and liver. Tamby-Raja et al[14] have suggested that fetal glucocorticoids may precipitate labour and if this is so it may be that the higher plasma oestriol in the pre-term labour group reflects excess glucocorticoid production from one or both the fetal adrenal systems.

NEONATAL OUTCOME AND THE PRE-TERM LABOUR

No evidence could be found that intra-uterine growth retardation of one or both fetuses precipitated pre-term labour (Table II). The pregnancy incidence of growth retardation in the pre-term labour group (19.0%) was lower than the incidence in the term labour group (33.7%). This corresponds with the growth of the twins judged by weight for gestation at delivery (Chapter II) where deviation from singleton growth rate occurred between 34 and 38 weeks of gestation.

The sex of the infant pair had no apparent effect on the incidence of pre-term labour (Table III).

THE CERVIX AND CHANGES IN THE CERVIX PRECEDING LABOUR

In all analyses there was no significant difference between the behaviour of the cervix preceding pre-term labour and preceding labour at term, therefore these analyses are considered in terms of the prediction of timing of onset of labour.

THE CERVICAL LENGTH

A single assessment of cervical length had no predictive value (Table IV) change in cervical length in relation to the onset of labour show that the length of the cervical canal measurably decreased in 30% of patients within 7 days of labour but only decreased in 6.2% of patients not destined to go into labour within 7 days (Fig. 9).   If a change in cervical length was used as an indication of impending labour only 30% of labours would have been predicted and in 8 out of 47 occasions (17.0%) the prediction would have been falsely positive.

THE CERVICAL DILATION

No predictive value could be found from a single assessment of the dilation of the internal cervical os (Table V) as in 30% of patients the cervical os was not dilated within 7 days of labour.

Changes in dilation of the internal cervical os show that the dilation measurably increased in 47% of patients within 7 days of the onset of labour whereas a change could be measured in 9% of patients and labour did not occur within 7 days.

If a change was noted and regarded as predictive of impending labour 47% would have been correctly predicted with a false positive prediction rate of 15.3%.

THE CERVICAL SCORE

As can be seen above changes occur in both cervical length and cervical dilation within 7 days of labour in a proportion

of patients.   The cervical score (Chapter II) will show the combined effect of these changes.

When considering single assessments of cervical score a score of 0 or less within 7 days of the onset of labour was noted in 52% of patients but on only 10.8% of all other assessments.   Changes in the cervical score preceding the onset of labour were then analysed.   It was shown as would be expected from the finding above that a change in score occurred in 52% of patients within 7 days of the onset of labour and that a change was noted in only 16% of patients who did not labour in the subsequent week (Fig. 12).

It was felt that the cervix in primiparous women might behave differently preceding labour than the cervix in multipara.   It was found that only 28% had a cervical score of 0 or less within 7 days of labour compared to 52% of all patients and that only 36% showed a change in cervical score preceding labour compared to 52% of all patients.

THE RELATIONSHIP BETWEEN A NOTED CHANGE IN CERVICAL SCORE AND THE ACTUAL TIMING OF LABOUR

It was thought possible that the rapidity of occurrence of a change in cervical score might be the reason for the failure to detect the change preceding labour in all patients on the basis of weekly visits.

Table IX shows that there is not a preponderance of patients going into labour in the first few days following a noted change in cervical score.

/This implies that .....

This implies that the rate of change of cervical state is very variable and that in 48% of patients the change is too rapid to be detected at weekly visits.

THE PREDICTIVE VALUE OF SINGLE AND SERIAL ASSESSMENT OF THE CERVICAL SCORE

Using the criteria of a single finding of a cervical score of 0 or less or a change in cervical score of 1 point or more over a week 19.5% of patients due to labour in the subsequent 14 days would not have been predicted and 20.3% of patients would have a false positive prediction.

It might be argued that these figures would have been achieved by random guessing as one of the criteria for inclusion in the study was a gestation of under 37 weeks while the mean gestation of onset of labour was 36.85 weeks (Chapter II).

When a similar analysis was carried out on the group going into pre-term labour similar figures were achieved and when primipara were excluded from the analysis in 20.5% of patients pre-term labour would not have been predicted and the false positive prediction rate would have been 3.0%.

UTERINE SENSITIVITY TO OXYTOCIN AND IMPENDING PRE-TERM LABOUR

This investigation though invasive proved most rewarding in terms of prediction of labour in the subsequent 2 weeks (Fig. 13). Although the false positive rate was high (29%) the false negative rate was low (4.5%).

It is possible that by chance the uterine sensitivity testing was carried out on patients where labour could have

been predicted by the cervical score but analysis of the
cervical score at the time of testing showed that a predictive
positive response was present with a cervical score of 1
or more on 10 out of 17 occasions.

It would appear from these results that increased myometrial
sensitivity to oxytocin, probably induced by the fetal
pituitary adrenal axis, occurs prior to changes in cervical
state.

THE POSSIBLE CAUSATION OF THE PRE-TERM LABOUR IN TWINS

Factors which might contribute to pre-term delivery in
twin pregnancy are over distension of the uterus and
the increased production of hormones by the feto-placental
unit.

The argument against distension of the uterus or "stretch"
being involved in the initiation of labour is that one
would then expect a twin pregnancy to deliver when the
combined weight of the twins is the same as that of a
singleton.

It is possible though that it may be a factor in twins
that is not usually acting in singletons. Malpas[15] ,
Comerford[16], Milic and Adamson's[17]have all noted that in
anencephaly where adrenal hypoplasia is present pregnancy
tends to be prolonged unless there is distension of the
uterus by hydramnios.

There is evidence that the fetal adrenal gland plays a major part whether directly or indirectly on the onset of parturition. Anderson et al[18] found that fetal adrenocortical hyperplasia with increased adrenal weight was present in babies delivered as a result of "unexplained" pre-term labour and this is supported by Lauritzen and Lehmann's[19] finding of a high urinary excretion of the fetal adrenal steroid dehydroepiandrosterone sulphate in these pre-term neonates. Further evidence that the fetus adrenal is involved in the onset of parturition was supplied by Murphy[20] and Cawson[21] with the finding of markedly higher cord blood concentrations of cortisol in babies born after spontaneous labour compared to babies born after induced labour.

Increased fetal adrenal activity might be expected to be reflected in plasma oestriol as fetal dehydroepiandrosterone is converted by the placenta to oestradiol, oestrone and oestriol. Of these the first two are the most relevant in terms of biological activity and Turnbull et al[22] sampling from 33 carefully selected multiparous women showed that oestradiol concentrations rose rapidly between 36 weeks gestation and term associated with a significant fall in progesterone.

Both the factors of distension and fetal adrenal activity may be operating in twin pregnancy. This supportive evidence from the data in this series is two-fold.

In terms of distension there seems to be a critical girth before which labour is highly unlikely, be it pre-term labour or term labour.

In addition the plasma oestriol level of the patients going into pre-term labour was higher for gestation than the patients labouring at term.

An hypothesis on the causation of labour in twins is therefore that distension of the uterus increases the inherent likelihood of labour which would then be precipitated by increased fetal adrenal steroid production either by virtue of excess adrenal metabolic activity and / or excess adrenal weight.

Much research work continues on the initiation of parturition in the human and it would be naive to state that this in any way either modifies or advances present knowledge but the simple hypothesis put forward will aid in the prediction of pre-term labour in twins.

CONCLUSIONS

Some epidemiological factors which apparently increase the risk of pre-term labour are:

1. Primiparity

2. Shortness

3. Low body weight corrected for height.

The finding of higher than normal plasma oestriol values
is associated with pre-term labour.

There is evidence that the intrauterine volume plays an
important role in the timing of onset of labour.

Weekly assessment of cervical state in terms of cervical
score is indicated.

The finding of a cervical score of 0 or less is associated
with labour in the subsequent 7 days in 52% of patients
destined to labour in this time and the false positive
predictive rate is 11%.

A change in cervical score in 7 days occurs in 52% of the
patients destined to labour in this time and the false
positive prediction rate is 24%.

When a cervical score of 0 is found or there is any change
in cervical score between weekly assessments 60% of
patients will labour in the next 14 days and both the false
positive and false negative predictive rates are 20%.

A positive uterine response (see text) to a bolus infusion
over a minute of 18 mu of oxytocin or less is predictive
of labour in the subsequent 14 days in 95% of patients.

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CHAPTER IV

THE CLINICAL ASSESSMENT OF FETAL GROWTH

THE DEFINITION OF FETAL GROWTH RETARDATION

THE INCIDENCE OF FETAL GROWTH RETARDATION

    In the Series and Weight for Gestation at Delivery

EPIDEMIOLOGICAL ASPECTS

    Maternal Age

    Parity

    Height

    Obstetric History

    The Gestation of Onset of Labour

    The Sex of the Babies

CLINICAL FACTORS IN ASSESSING FETAL GROWTH

    Weight and Weight Change

    Girth and Girth Change

    The Behaviour of the Cervix

    Hypertension

DISCUSSION

CONCLUSION

A growth retarded infant is defined as an infant with a birthweight of less than the 10th centile for gestation. In a twin pregnancy one or both fetuses can be growth retarded.

A second form of growth retardation in twin pregnancy is where the combined weight of the neonates is low, this is arbitrarily defined for the purpose of this study as when the mean combined weight for gestation.   This is referred to as a pregnancy growth retardation.

The problems associated with fetal growth retardation are discussed in Chapter I.

In this chapter the incidence of growth retardation of either type is related to the epidemiological factors of maternal age, parity and height, the past obstetric history and the neonatal outcome in terms of the gestation of delivery and the sex of the neonates.   It was not possible to assess the effect of social status or smoking as is mentioned in the text.

The clinical findings in pregnancy of weight and weight change, girth and girth change, the behaviour of the cervix and hypertension are compared to the incidence of both types of growth retardation.

All tables and figures exclude the two pregnancies with a fetus papyraceous.

INCIDENCE

The incidence of fetal growth retardation in this series
is shown in Table I.   The birthweight figures used to
identify the growth retarded infants are those derived from
the singletons of the local population group (Chapter II).

TABLE I

THE INCIDENCE OF FETAL GROWTH RETARDATION

Pregnancy incidence	37 out of 130	- 28.5%
Fetal incidence	45 out of 260	- 17.3%
Single fetus affected	29 out of 130	- 22.3%
Both fetuses affected	8 out of 130	- 6.2%

There were four antepartum fetal deaths where growth
retardation was the only recognisable precipitating
factor and these are detailed in Table II.

TABLE II

THE ANTEPARTUM DEATHS ATTRIBUTABLE TO FETAL GROWTH RETARDATION

SEX	BIRTHWEIGHT (KG)	GESTATION (WEEKS)	SURVIVING CO-TWIN
Male	1.8	37	Female 2.95 kg.
Male	2.2	37	Female 3.5 kg.
Male	2.1	38	Male 2.2 kg.
Female	2.1	38	Female 2.5 kg.

The pregnancy incidence of antepartum death attributable to
growth retardation was 4 out of 130 - 3.1%.

The fetal incidence of antepartum death attributable to
growth retardation was 4 out of 260 - 1.55%.

The second type of growth retardation in twins as defined for the purposes of this study is a pregnancy where the combined weight of the twins was lower than the mean for gestation in the series.

The mean combined weight is shown in Figure 1 as a smoothed curve for the mean(correlation coefficient = 0,96) tabulated data in Appendix III .

Fig. 1

THE MEAN COMBINED WEIGHT FOR GESTATION OF THE TWINS IN THE SERIES
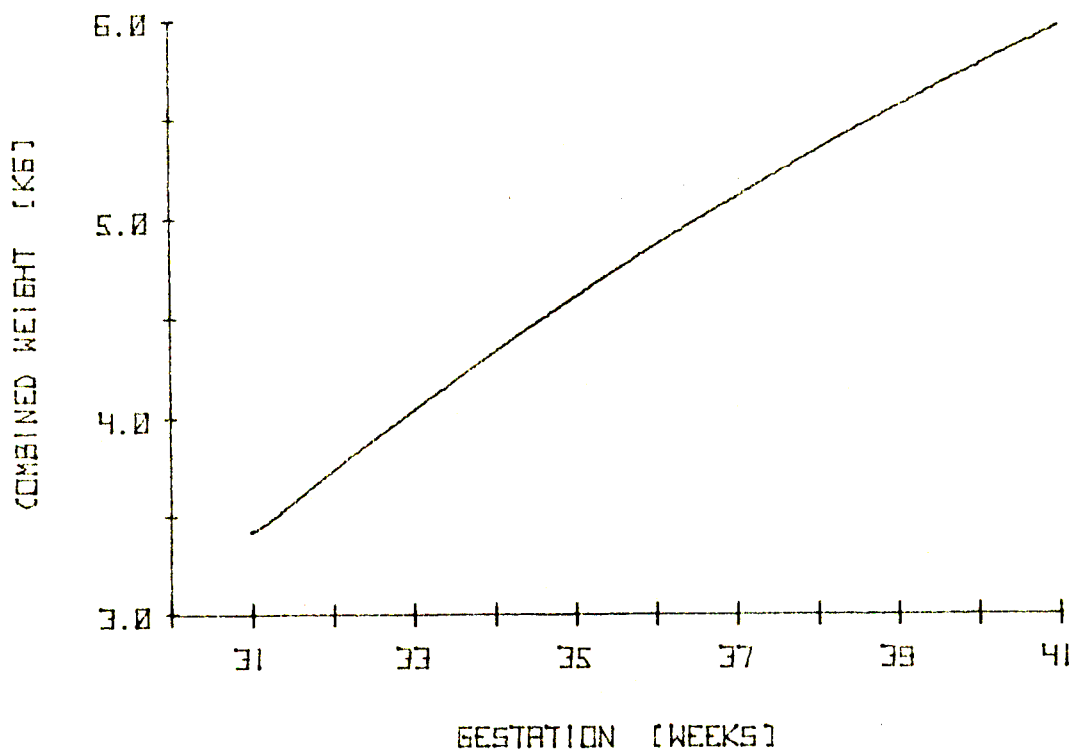
Thirty-six of the 37 pregnancies with single or dual growth retardation (97.3%) had a combined fetal weight equal to

/or less than the

or less than the mean whereas 27 out of the 93 pregnancies where there was no growth retardation (29%) had a combined fetal weight equal to or less than the mean (Table III).

TABLE III

THE RELATIONSHIP BETWEEN SINGLE OR DUAL FETAL GROWTH RETARDATION AND THE COMBINED WEIGHT OF THE PAIR

	COMBINED WEIGHT	
	<MEAN	>MEAN
Single or dual growth retardation	36	1
Neither fetus growth retarded	27	66

These figures indicate that if a pregnancy with a low combined weight for gestation can be identified the risk of single or dual growth retardation is 57%.

EPIDEMIOLOGY

MATERNAL AGE AND FETAL GROWTH RETARDATION

The mothers were divided into 5 year age groups and the incidence of growth retardation was compared in each group. The relationship between growth retardation and age is shown in Figures 2 and 3 (tabulated data in appendix III). For clarity the age groups are condensed to less than 20 years, 20 to 30 years and more than 30 years.

/Fig. 2 ....

Fig. 2

MATERNAL AGE AND THE INCIDENCE OF SINGLE OR DUAL FETAL
GROWTH RETARDATION
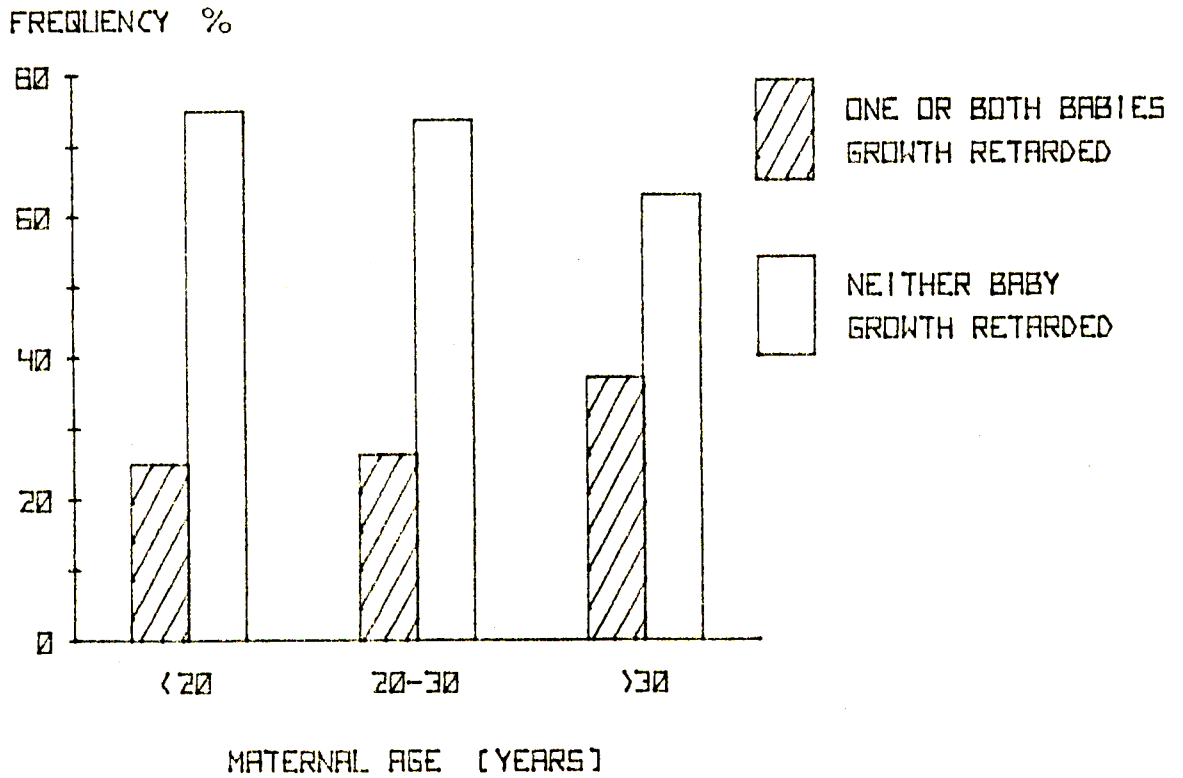
Fig. 3

MATERNAL AGE AND THE INCIDENCE OF GROWTH RETARDATION OF THE
COMBINED PREGNANCY (PREGNANCY GROWTH RETARDATION)
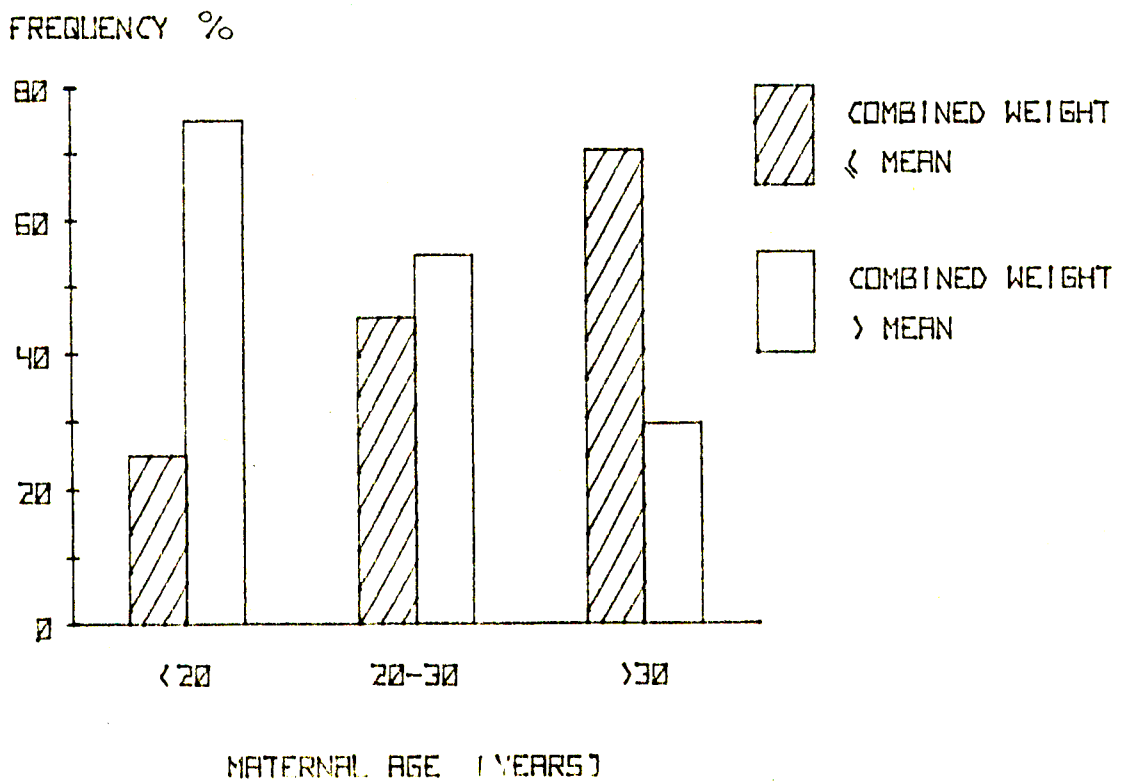
The incidence of fetal growth retardation appear to rise in women of more than 30 years of age (25.7% to 37%), but the differing incidence did not achieve statistical significance.   The frequency of twins delivered with a combined weight below the mean increases significantly with increasing maternal age from 22% at less than 20 years to 69% at more than 30 years (p = <0.05).

PARITY AND FETAL GROWTH RETARDATION

The relationship between parity and growth retardation is shown in Figures 4 and 5 (tabulated data in Appendix III).

Fig. 4

PARITY AND THE INCIDENCE OF SINGLE OR DUAL FETAL GROWTH
RETARDATION
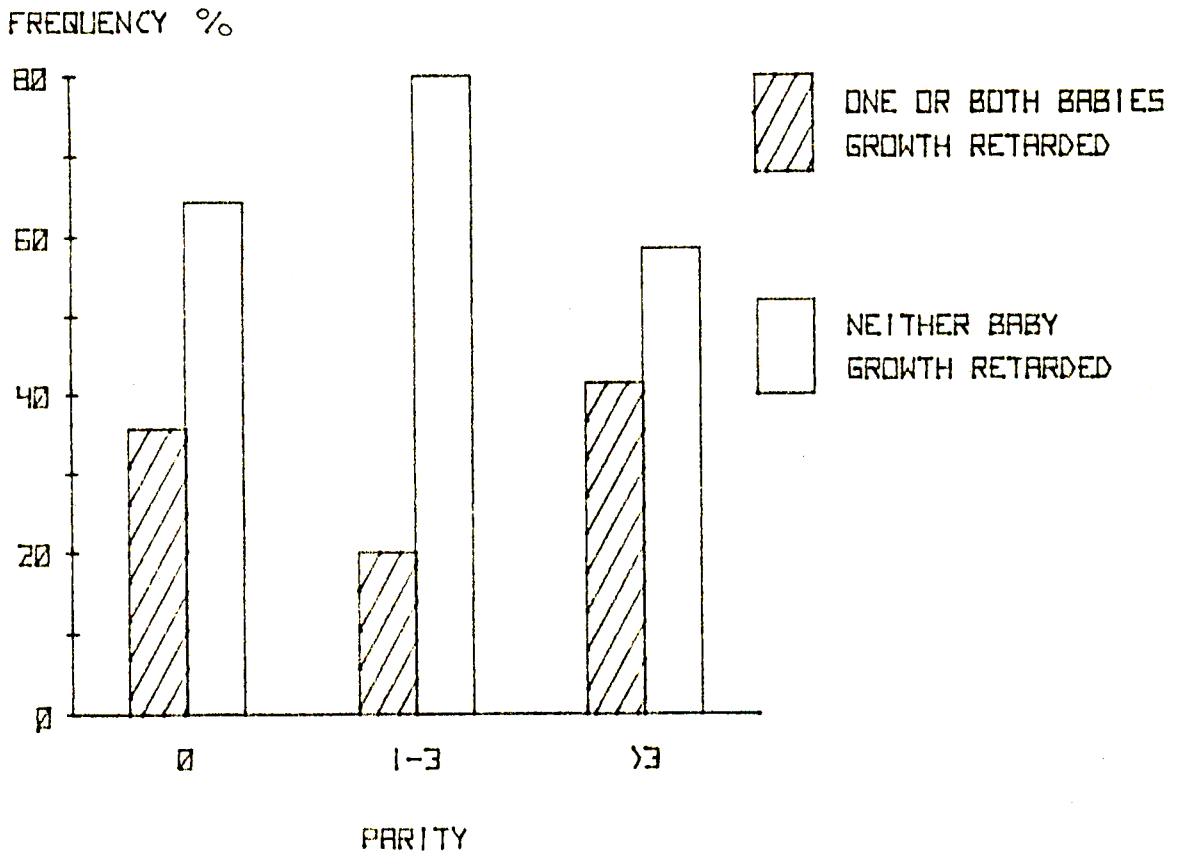
Fig. 5

PARITY AND THE INCIDENCE OF PREGNANCY GROWTH RETARDATION
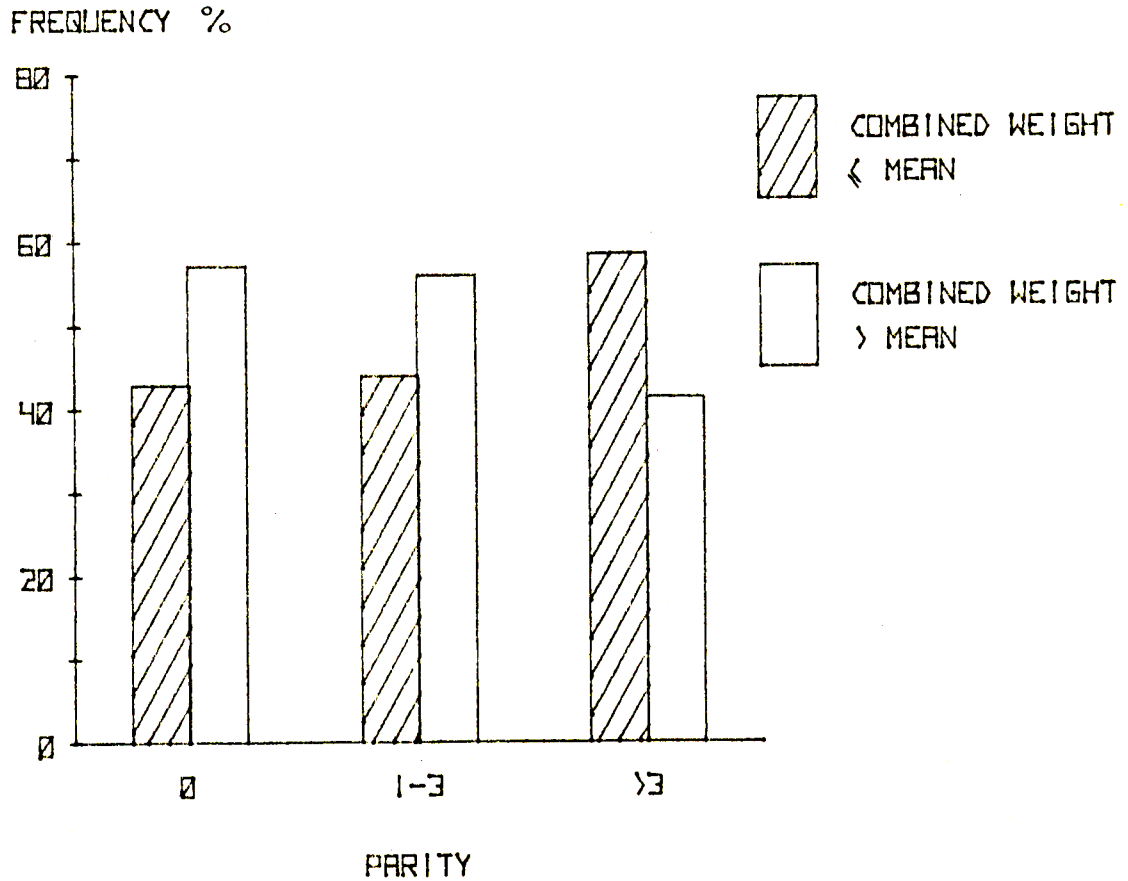
The incidence of single or dual fetal growth retardation is significantly less in women of parity 1 - 3 (20%) when compared to that of primipara (35.7%) and women of a parity more than 3 (41.5%). (p = <0.05). The incidence of twins with a combined weight of equal to or less than the mean appears to be increased in women of a parity of more than 3 (43.8% to 58.5%) though the difference is not statistically significant.

/MATERNAL WEIGHT

MATERNAL HEIGHT AND FETAL GROWTH RETARDATION

The mothers were grouped according to height and the incidence of growth retardation was assessed in each group (Figures 6 and 7, tabulated data in appendix III).

Fig. 6

MATERNAL HEIGHT AND THE INCIDENCE OF SINGLE OR DUAL GROWTH RETARDATION
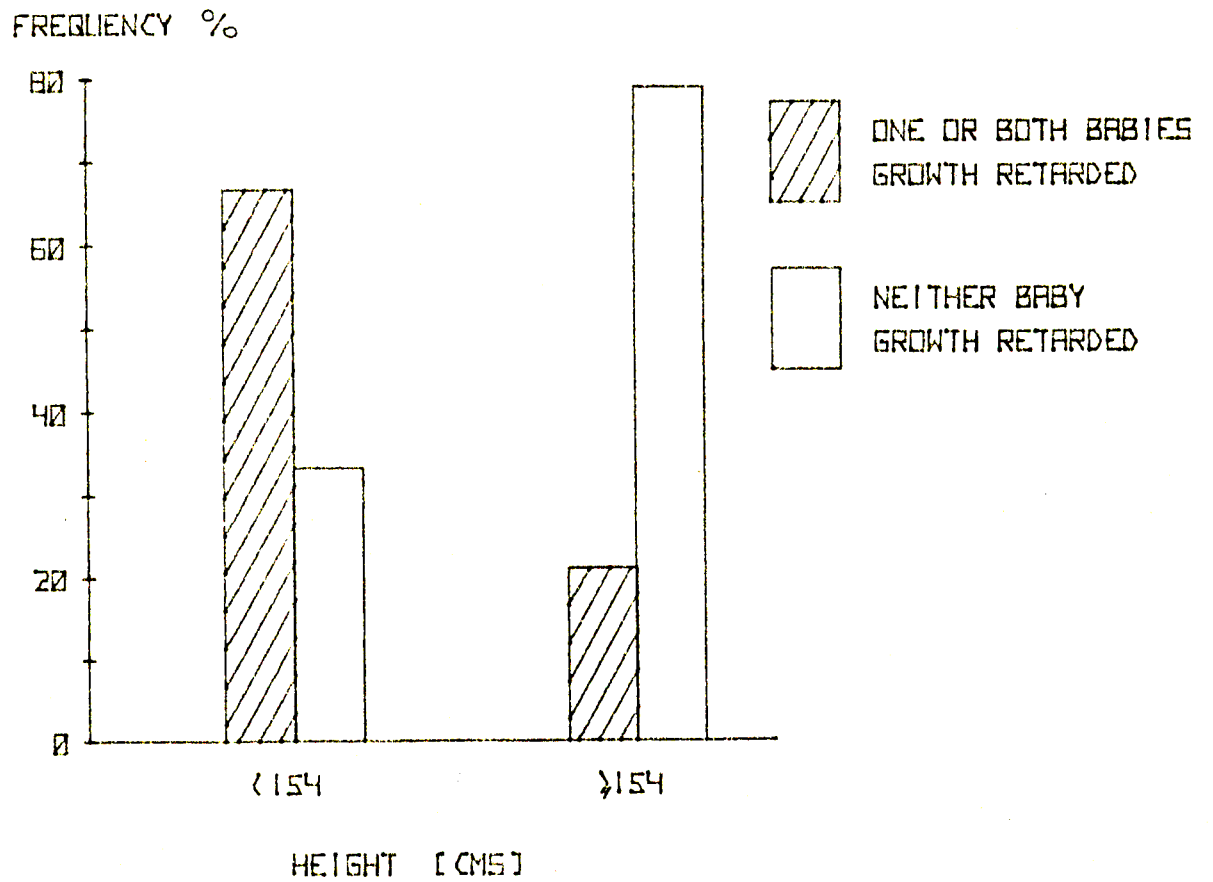
Fig. 7

MATERNAL HEIGHT AND THE INCIDENCE OF PREGNANCY GROWTH RETARDATION

FREQUENCY %
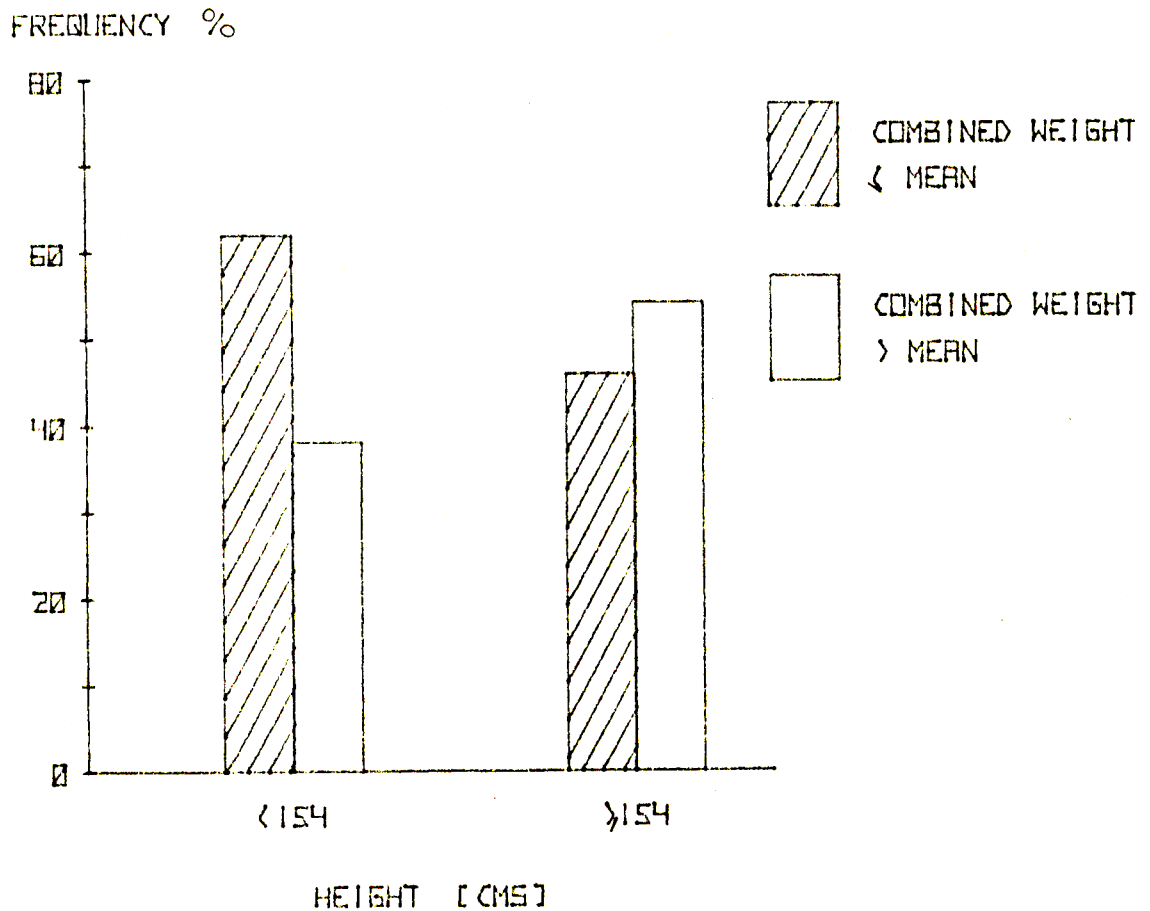
There is a significant tendency for the women below mean height (154 centimetres) to have single or dual fetal growth retardation (66%) as compared to the taller women (22%) (p = <0.001).   The shorter women more often produced twins whose combined weight is equal or less than the mean (62%) as compared to the taller women (46%).   Though this difference was not statistically significant.

PREVIOUS PREGNANCY LOSS AND FETAL GROWTH RETARDATION

To determine the effect of previous pregnancy loss on individual or combined fetal growth the obstetric history was related to fetal growth retardation (Table IV and V). Previous pregnancy loss was divided into abortions prior to 14 weeks gestation, fresh or macerated stillbirths and neonatal deaths.   The abortions could not be further subdivided into spontaneous or induced.

TABLE IV

PREVIOUS PREGNANCY LOSS AND THE INCIDENCE OF FETAL GROWTH
RETARDATION

	GROWTH RETARDATION	NO GROWTH RETARDATION
Abortion	6	6
Stillbirth	5	2
Neonatal death	2	1

TABLE V

PREVIOUS PREGNANCY LOSS AND THE INCIDENCE OF PREGNANCY
GROWTH RETARDATION

	COMBINED WEIGHT	
	$\leq$ MEAN	> MEAN
Abortion	6	6
Stillbirth	6	1
Neonatal death	2	1

With a history of a stillbirth or neonatal death the risk of one or both fetuses being growth retarded is significantly increased (70%) compared to an overall risk of 28.5% (p= <0.01) and the risk of delivering twins with a low combined weight appears to be increased (80% compared to an overall risk of 48.5%).   Although this difference did not achieve statistical significance.

THE GESTATION OF ONSET OF LABOUR AND SINGLE OR DUAL GROWTH RETARDATION

The gestation of onset of labour was later (mean 37.8 weeks) in the group of women with single or dual fetal growth retardation when compared to the series as a whole (mean 36.85 weeks).

THE SEX OF THE BABIES AND FETAL GROWTH RETARDATION

The sex of the pair in relation to growth retardation is shown in Table VI and the sex of the individual in relation to growth retardation is shown in Table VII.

TABLE VI

THE SEX OF THE PAIR AND SINGLE OR DUAL GROWTH RETARDATION

SEX OF PAIR	GROWTH RETARDATION	NO GROWTH RETARDATION
Male / Male	10	32
Female / Female	11	22
Male / Female	16	39
Like sexed	21	54

TABLE VII

THE SEX OF THE FETUS AND GROWTH RETARDATION

SEX	GROWTH RETARDED	SERIES TOTAL
Male	19	139
Female	26	131

/There was no ....

There was no relationship between either the sex of the pair or the sex of the individual and growth retardation.

SOCIAL STATUS

Using the criteria of the occupation of the women prior to pregnancy there was little variation in the social status of the patients in the study. There were only 3 patients that could be regarded as professional people, 2 nursing sisters and a medical student, the remainder were either unemployed or domestic, industrial or farm workers.

It was not possible to ascertain the social status by the occupation of the husband as this was not ascertainable in 23% of the patients who were unmarried.

For these reasons it was felt that any analysis of the effect of social status on the incidence of growth retardation would be invalid.

SMOKING

Whether the patient smoked or not was not ascertained because it is customary for the women in this population group not to smoke and at enquiry at the ante-natal clinic less than 2% of 148 patients admitted to any form of tobacco smoking.

INCREMENTAL WEIGHT CHANGE AND GROWTH RETARDATION

The incremental weight change was calculated as the mean weight change over the three assessments prior to delivery and related to both incidence of fetal growth retardation and twins delivered with a combined weight of equal to or less than the mean.   The simplified results are shown in Figures 8 and 9 (tabulated data in appendix III).

Fig. 8

INCREMENTAL WEIGHT CHANGE IN THE THIRD TRIMESTER AND SINGLE
OR DUAL GROWTH RETARDATION
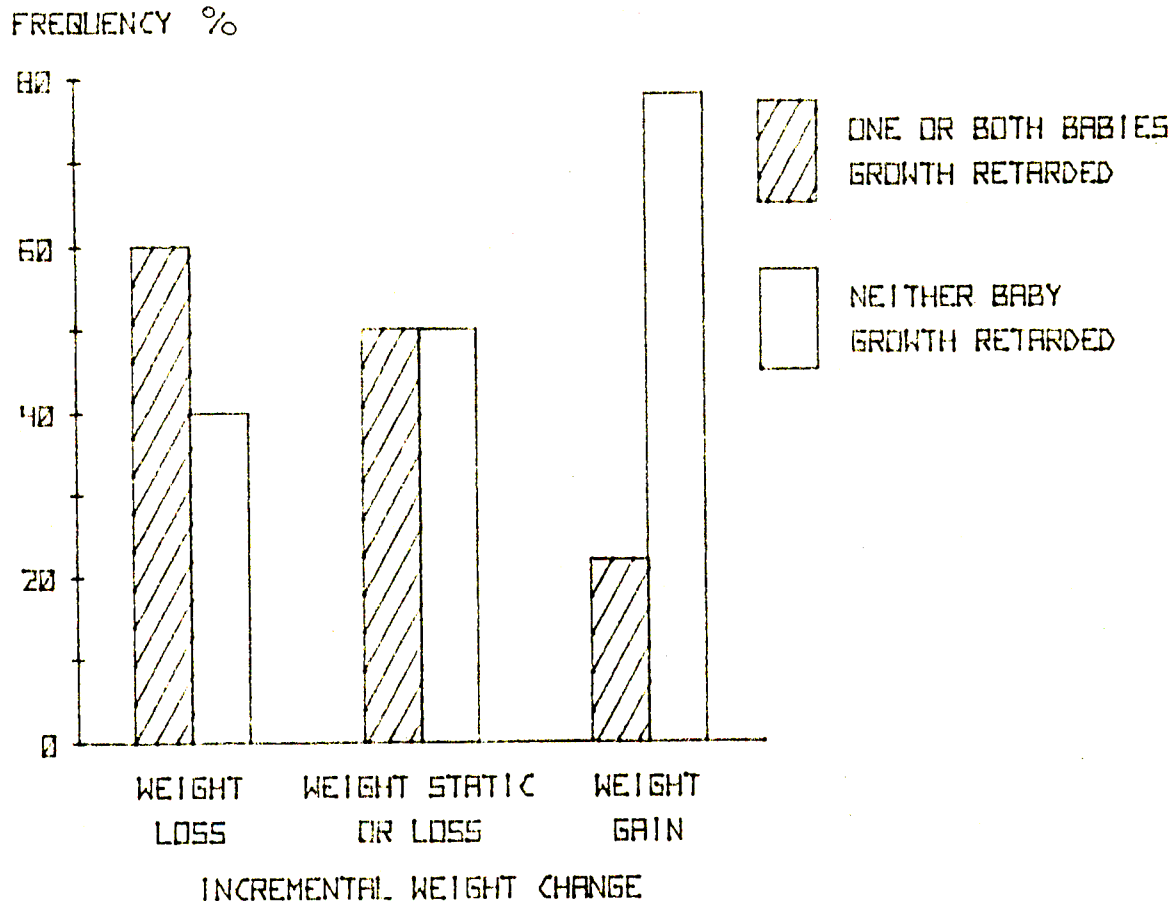
FREQUENCY %

Fig. 9

INCREMENTAL WEIGHT CHANGE IN THE THIRD TRIMESTER AND THE

INCIDENCE OF PREGNANCY GROWTH RETARDATION

FREQUENCY %
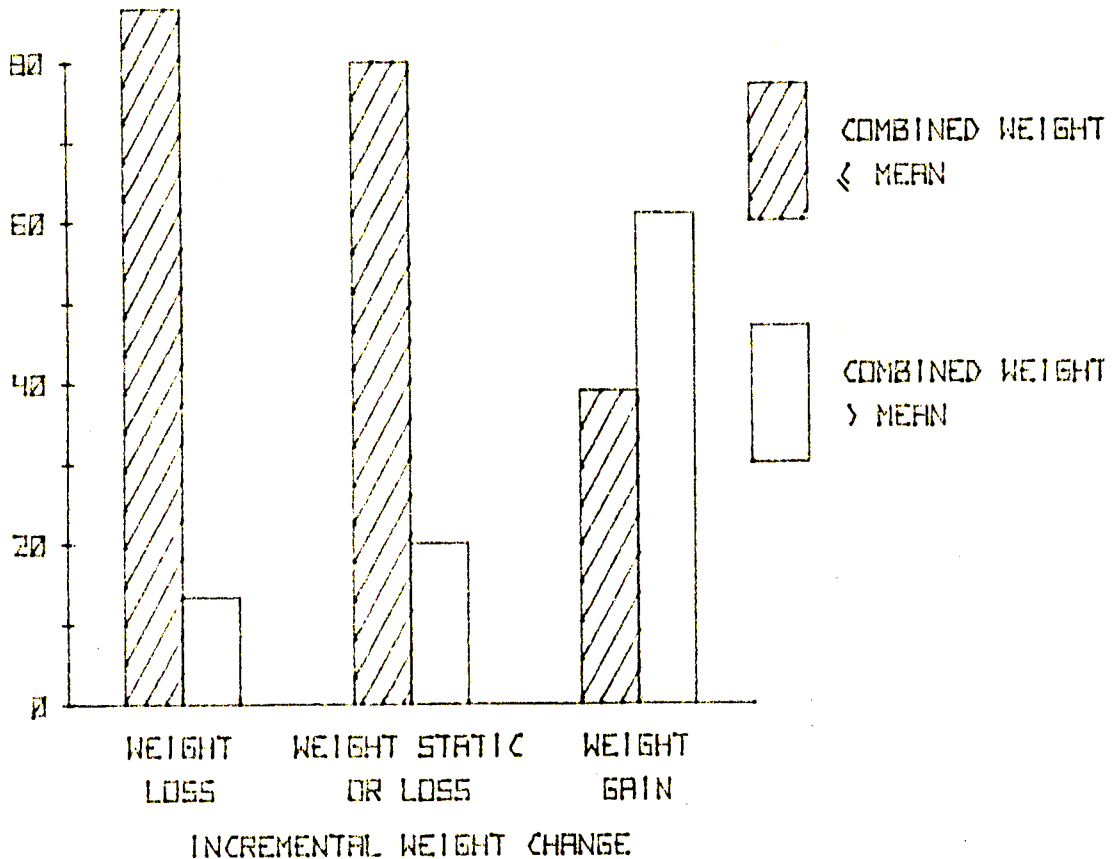
When the maternal weight is static or there is weight loss
occurring over a 2 week period there is a 60% chance of one
or both fetuses being growth retarded which is significant
when related to the incidence (22%) when weight gain is
occurring (p = <0.01).

Similarly when the weight is static or there is weight
loss there is a significant risk of twins of a low combined
weight being delivered (80%) as compared to those with
weight gain (39%) (p = <0.001).

In all 3 patients in which there was weight loss of more than 0.5 kilograms per week both types of growth retardation occurred (appendix III).

FINAL BODY WEIGHT AND GROWTH RETARDATION

The body weight expressed as height to weight ratio assessed within 7 days of labour is compared to the incidence of single or dual growth retardation and twins with a combined weight or equal to or less than the mean for gestation. In Figures 10 and 11 (tabulated data in appendix III). Low values for height to weight ratio imply obesity.

Fig. 10

HEIGHT TO WEIGHT RATIO AT FINAL ASSESSMENT AND THE INCIDENCE OF SINGLE OR DUAL GROWTH RETARDATION

FREQUENCY %

ONE OR BOTH BABIES GROWTH RETARDED

NEITHER BABY GROWTH RETARDED
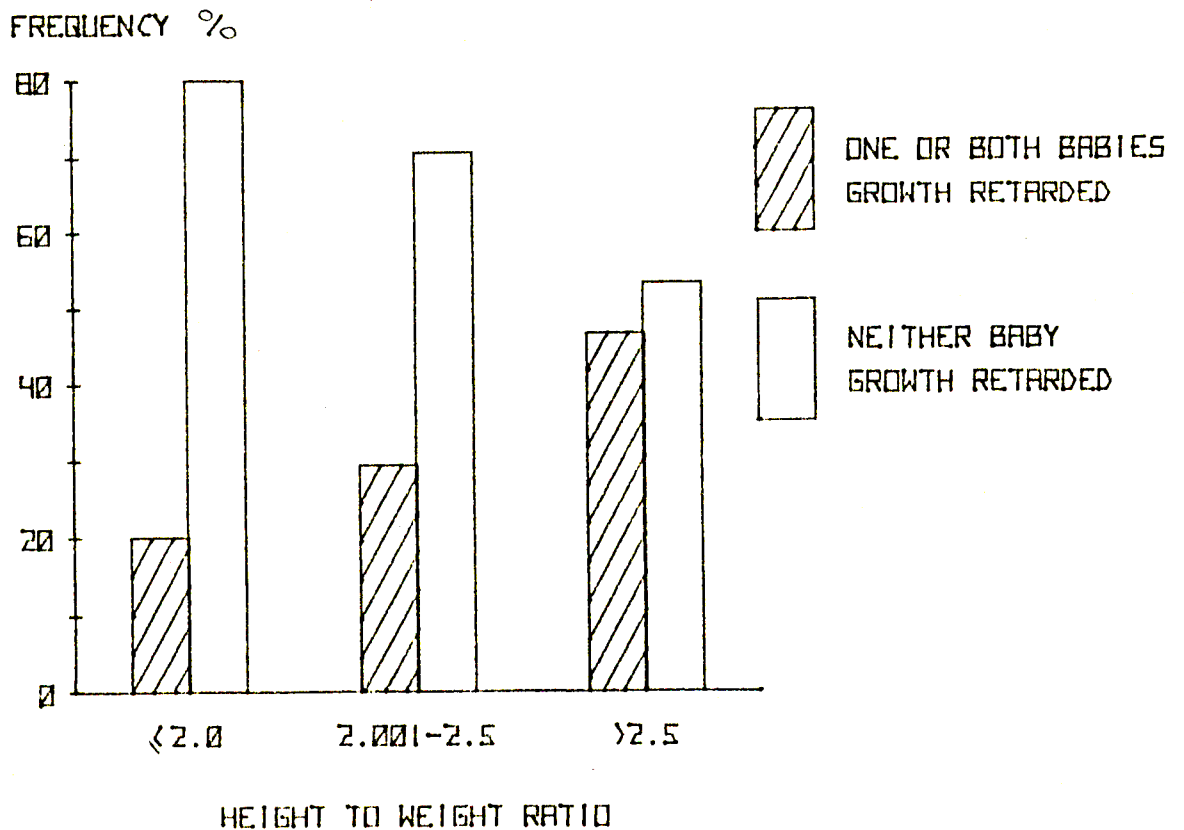
HEIGHT TO WEIGHT RATIO

Fig. 11

HEIGHT TO WEIGHT RATIO AT THE FINAL ASSESSMENT AND THE

INCIDENCE OF PREGNANCY GROWTH RETARDATION

FREQUENCY %

HEIGHT TO WEIGHT RATIO
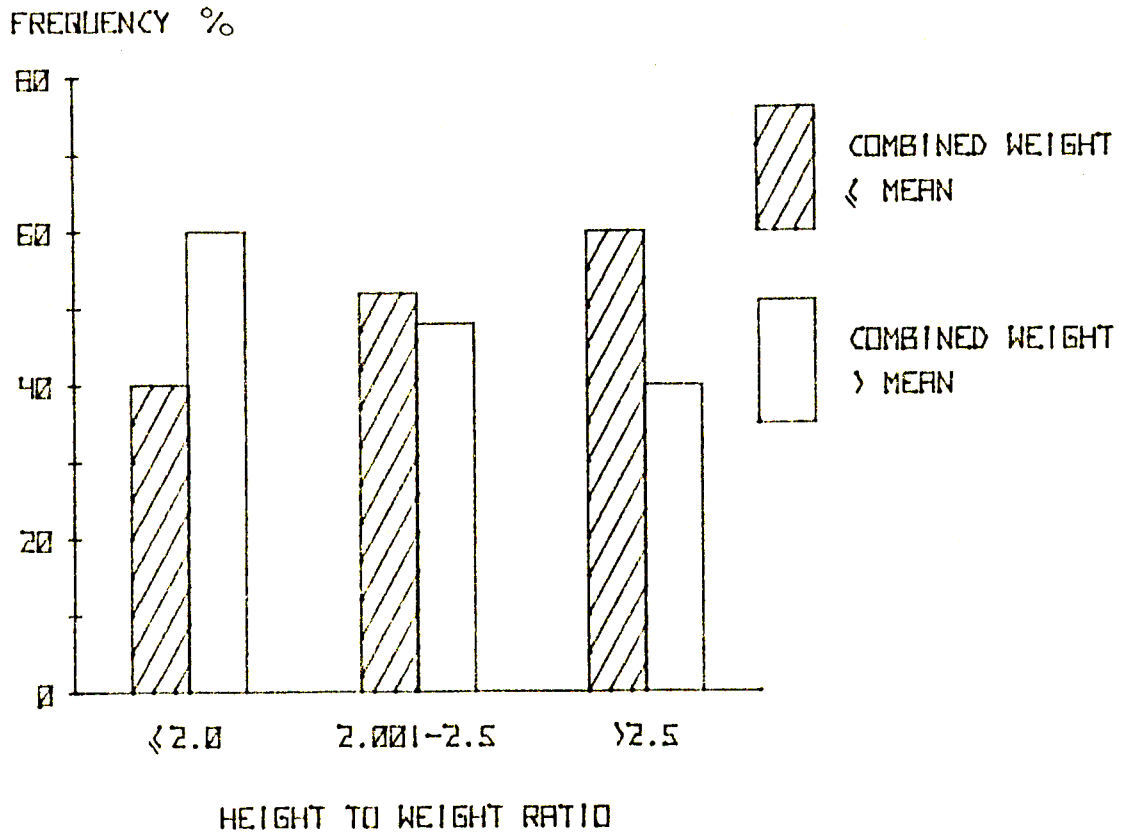
Using height to weight ratio it appears that the obese

women (ratio <2.0) have a lesser chance of pregnancy with

single or dual growth retardation (20%) as against thin

women (ratio >2.5, 47%).   Similarly obese somen are less

likely to produce twins of low combined weight (40%) as

compared to thin women (60%).

Although there is an apparent trend in both comparisons for

the incidence of growth retardation of either sort to

increase with decreasing body weight the differences did not

achieve statistical significance.

INCREMENTAL GIRTH CHANGE AND GROWTH RETARDATION

The women were divided into groups according to the increment
of girth change over the three final assessments and the
incidence of either type of growth retardation was compared
with incremental girth change in each group.

This is shown in Figures 12 and 13 (tabulated data in
appendix III).

Fig. 12

INCREMENTAL GIRTH CHANGE IN THE THIRD TRIMESTER AND THE
INCIDENCE OF SINGLE OR DUAL GROWTH RETARDATION

FREQUENCY %

INCREMENTAL GIRTH CHANGE [CMS/WEEK]
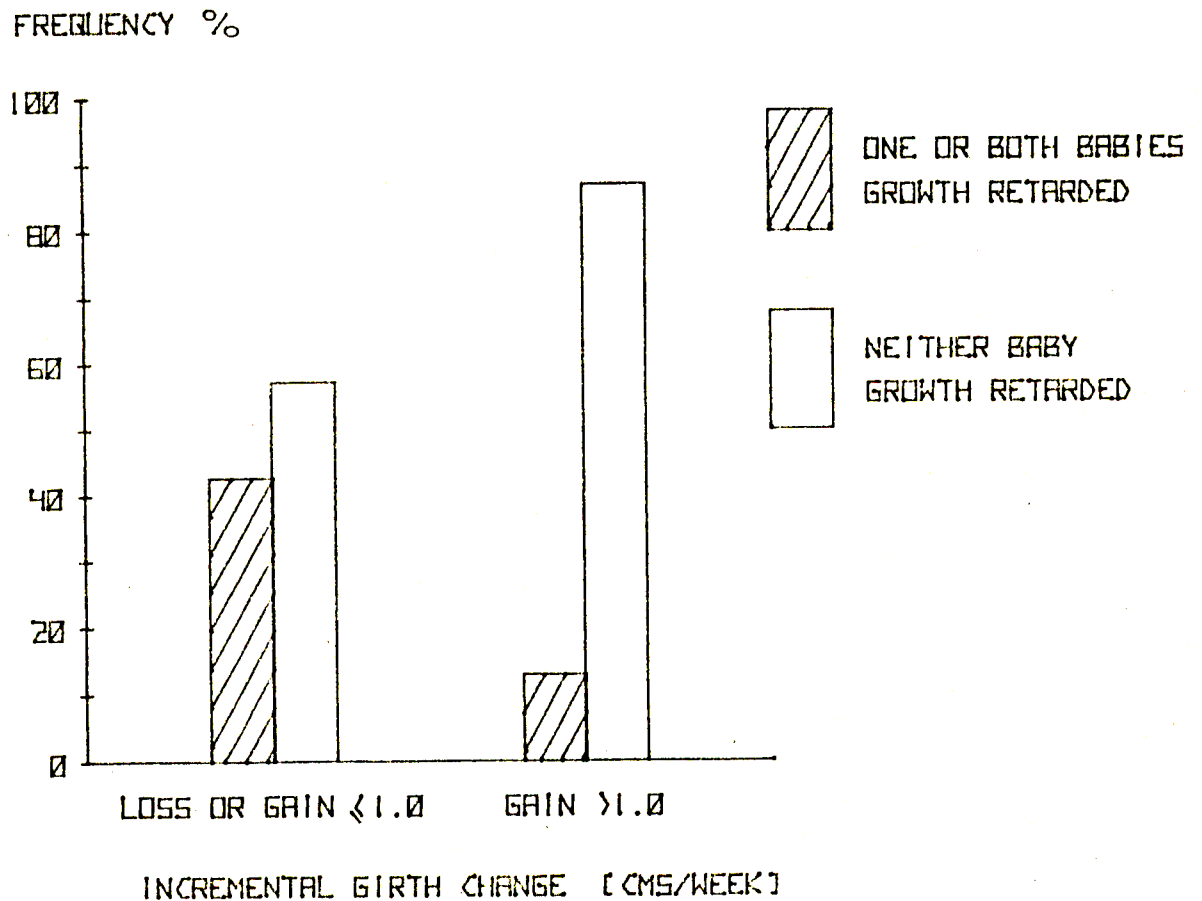
Fig. 13

INCREMENTAL GIRTH CHANGE IN THE THIRD TRIMESTER AND THE
INCIDENCE OF PREGNANCY GROWTH RETARDATION
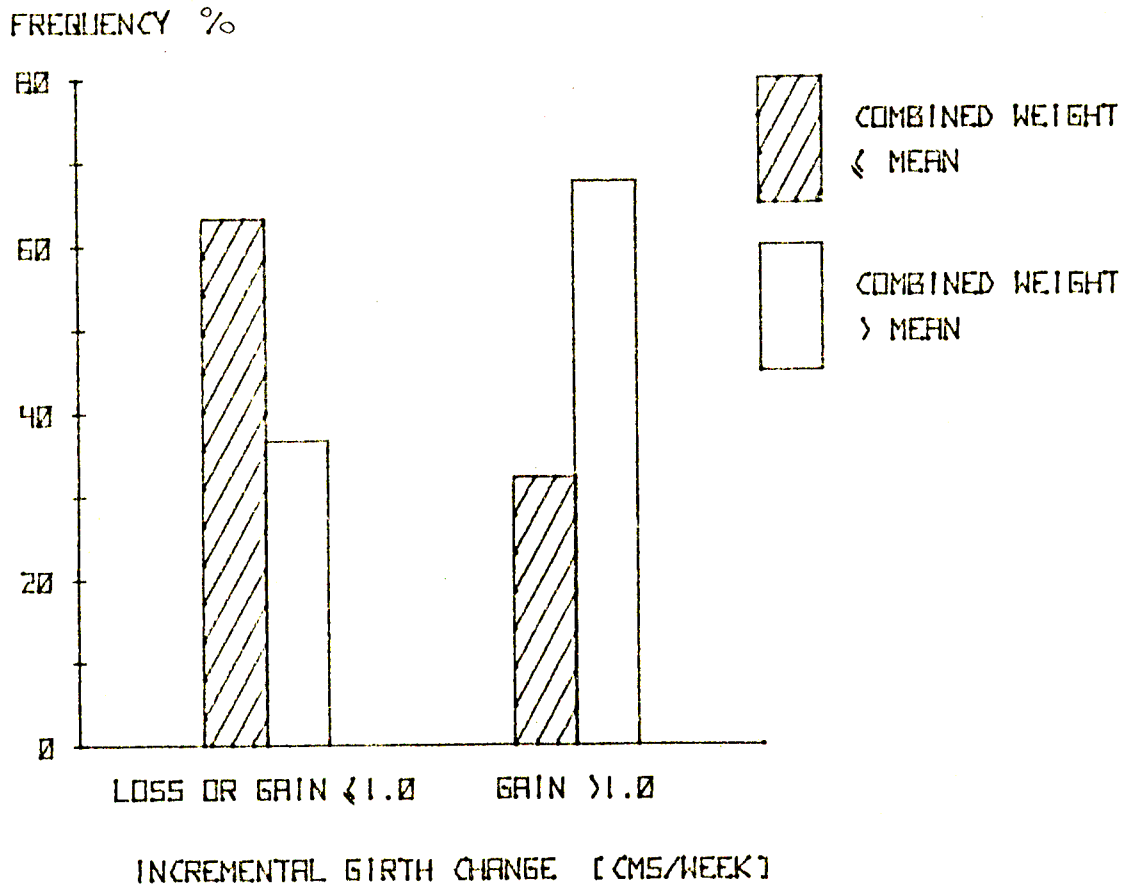
It appears that when there is a girth increase of more than
1.0 centimetres per week that the single or dual growth
retardation rate (13%) is significantly reduced when compared
to those women who lose or gain less than 1 centimetre per
week (43%) (p = <0.001).

Similarly with a girth gain of more than 1.0 centimetre a
week the incidence of twins with a low combined weight (37%)
is significantly reduced compared to the women who do not
achieve this gain in girth 63% (p = <0.001).

FINAL ACTUAL GIRTH AND GROWTH RETARDATION

The women were grouped according to girth at the final

assessment and the incidence of either type of growth

retardation was compared in each group.   The results are

shown in Figures 14 and 15 (tabulated data in appendix III).

<u>Fig. 14</u>

GIRTH AT THE FINAL ASSESSMENT AND THE INCIDENCE OF SINGLE

OR DUAL GROWTH RETARDATION
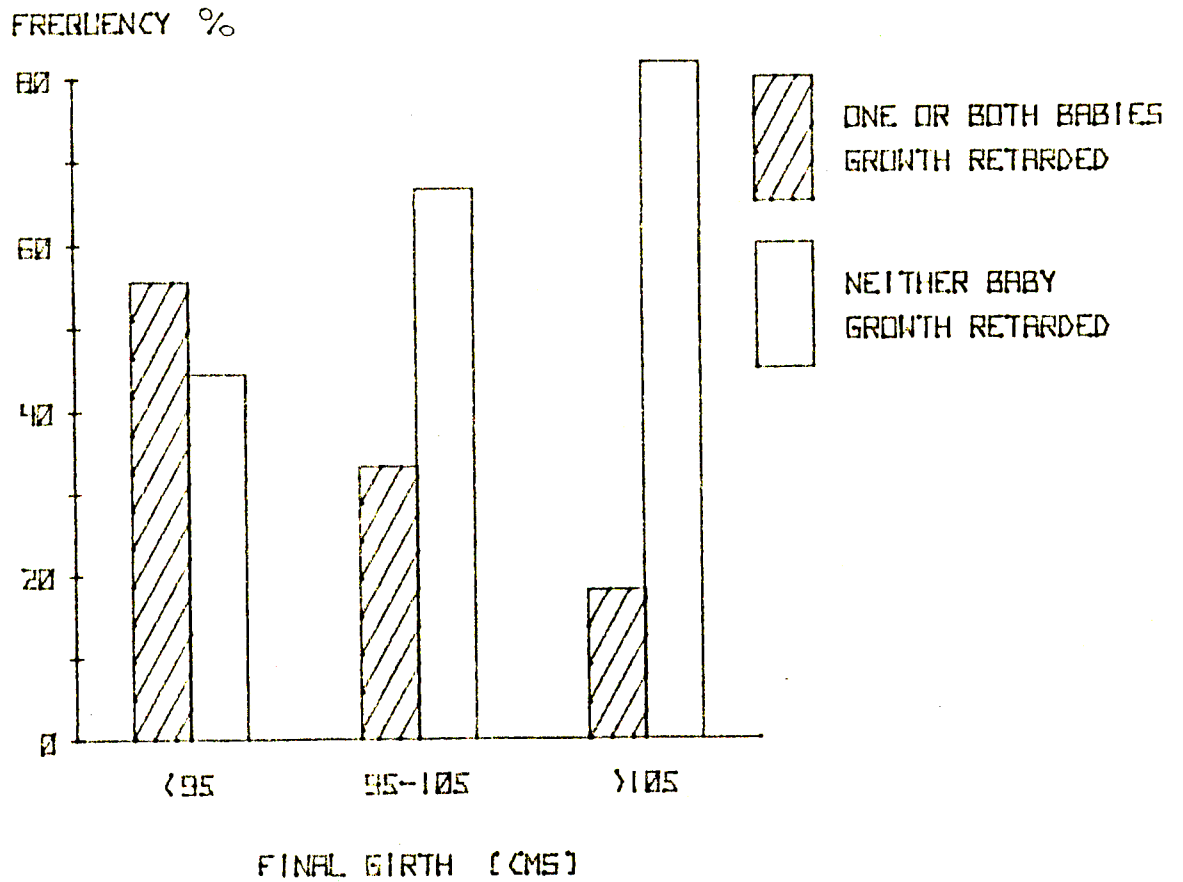
Fig. 15

GIRTH AT FINAL ASSESSMENT AND THE INCIDENCE OF PREGNANCY
GROWTH RETARDATION
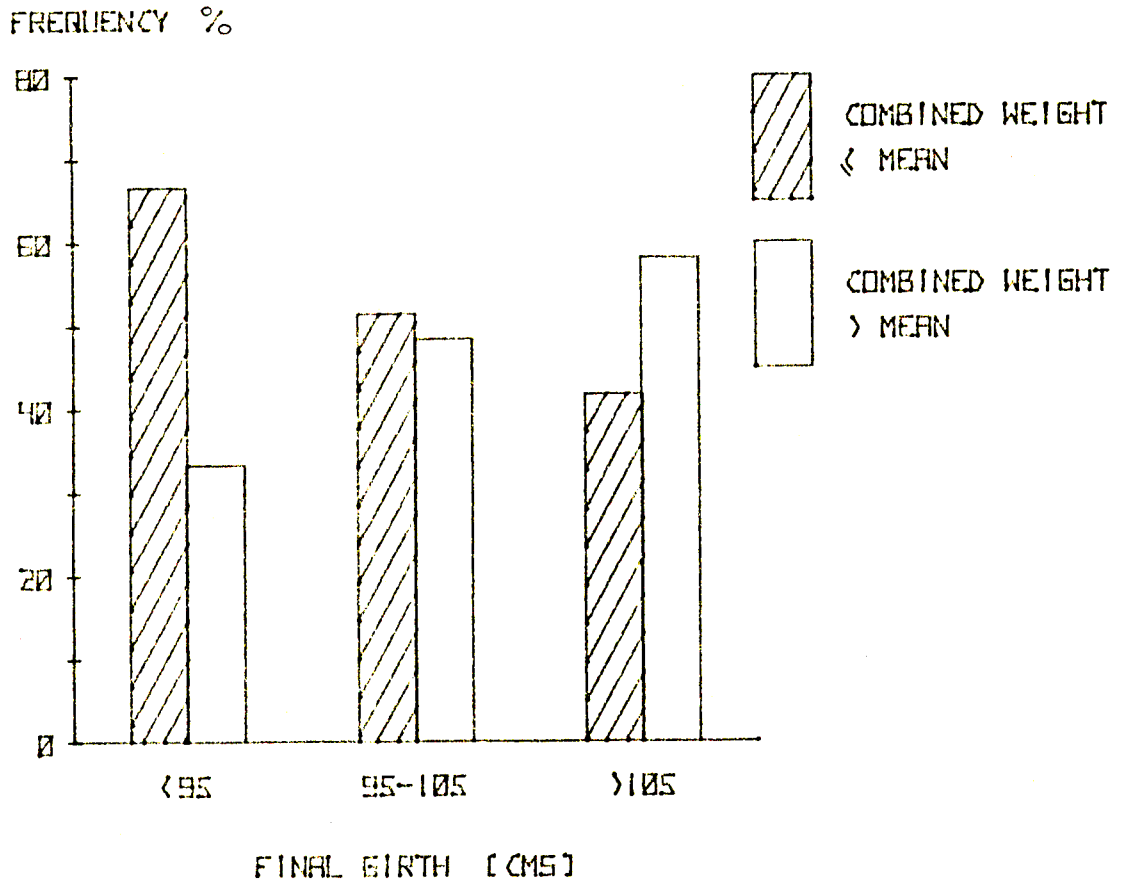
A trend for a decreased incidence of individual growth
retardation with increasing final girth is clear as is the
trend for a decreased incidence of low combined weight twins.

PRODUCT OF FINAL HEIGHT TO WEIGHT RATIO AND GIRTH IN RELATION
TO GROWTH RETARDATION

The relationship between girth and growth retardation may
simply be that girth reflects the volume of the intra-
uterine contents prior to labour, alternatively it may be due

to maternal obesity. To determine which of these factors
plays the major role in this relationship the product of
the height to weight ratio and girth was related to the
incidence of growth retardation (Figures 16 and 17, tabulated
data in appendix III).

<u>Fig. 16</u>

PRODUCT OF HEIGHT TO WEIGHT RATIO WITH FINAL GIRTH AND THE
INCIDENCE OF SINGLE OR DUAL GROWTH RETARDATION
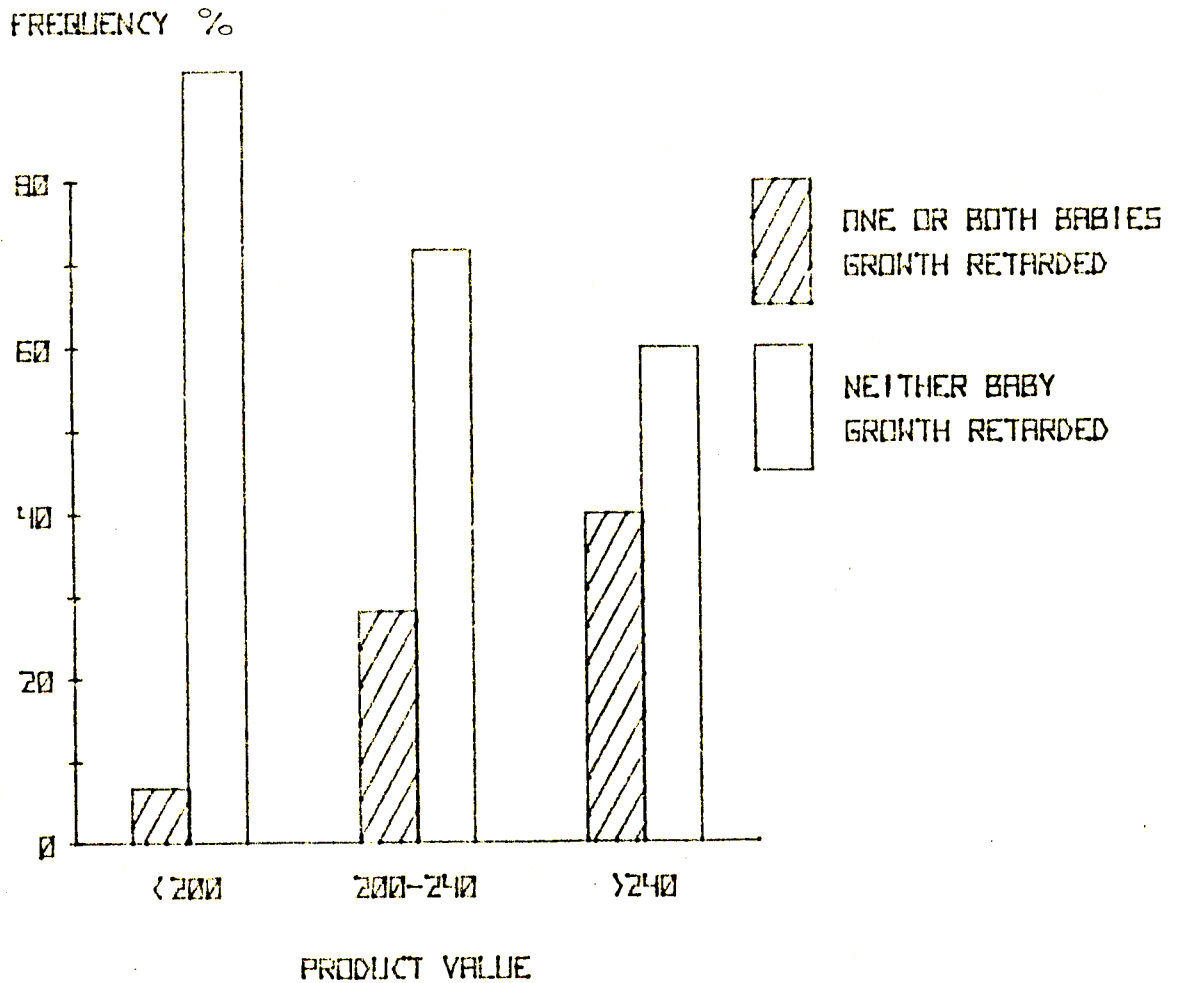
Fig. 17

PRODUCT OF HEIGHT TO WEIGHT RATIO WITH FINAL GIRTH AND THE

INCIDENCE OF PREGNANCY GROWTH RETARDATION
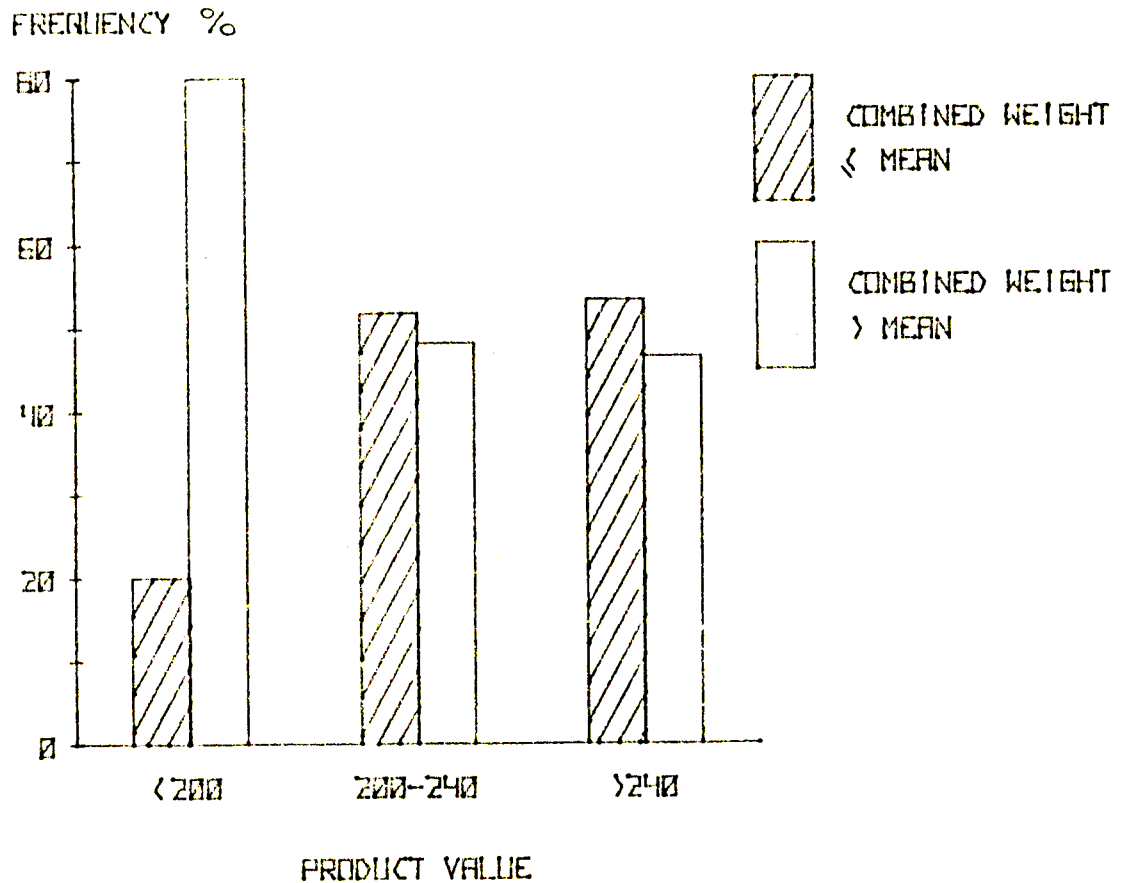
The increasing incidence of either type of growth retardation

with increasing product value is the reverse of what would

be expected if the relationship between girth and growth

retardation was attributable to girth measurement reflecting

intra-uterine volume and suggests the maximum effect is

attributable to weight rather than girth.

When the product value is equal to or less than 200 there

is a trend for the incidence of single or dual growth

retardation to be lowered (7%) as compared to when the

product value is greater than 240 - 40% (p = <0.1 = >0.05).

When the product value is equal to or less than 20o the risk of low combined weight is 20% as compared to when the product value is greater than 200 - 52% (p = <0.01).

THE BEHAVIOUR OF THE CERVIX AND GROWTH RETARDATION

No difference could be found in the mean cervical score at a given gestation between the pregnancies with either type of growth retardation and the scores for all the twins (tabulated data in appendix III).

HYPERTENSION

The incidence of hypertension in the series was 11 out of 132 patients (8.3%) when hypertension was defined as a blood pressure of 140/90 millimetres of Mercury or more.

Four of these patients developed persistent proteinuria the 3 elective deliveries for hypertensive states prior to 37 weeks gestation are included in this group.

Of the 22 babies delivered from the hypertensive women 4 were growth retarded (18.2%) compared to an overall incidence of 17.5%.

DISCUSSION

The purpose of this chapter is, firstly to define which
group of patients with a twin pregnancy have an increased
risk of delivering growth retarded infants and secondly
to assess the predictive value of clinical parameters of
fetal growth.

The clinical measurements of weight and girth are an indirect
assessment of the status of the fetuses and rely on the
measurement of a response to pregnancy.

Two types of growth retardation were considered that is a
pregnancy where one or both babies were growth retarded or
a pregnancy where the combined weight of the babies was
less than the mean for twins at a given gestation.   The
purpose of this second definition is to analyse the
relationship between a low combined weight and individual
or dual growth retardation and to determine whether clinical
parameters have a better predictive value with this type
of growth retardation, this definition was entirely arbitrary
and made for the purpose of the study appreciating that
approximately 50% of the patients would fall into each group.

INCIDENCE

Very few references can be found in the literature to the
incidence of single or dual fetal growth retardation. The
majortiy of series report the incidence of low birthweight
babies which might be attributable to either early delivery
or intra-uterine growth compromise. Gruenwald[1] in 1966
in a large retrospective study found the overall incidence

of growth retardation defined as a body weight of less than 2 standard deviations from the mean to be 17.25% as compared to controls. He also found that the incidence increased from 3% between 29 and 34 weeks to 27% after 38 weeks.

The overall incidence of growth retardation in this series defined as an infant with a birthweight of less than the 10th centile for gestation was 17.3% (Table I) which closely agrees with Gruenwald's figures. The finding that the mean gestation of delivery of the growth retarded infants was 37.8 weeks compared to 36.85 weeks for all the twins supports his expected finding that the further a twin pregnancy progresses the greater the chance of fetal growth retardation.

No reference can be found to the incidence of twins with a low combined weight for gestation. When defined as a combined weight equal to or less than the mean the incidence in this series was 48.5% (Table III).

When the combined weight was low the risk of single or dual fetal growth retardation was 57% and in only 1 out of the 37 pregnancies (2.7%) with a growth retarded fetus was the combined weight greater than the mean.

The smoothed curve for combined weight for gestation as shown in Figure 1 suggests that there is cessation of fetal growth after 39 weeks.

The incidence of growth retardation was similar in the like sexed pairs and the unlike sexed pairs. It would be expected

to be greater in the like sexed pairs because of the effect that monozygosity has on growth causing smaller babies and greater inter-pair weight difference[2] [3]. The similarity between the like and unlike sexed pairs in this series is explicable by the fact that the frequency of monozygotic twins is small when compared to the overall rate (Chapter II).

EPIDEMIOLOGY

AGE

There appears to be a progressive increase in the incidence of both types of growth retardation with increasing age particularly when the maternal age is greater than 30 years when there is a 44% increase in the risk of individual fetal growth retardation over the risk in mothers of 30 years of less and a 60% increase in risk of twins with a low combined weight for gestation (Figures 2 and 3).

No references can be found in the literature to the incidence of growth retardation according to maternal age. The finding of an apparently increased incidence with advancing age is readily explained on the assumption that the ageing process narrows the diameter of the uterine arteries. The effect of age might be expected to be greater in twin pregnancy than single because of the added demand of two babies. Alternatively the effect of age may be artificial and related to parity when is considered below.

PARITY

There is a significant increase in the pregnancy incidence of single or dual fetal growth retardation in primipara (38.5%) and women of a parity of 4 or more (41.5%) when compared to women of parity 1 - 3 inclusive (20%) Figure 4.

The incidence of low combined weight twins appears to increase with a parity of 4 or more 58.5% when compared to all women of a lower parity (43.8%) Figure 5 though the differences were not significant.

Parity rather than age seems to be the more important factor associated with fetal growth retardation in twins as is indicated by the significance of the differing incidence between women of parity 1 - 3 and primipara or women of a parity of 4 or more.

The higher incidence in primipara is interesting and it could be postulated that the limitation of growth support in these patients is attributable to uterine artery resistance to distension because the elastic and fibro-muscular tissue of the arterial walls has not been stretched by distension in a previous pregnancy. This effect of primiparity and reduced baby size has been noted in singletons by MacGillivray et al[4].

The risk of fetal or neonatal loss is clearly linked to low birthweight and the perinatal loss in primipara with twins is known to be higher than that in multipara. Farrell[5] found the overall mortality in primiparous patients with twins was 16.18%. This was confirmed by Klein[6] who found that this increase was independent of the effect of either congenital

malformations or babies weighing less than 1.0 kilograms. From this series the apparent causation of the high chance of primipara delivering small babies is a combination of both an increased pre-term delivery rate (Chapter III) and an increased risk of fetal growth retardation.

MATERNAL HEIGHT

There is a clear tendency for women below the mean height for the population group (154 centimetres, Chapter II) to have either individually growth retarded infants (66%) or twins of a low combined weight (62%).

This might explain Anderson's[7] finding that the perinatal mortality for babies weighing between 1.4 and 2.3 kilograms was three times higher in short women than in tall.

MATERNAL WEIGHT

When weight is corrected for height by using the simple height to weight ratio as assessed within 1 week of delivery there appears to be a progressive increase in the incidence of both types of growth retardation with decreasing body weight (Figures 10 and 11). This is particularly evident in the rates of individual growth retardation which increases from 20% in the obese women (ratio <2.0) to 47% in the thin women (ratio >2.5).

This may reflect either weight gain in pregnancy, pre-pregnancy weight or, as is most likely, a combination of both factors.

OBSTETRIC HISTORY

The obstetric histories in terms of perinatal loss showed clearly that with a history of such a loss there was a marked risk of individual growth retardation (70%) and low combined weight for gestation (80%). A history of previous first trimester abortions had an effect on the risk of individual growth retardation, 50% as compared to an overall risk of 28.5% but no effect on the risk of delivering twins of a low combined weight for gestation.

CLINICAL MEASUREMENTS IN PREGNANCY

WEIGHT GAIN

Static weight or weight loss is associated with a marked increase in the risk of individual growth retardation 53% and low combined weight 85%. though gain in weight in the 2 to 3 weeks prior to delivery cannot lead to complacency as the risk of individual growth retardation is not significantly reduced compared to the overall risk (22% compared to 28.5%) unless the weight gain is greater than 1.0 kilograms per week when the risk is reduced to 9.3% (Figure 8 and appendix III).

The association between weight gain and combined fetal weight shows that weight gain reduces the risk of a low combined weight pregnancy from 48.5% to 22%.

Mac Gillivray[4] has suggested that if weight gain is below average for a multiple pregnancy this should be regarded as poor response to pregnancy and careful monitoring of the growth of the babies is required but he does not mention how.

Campbell and Mac Gillivray[8] found that, as in singletons, there was a relationship between weight gain in pregnancy and the weight of the babies in primigravida but not in multipara. This finding regarding multipara is not supported in this series.

GIRTH

The measurement of girth is indirectly a measure of uterine volume. The limitation of this measurement of volume is that no account is taken of maternal tissue other than the uterus or the shape of the uterus.

Although these two sources of error are unlikely to remain absolutely constant progressive changes in girth might be expected to reflect an increase in the uterine volume.

In Figure 11 and Figure 12 it can be clearly seen that a weekly increase in girth of more than 1 centimetre indicates a low risk of both individual growth retardation (13%) and low combined weight for gestation (32%) and similarly a gain of less than 1 centimetre a week or loss gives a high risk of both individual growth retardation (43%) and low combined weight for gestation (63%).

When considering the actual girth as measured within a week of delivery in relation to fetal growth (Figures 13 and 14) there is a decreasing risk of either type of growth retardation with increasing girth but this may reflect the degree of obesity rather than uterine volume. The product of the actual girth and height to weight ratio will, at least compensate for obesity and the result

should bear a constant relationship to uterine circumference.

It can be seen from Figures 16 and 17 that the relationship between the girth as measured within one week of labour and either type of growth retardation is mainly due to obesity. When this product value is equal to or less than 200 the risk of individual growth retardation is 7% and the risk of low combined weight for gestation is 20%. With product values of between 200 and 240 the risk of either type of growth retardation is the same as the overall risk but when the product value is greater than 240 the risk of individual growth retardation is increased to 40% and the risk of low combined weight twins is increased to 53%.

THE BEHAVIOUR OF THE CERVIX

In singleton pregnancies with fetal growth compromise it is often stated that the cervix is likely to be "ripe". The same does not hold true in twin pregnancies as the progressive changes in the cervix in the third trimester are the same with either type of growth retardation as in the series overall.

HYPERTENSION

Hypertension did not appear to increase the incidence of fetal growth retardation though the numbers were too small to enable valid conclusions to be drawn.

SUMMARY

A group of patients can be defined as being at greater risk than normal of having a twin pregnancy where one or both

babies are growth retarded. "S" indicates significance, the factors in which differences were observed that did not achieve statistical significance are mentioned as they are included in the discriminant analysis in Chapter VI. The epidemiological factors are:-

1. Age - more than 30 years.

2. Primipara and women of a parity of more than 3. (S)

3. Women less than the mean height for the population group. (S)

4. Women with a history of a previous stillbirth or neonatal death. (S)

In third trimester assessments further risk factors are:-

1. No weight gain or weight loss over 3 consecutive weekly assessments. (S)

2. A girth increase if less than 1.0 centimetres per week over 3 consecutive weekly assessments. (S)

3. Women with a low body weight prior to labour as assessed as a height to weight ratio of more than 2.25 (height in centimetres and weight in kilograms).

4. Women where the product of the height to weight ratio and girth in centimetres prior to labour in more than 240. (S)

The factors which indicate a markedly reduced risk of fetal growth retardation are:-

1. An increase in girth of more than 1.0 centimetres per week (S

2. A weight gain of more than 1.0 kilograms per week. (S)

3. A product of the height to weight ratio and girth of less than 200. (S)

R E F E R E N C E S

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CHAPTER V

PLASMA OESTRIOL, PLACENTAL LACTOGEN AND ULTRASONIC BIPARIETAL DIAMETER MEASUREMENT IN GROWTH RETARDATION

INTRODUCTION

PLASMA OESTRIOL

Trends

Actual Values

PLACENTAL LACTOGEN

Trends

Actual Values

BIPARIETAL DIAMETER

Series Growth Rates

The Biparietal Diameter Growth Rate and Growth Retardation

Divergent Biparietal Diameter Growth Rate

DISCUSSION

SUMMARY

This chapter is divided into 2 parts:-

1. Plasma oestriol and placental lactogen levels are assessed in the series with reference to the diagnosis of either type of growth retardation.

2. The individual biparietal diameters, as measured by ultrasound, are analysed in terms of growth of the biparietal diameter of the twins and the value of this particular measurement in the diagnosis of single or dual fetal growth retardation.

The methodology for all these assessments is discussed fully in Chapter II.

The normal values for plasma oestriol and placental lactogen for the series have been established and are presented in Chapter II. These are the values used for analysis purposes.

PLASMA OESTRIOL AND PLACENTAL LACTOGEN

PLASMA OESTRIOL TREND

The trend is defined as the average weekly increment of change over the final 3 measurements prior to delivery. If only the final reading has shown a fall this is not regarded as a falling trend, and the trend is then taken as the weekly incremental change in the assessments prior to the final assessment.

The results are shown in Figures 1 and 2 (tabulated data in appendix IV). Static levels of oestriol are defined as a weekly incremental change of less than 10 ug/ml.

Fig. 1

THE FREQUENCY OF DIFFERENT TRENDS IN WEEKLY INCREMENTAL CHANGES IN PLASMA OESTRIOL LEVELS IN RELATION TO SINGLE OR DUAL GROWTH RETARDATION
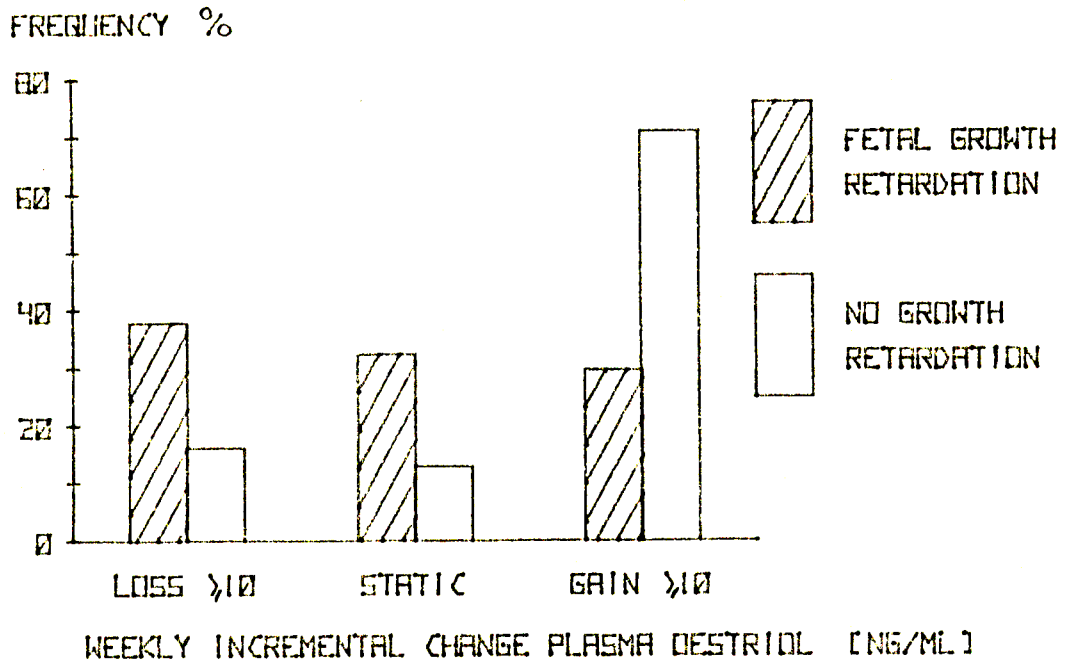
FREQUENCY %

Fig. 2

THE FREQUENCY OF DIFFERENT TRENDS IN WEEKLY INCREMENTAL CHANGES IN PLASMA OESTRIOL LEVEL IN RELATION TO PREGNANCY GROWTH RETARDATION

FREQUENCY %
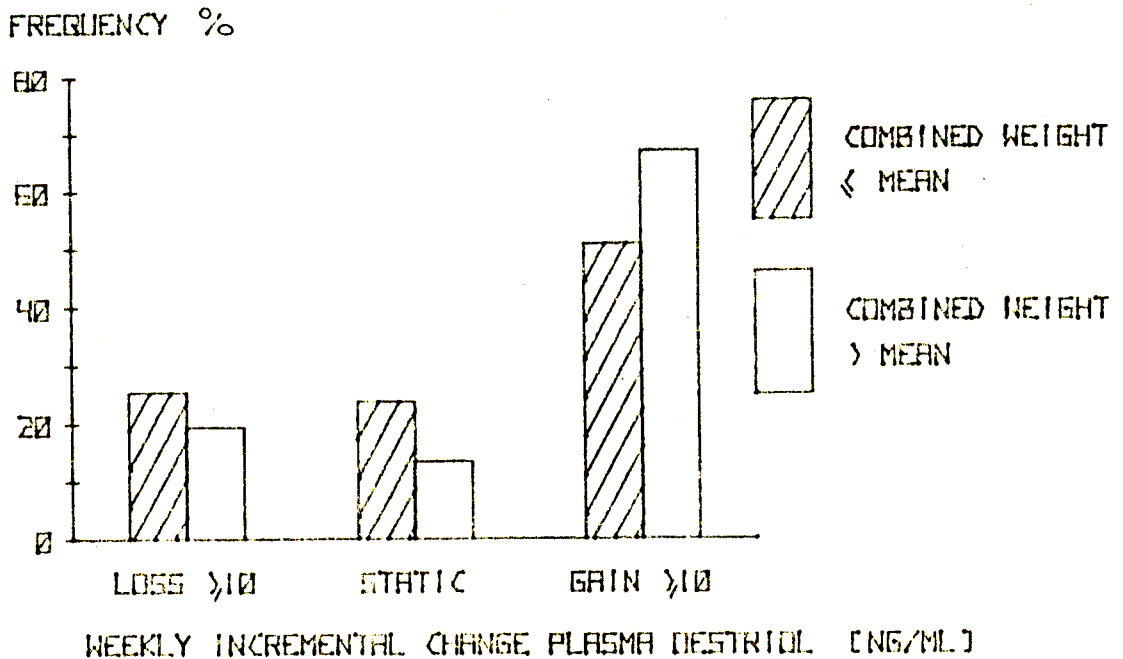
The difference in distribution of patterns of loss, static or rising levels of plasma oestriol is highly significant when related to the incidence of single or dual growth retardation (p = <0.001) and significant when related to pregnancy growth retardation (p = <0.02).

Plasma oestriol levels were static or falling in 43 patients of whom 26 had single or dual growth retardation (60%) and 31 had a combined fetal weight equal to or below the mean for gestation (72%). In all the four pregnancies with antepartum death attributable to growth retardation the plasma oestriol levels were falling.

PLASMA OESTRIOL VALUES

Plasma oestriol values for the 3 assessments prior to delivery were related to both types of growth retardation in terms of their relationship to the normal values for the series (Chapter II). For analysis purposes the last three plasma oestriol values obtained after 30 weeks gestation were taken and allocated to the centile range in which most occurred. The results are shown in Tables I and II.

TABLE I

PLASMA OESTRIOL VALUES AND SINGLE OR DUAL GROWTH RETARDATION

VALUE (Centile)	GROWTH RETARDATION	NO GROWTH RETARDATION
>50th	15+	53
10th - 50th	18+++	33
10th	4	4

+Denotes antepartum death attributable to growth retardation.

TABLE II

PLASMA OESTRIOL LEVELS AND PREGNANCY GROWTH RETARDATION

	COMBINED FETAL WEIGHT	
OESTRIOL VALUE (CENTILE)	<MEAN	>MEAN
>50th	22	46
10th - 50th	34	17
10th	6	2

Both these analyses exclude the 3 patients in whom 3 values after 30 weeks were not obtained due to pre-term delivery.

There is no significant relationship between the majority of oestriol values falling below the 50th centile and single or dual growth retardation (p = <0.01 = <0.05), whereas 65% of the women with a growth retarded pregnancy had value below the 50th centile compared to 29% of women with a combined fetal weight greater than the mean for gestation (p = <0.001).

PLACENTAL LACTOGEN TREND (ug/ml=MICROGRAMS/MILLILITRE)
The trend of placental lactogen levels after 30 weeks gestation was related to both types of growth retardation in the same way as plasma oestriol (vide supra).

The trend was regarded as static when the incremental weekly change was less then 0.5 ug/ml. The results are shown in Figures 3 and 4 (tabulated data in appendix IV).

Fig. 3

THE FREQUENCY OF DIFFERENT TRENDS IN WEEKLY INCREMENTAL
CHANGE IN PLACENTAL LACTOGEN LEVELS AND SINGLE OR DUAL
GROWTH RETARDATION
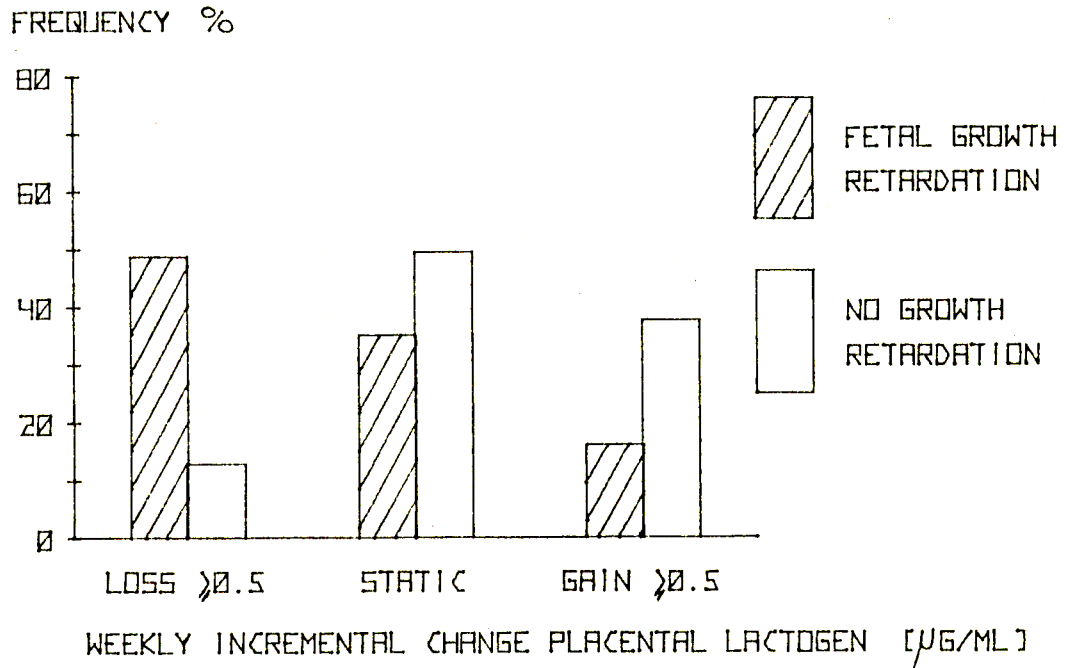
Fig. 4

THE FREQUENCY OF DIFFERENT TRENDS IN WEEKLY INCREMENTAL
CHANGE IN PLACENTAL LACTOGEN LEVELS AND PREGNANCY
GROWTH RETARDATION
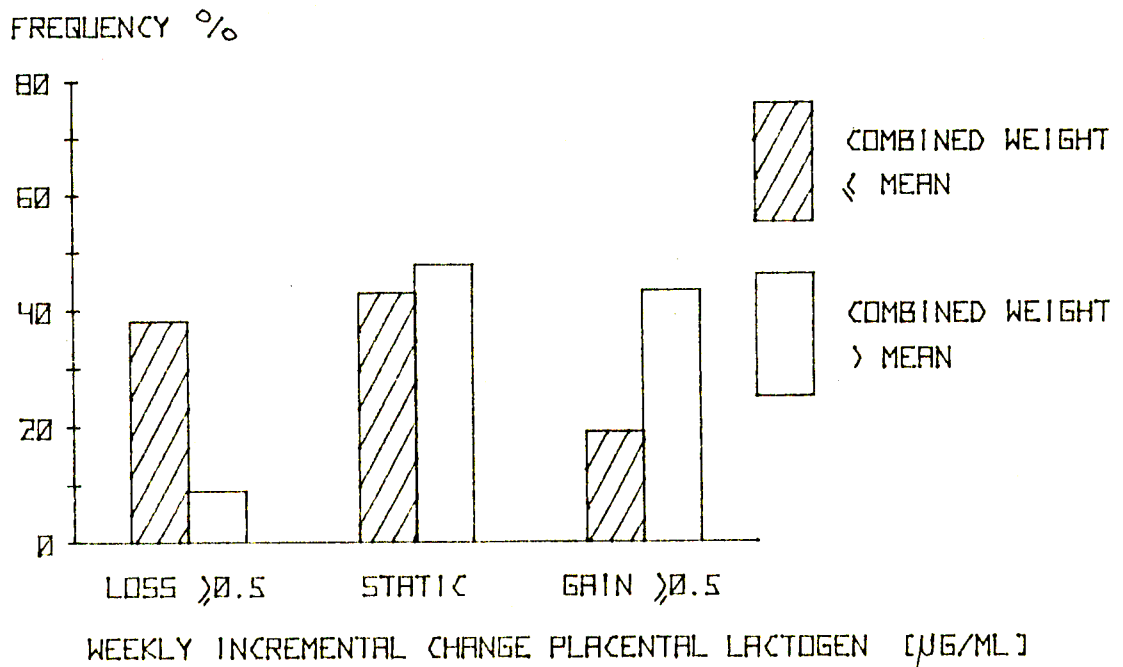
The difference in distribution of patterns of loss, static or gain in placental lactogen levels are highly significant when related to both single or dual growth retardation (p = <0.001) and a combined fetal weight below the mean for gestation (p = <0.001).

Placental lactogen levels were falling in 30 patients. Of these 18 (60%) had a pregnancy with single or dual growth retardation and 24 (80%) a low combined fetal weight for gestation.

PLACENTAL LACTOGEN VALUES

Placental lactogen values were assessed in terms of actual value rather than centiles because of the relatively flat levels maintained during the third trimester in the series. (Chapter II).

In these analyses, as in those for plasma oestriol values the three patients who did not have at least 3 assessments of placental lactogen after 30 weeks because of pre-term delivery are excluded. The analysis was made in terms of the number of occasions a value fell at or below 6.0 ug/ml, 7.0 ug/ml and 8.0 ug/ml in relation to both types of growth retardation. The frequency of values falling at or below 7.0 ug/ml was too small to be of clinical value and the relative frequency of occurrence of values equal to or less than 8.0 ug/ml are considered in tables III and IV (full tabulated data in appendix IV).

TABLE III

THE FREQUENCY OF OCCURRENCE OF PLACENTAL LACTOGEN LEVELS
$\leqslant 8.0$ (ug/ml) AND SINGLE OR DUAL GROWTH RETARDATION

NUMBER OF OCCASIONS $\leqslant 8.0$	GROWTH RETARDATION	NO GROWTH RETARDATION
1	7	20
2	11++	7
3 or more	8++	18

+Denotes antepartum death attributable to growth retardation.

TABLE IV

THE FREQUENCY OF OCCURRENCE OF PLACENTAL LACTOGEN LEVELS
$\leqslant 8.0$ (ug/ml) AND PREGNANCY GROWTH RETARDATION

NUMBER OF OCCASIONS $\leqslant 8.0$	COMBINED WEIGHT	
	$\leqslant$MEAN	>MEAN
1	11	16
2	17	1
3 or more	18	8

There was a significant difference in the frequency of
occurrence of 2 or more placental lactogen levels $\leqslant 8.0$
ug/ml in the third trimester between pregnancies with
single or dual growth retardation and pregnancies where
neither fetus was growth retarded (p = <0.02).   Similarly
with pregnancies where the combined weight was less than
the mean for gestation compared to those where the combined

weight is greater than the mean (p = <0.001).

Placental lactogen levels of equal to or less than 8.0 µg/ml on 2 or more occasions were found in 44 patients. Of these, 19 (44%) had single or dual growth retardation and 35 (80%) a combined fetal weight of equal to or less than the mean for gestation.

The frequency of occurrence of one value of ≤8.0 ug/ml was not significant different in any of the groups.

THE COMBINATION OF PLASMA OESTRIOL AND PLACENTAL LACTOGEN VALUES

In order to determine whether plasma oestriol and placental lactogen were complementary in the diagnosis of single or dual growth retardation the results were analysed in terms of whether there was an abnormality of plasma oestriol alone (static or falling trend) or abnormality of placental lactogen alone (falling trend and/or 2 or more results ≤8.0 ug/ml) or an abnormality of both parameters.

The results are shown in Table I.

TABLE V

THE INTER-RELATIONSHIP BETWEEN PLASMA OESTRIOL AND PLACENTAL LACTOGEN LEVELS IN THE DIAGNOSIS OF SINGLE OR DUAL GROWTH RETARDATION

ABNORMALITY	GROWTH RETARDATION	NO GROWTH RETARDATION
Oestriol	1	9
Placental Lactogen	5	20
Oestriol and Placental Lactogen	23	10

There is a highly significant difference in the distribution
of an abnormality of both parameters between the two groups
$(p = <0.001)$.

Abnormalities of both plasma oestriol and placental lactogen
occurred in 33 patients of whom 23 (70%) had a pregnancy
with growth retardation and an abnormality of only one
parameter occurred in 35 patients of whom 6 (17%) had
pregnancies with single or dual growth retardation.

Using the criteria of an abnormality in both plasma
oestriol and placental lactogen 23 out of 37 pregnancies
(62%) with single or dual growth retardation would have
been correctly predicted and 10 out of 97 pregnancies (10%)
would have been falsely predicted.

All four pregnancies with an antepartum death attributable
to growth retardation showed abnormal patterns in both
plasma oestriol and placental lactogen.

Representative examples are shown in Figures 5 and 6.

Fig. 5

DELIVERED 37 WEEKS - TWIN I 3.5 KG, TWIN II 2.2 KG F.S.B.
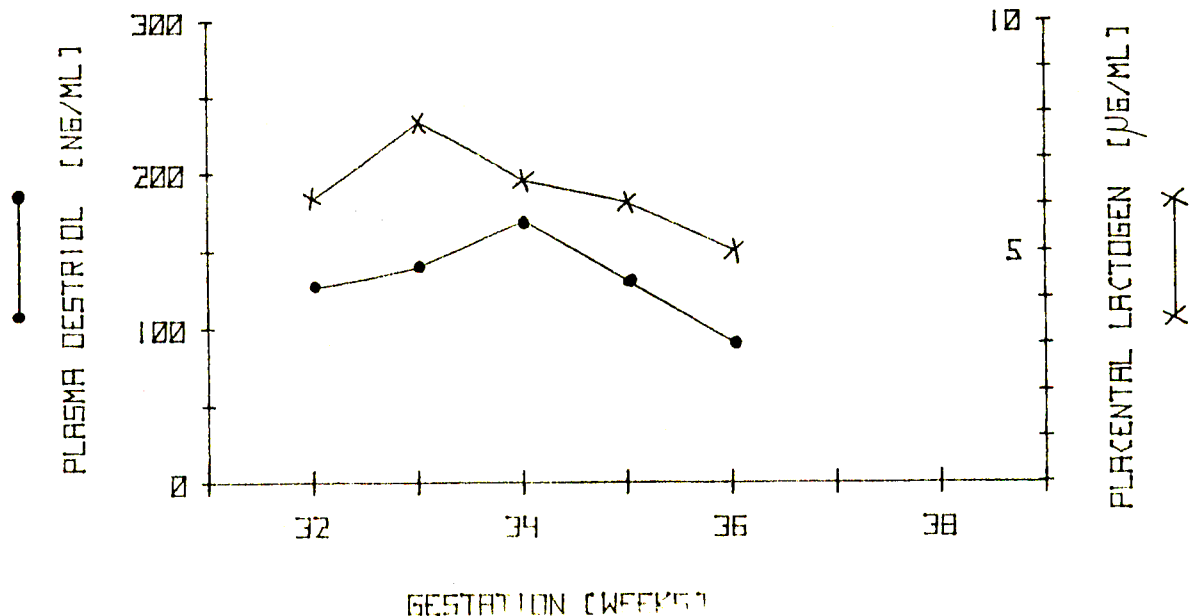
Fig. 6

DELIVERED 36 WEEKS - TWIN I 2.15 KG, TWIN II 1.15 KG
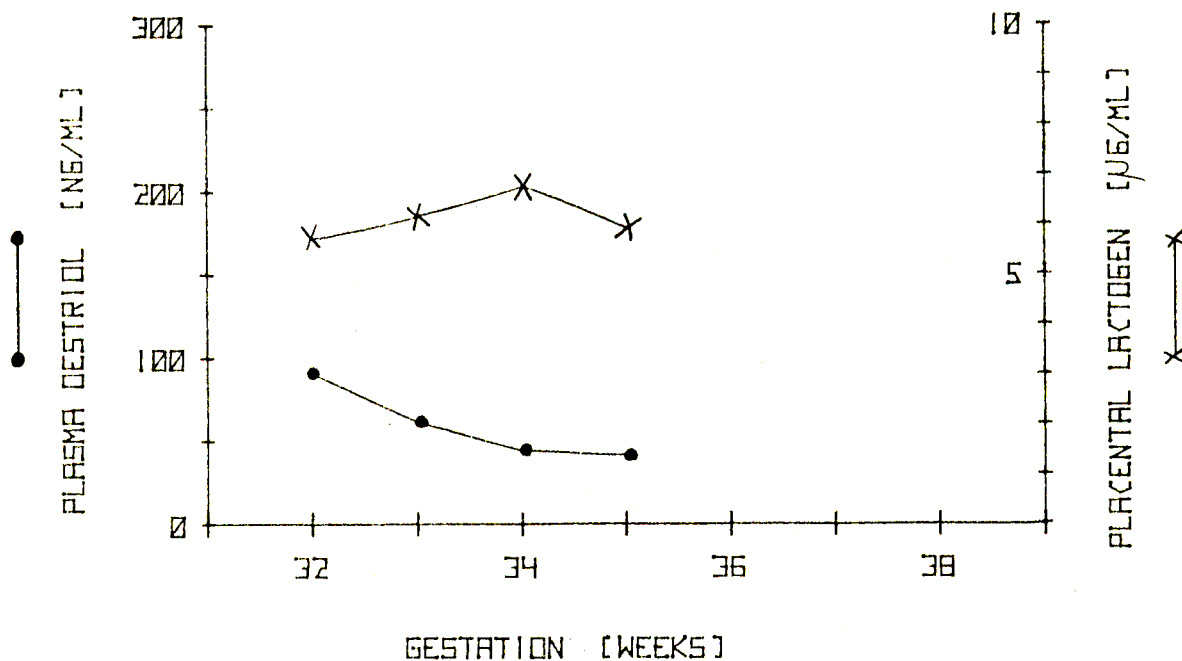
THE BIPARIETAL DIAMETERS

Biparietal diameter measurements of both twins were measured

on 295 occasions at or after 30 weeks gestation.   In one

patient measurement of the biparietal diameter of one of

the twins failed on all 3 occasions on which it was

attempted due to fetal head position and motility.

TIMING OF FINAL BIPARIETAL DIAMETER MEASUREMENT

Seventy eight patients had the final biparietal diameters

measured within 1 week of delivery, the remaining 51 patients

had the final measurement within 2 weeks of delivery.

/The approach ....

The approach to the analysis of the ultrasonically measured biparietal diameters was as follows:-

1. The correlation between ultrasonically measured biparietal diameter and actual biparietal diameter.

2. The biparietal diameter growth rate for all the twins.

3. The growth rates of the larger and the smaller biparietal diameters.

4. The growth rate of the biparietal diameter of the growth retarded twins.

5. The relationship between the growth rate of the biparietal diameter of the growth retarded twins and the growth rates of a) singletons b) the mean for normally grown twins and c) - 1.S.D. for normally grown twins.

6. The weekly incremental growth rate of the growth retarded twins, normally grown twins and singletons.

7. The final biparietal diameter difference and neonatal weight difference.

8. Divergent biparietal diameter growth rates.

9. Head circumference in relation to final biparietal diameter difference and neonatal weight disparity.

THE CORRELATION BETWEEN BIPARIETAL DIAMETER AS MEASURED
BY ULTRASOUND AND THE ACTUAL BIPARIETAL DIAMETER

In one patient the actual biparietal diameters were not
measured, this was the patient with an abruption of the
placenta at 31 weeks gestation.

The correlation was therefore made on the 77 patients who
had both ultrasound measurement within a week of delivery
and actual measurement.   The 51 patients who did not have
biparietal diameters measured ultrasonically within a week
of delivery were considered separately because it was felt
that the growth that would occur in the biparietal diameter
in a period of longer than a week would not give a true
correlation.

In 19 out of 154 babies the actual biparietal diameter was
less than the ultrasonically measured biparietal diameter
with errors as follows:-

Error 1 millimetre   -   11
Error 2 millimetres   -   5
Error 3 millimetres   -   3

In the remaining 135 babies the actual biparietal diameter
differed from the ultrasonically measured biparietal
diameter as follows:-

No difference   -   85
1 millimetre difference   -   27
2 millimetres difference -   18
3 millimetres difference -   5

When the correlation was made in terms of the difference
in biparietal diameter as measured by ultrasound and the
actual difference in biparietal diameters the results
were as follows:-

No difference between the two measurements   - 38

1 millimeter difference between the two
    measurements   - 28

2 millimetres difference between the two
    measurements   - 10

3 millimetres difference between the two
    measurements   -   1

Similar analysis on the 57 patients who had ultrasonically
measured biparietal diameters within 2 weeks of delivery
were as follows:-

No difference   - 18
1 millimetre difference - 26
2 millimetres difference -   7

In the pregnancies where one or both babies were growth
retarded the smaller actual biparietal diameter occurred
in the smaller baby on every occasion.

Measurements of both biparietal diameters were carried out
on 295 occasions at gestations varying from 30 weeks to 40
weeks.   Assessments prior to 30 weeks were performed on
46 patients for initial diagnosis, these were not
repeated until 30 weeks gestation.

The results of the biparietal diameters for gestation from 30 weeks onwards of all the twins are shown in Figure 7 in relation to Campbell and Newmans[1] figures for singletons (tabulated data in appendix IV).

Fig. 7

THE RATE OF BIPARIETAL DIAMETER GROWTH OF THE TWINS COMPARED TO RATES FOR SINGLETONS (CAMPBELL and NEWMAN[1])
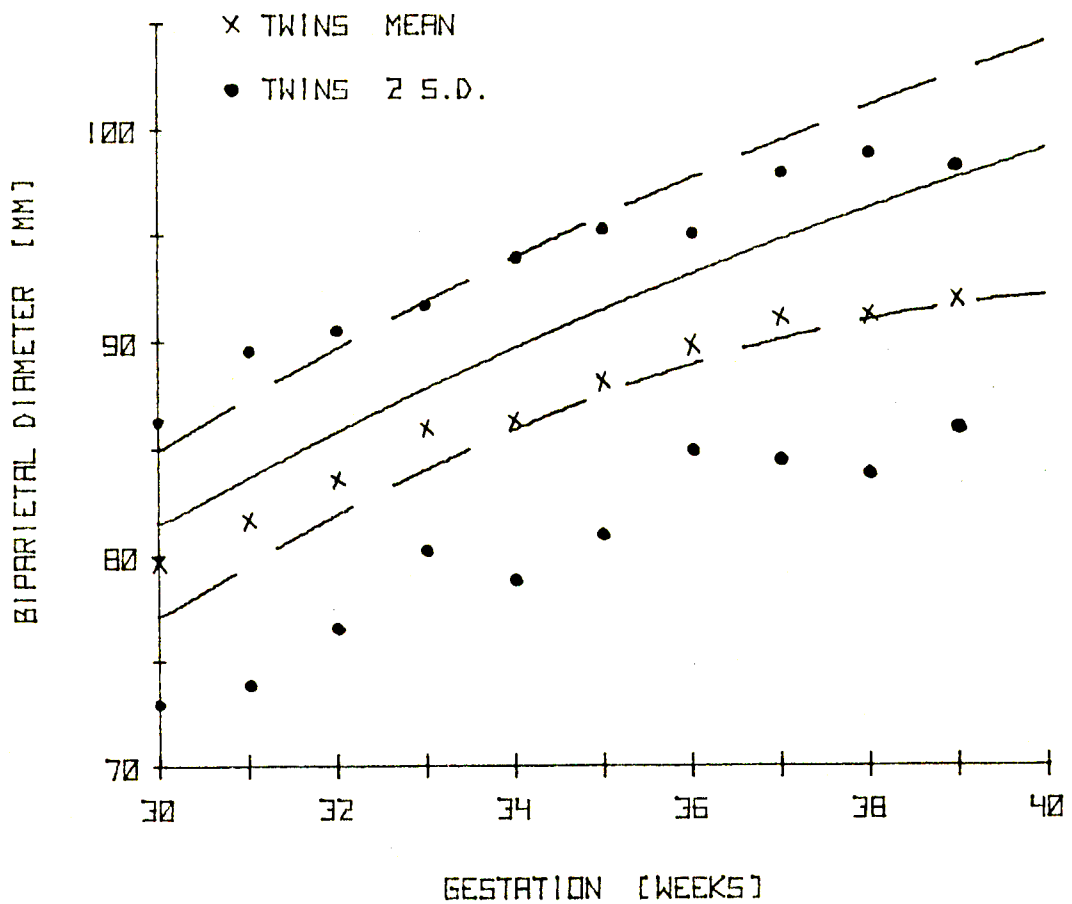
The mean biparietal diameter of the twins is the same as the value for -2 S.D. for singletons from 34 weeks gestation but the S.D. at each gestation is greater than that for singletons.

The mean growth rate of the larger biparietal diameter and the smaller biparietal diameter is shown in relation to the mean for singletons in Figure 8.

Fig. 8

THE MEAN GROWTH RATE OF THE LARGER BIPARIETAL DIAMETER AND THE SMALLER BIPARIETAL DIAMETER COMPARED TO THE MEAN FOR SINGLETONS'
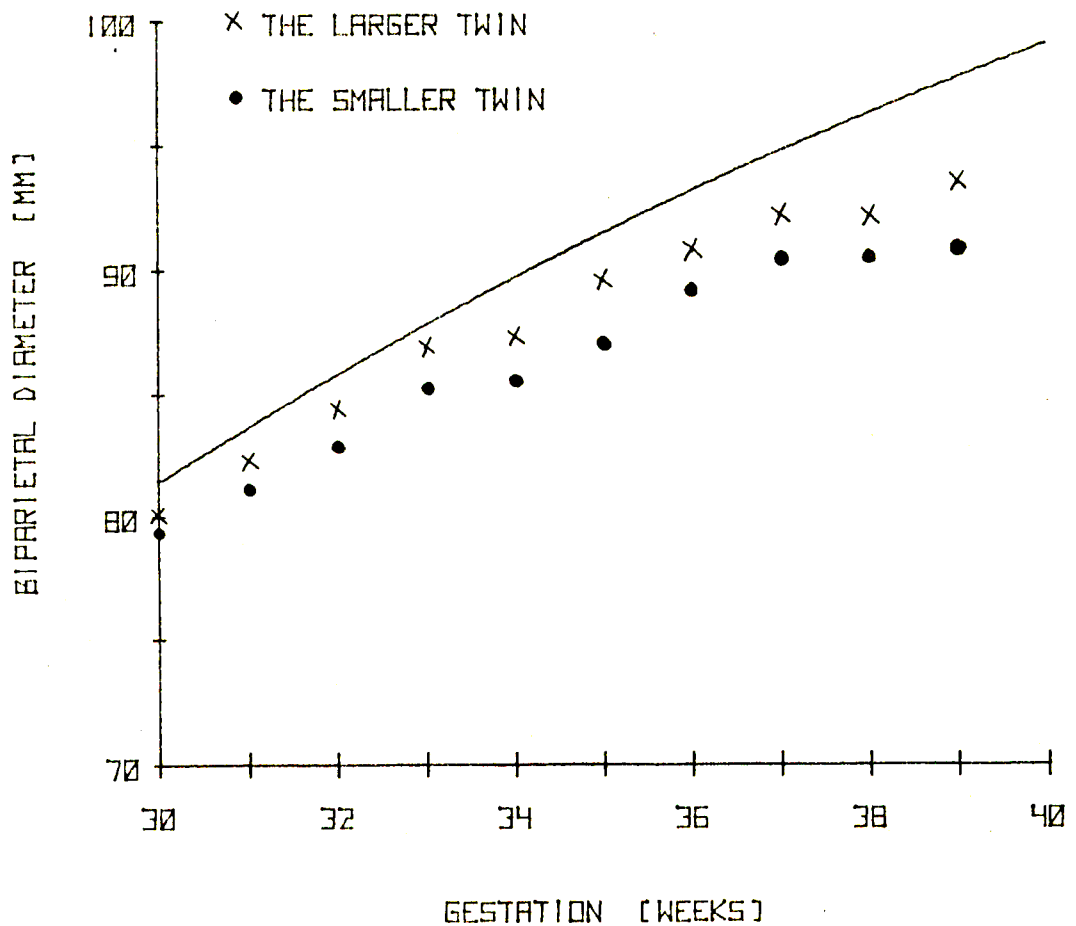
BIPARIETAL DIAMETER GROWTH AND GROWTH RETARDATION

It would be logical if the mean biparietal diameter growth

rate in the pregnancies with single or dual growth

retardation was lower than the mean where neither fetus

was growth retarded.

These means are shown in Figure 9 (tabulated data in

appendix IV) in relation to the means for singletons.

Fig. 9

MEAN BIPARIETAL DIAMETERS OF PREGNANCIES WITH SINGLE OR
DUAL GROWTH RETARDATION COMPARED TO THOSE OF THE PREGNANCIES
WHERE NEITHER BABY WAS GROWTH RETARDED AND THOSE OF SINGLETON'S
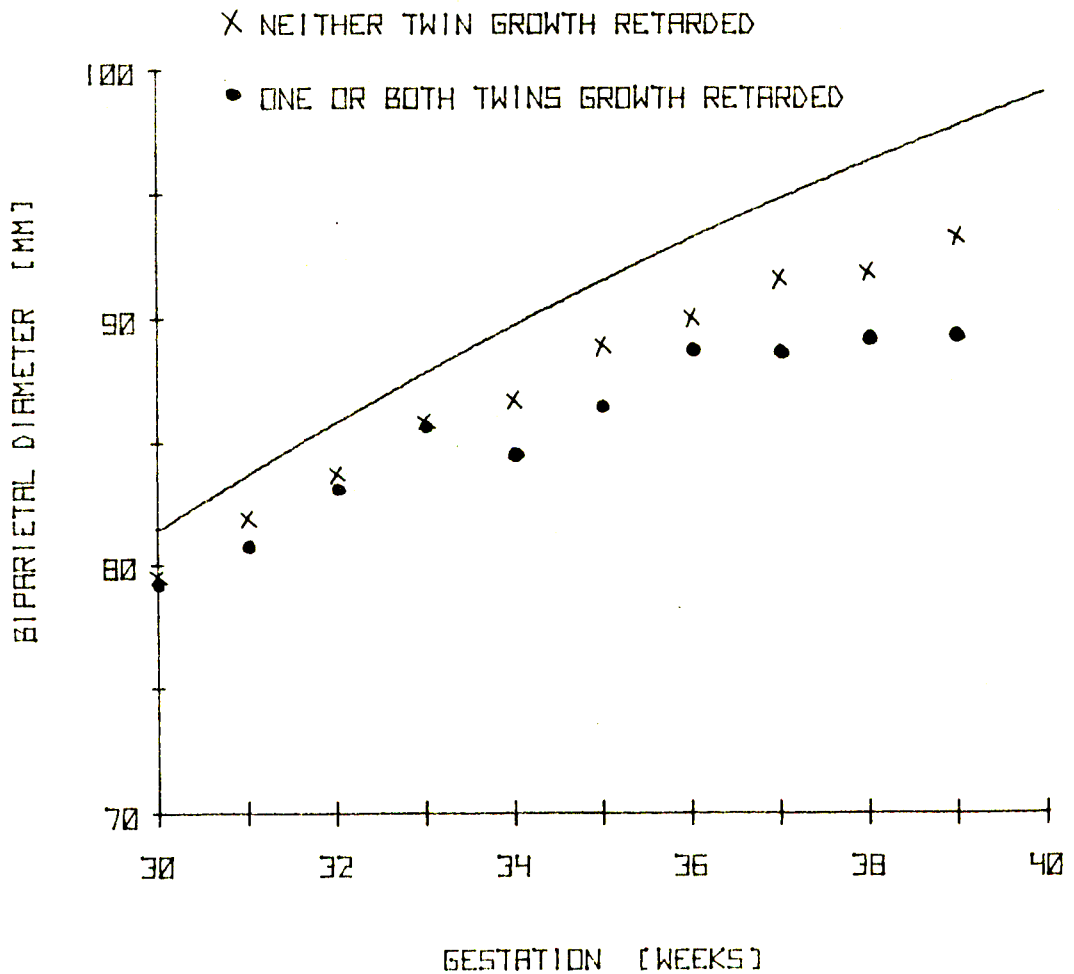
/The difference .....

The difference between these growth rates is not marked because the results for the pregnancies where growth retardation is occurring include the 29 pregnancies in which only one fetus was growth retarded.

To ascertain whether serial biparietal diameters are of value in the diagnosis of growth retardation the mean rate for all the growth retarded babies is compared to the mean and $\pm$ 1 S.D. for twins where neither baby was growth retarded in Figure 10 and Singletons in Figure 11 (tabulated data in appendix IV).

The biparietal diameter of the growth retarded twin in a pregnancy where only one fetus was growth retarded was taken as the smaller biparietal diameter on the basis that the smaller biparietal diameter occurred in the smaller twin on every occasion in this series.

Fig. 10

THE MEAN BIPARIETAL DIAMETER GROWTH OF THE GROWTH RETARDED TWINS COMPARED TO THAT OF THE PREGNANCIES WHERE NEITHER TWIN WAS GROWTH RETARDED
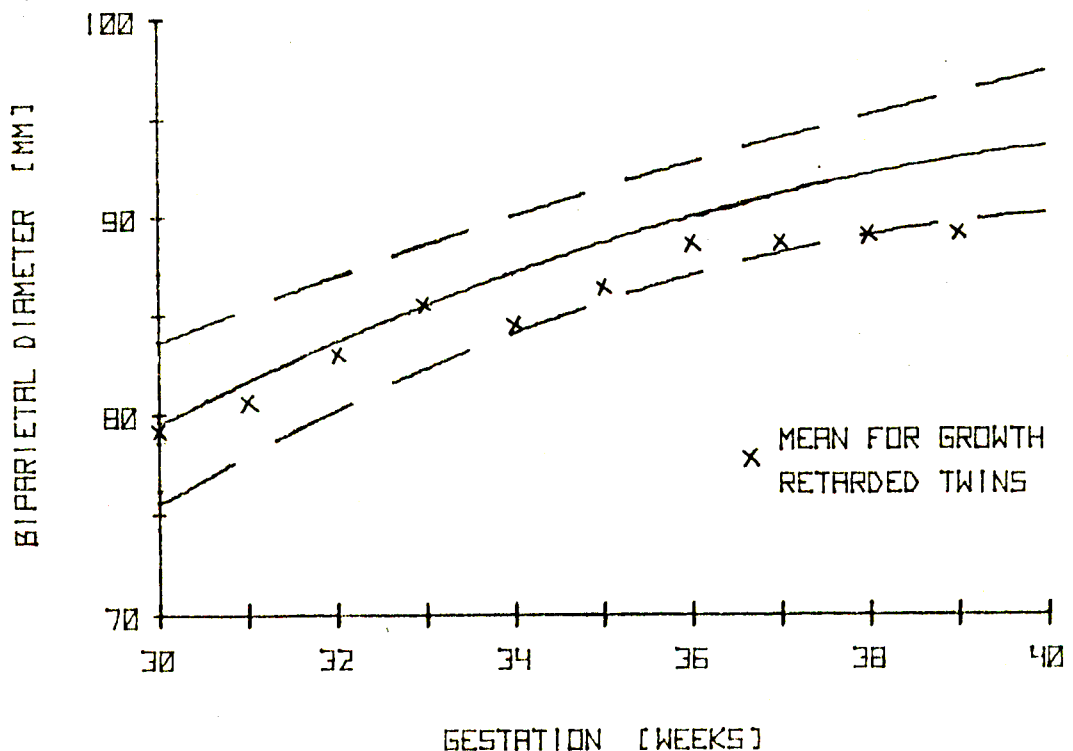
Fig. 11

THE MEAN B.P.D. GROWTH OF THE GROWTH RETARDED TWINS
COMPARED TO THAT OF SINGLETONS
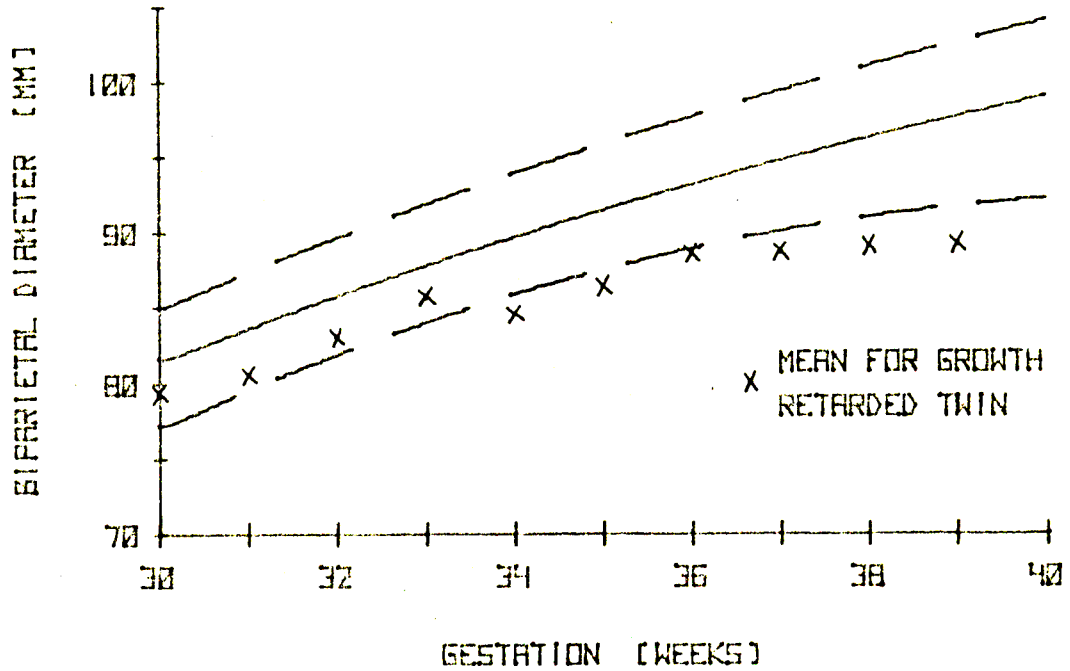
THE RELATIONSHIP BETWEEN INDIVIDUAL TWIN BIPARIETAL
DIAMETER GROWTH RATE AND FETAL GROWTH RETARDATION

In order to determine whether the growth rates of individual
biparietal diameters would be of value in the diagnosis of
individual growth retardation the final (ultrasonic)
biparietal diameter was related to 2 S.D. for singletons,
the mean for twin pregnancies where both babies were
normally grown and -1 S.D. for this latter group. The
results are shown in Table VI.

This analysis excludes the one pregnancy where there was
failure to measure one biparietal diameter in addition to
the 2 pregnancies with a fetus papyraceous.

TABLE VI

THE RELATIONSHIP OF THE FINAL (ULTRASOUND) BIPARIETAL
DIAMETER TO -2 S.D. FOR SINGLETONS, MEAN FOR NORMALLY
GROWN TWINS AND -1 S.D. FOR NORMALLY GROWN TWINS IN THE
GROWTH RETARDED BABIES AND THE NORMALLY GROWN BABIES

| | THE FINAL BIPARIETAL DIAMETER COMPARED TO SINGLETON STANDARD | |
	≤-2 S.D.	>-2 S.D.
Growth Retardation	35	10
No Growth Retardation	80	133

p = <0.001

| | THE FINAL BIPARIETAL DIAMETER COMPARED TO THE MEAN FOR NORMALLY GROWN TWINS | |
	≤MEAN	>MEAN
Growth Retardation	38	7
No Growth Retardation	96	117

p = <0.001

| | THE FINAL BIPARIETAL DIAMETER COMPARED TO -1 S.D. FOR NORMALLY GROWN TWINS | |
	≤-1 S.D.	>-1 S.D.
Growth Retardation	22	23
No Growth Retardation	30	183

p = <0.001

The differences in distribution in the three analyses are
all highly significant (p = <0.001).

The predictive value of these analyses in relation to
individual growth retardation is analysed in Table VII.

TABLE VII

THE PREDICTIVE VALUE OF THE ULTRASONIC BIPARIETAL DIAMETER
(WITHIN TWO WEEKS OF DELIVERY) WHEN RELATED TO THE MEAN
FOR NORMALLY GROWN TWINS, -1 S.D. NORMALLY GROWN TWINS AND
-2 S.D. SINGLETONS'

		FINAL BIPARIETAL DIAMETER OF THE GROWTH RETARDED TWINS	
-2 S.D.	SINGLETONS	35/115	(30%)
MEAN	TWINS	38/134	(28%)
-1 S.D.	TWINS	22/52	(42%)

Interpretation of ultrasonically assessed biparietal diameter
measurements is dependent on an exact knowledge of gestation
whereas growth rate is far less so.   The growth rates as
calculated from mean values for gestation are shown in
Table VIII (tabulated data in appendix IV).

TABLE VIII

THE GROWTH RATE OF SINGLETON'S, NORMALLY GROWN TWINS
AND GROWTH RETARDED TWINS

MEAN GROWTH RATE (mm/week)

GESTATION PERIOD	SINGLETONS	ALL TWINS	NEITHER TWIN GROWTH RETARDED	GROWTH RETARDED TWINS
30 - 33 weeks	2.43	2.30	2.40	1.97
33 - 36 weeks	1.53	1.3	1.63	1.3
36 - 40 weeks	1.40	0.77	0.9	0.57

It can be clearly seen that the actual growth rates of the
twins are lower in the third trimester than those of
singletons as found by Campbell and Newman[1].

To determine the predictive value of the growth rates as measured by ultrasound, the growth retarded twins were compared with the normally grown twins using the parameter of a growth rate after 33 weeks gestation of equal to or less than 1 millimetre a week.

In addition to the two pregnancies with a fetus papyraceous and the one pregnancy where biparietal diameter could not be measured 22 pregnancies were excluded because 2 or more ultrasonic assessments were not performed at or after 33 weeks gestation. The results are shown in Table IX.

TABLE IX

BIPARIETAL DIAMETER GROWTH RATE OF EQUAL TO OR LESS THAN ONE MILLIMETRE PER WEEK AFTER 33 WEEKS GESTATION AND FETAL GROWTH RETARDATION

	BIPARIETAL DIAMETER GROWTH (mm/week)	
	$\leqslant 1.0$	>1.0
Growth Retardation	25	14
No Growth Retardation	46	130

There is a significant difference in distribution between thw two groups ($p = <0.01$).

When the growth rate is equal to or less than 1.0 millimetres per week the risk of a fetus being growth retarded is 35% and 10 out of 28 growth retarded fetuses (35%) would not

have been predicted.

FINAL BIPARIETAL DIAMETER DIFFERENCE (ULTRASONIC) AND NEONATAL WEIGHT DIFFERENCE

The difference between the biparietal diameters was assessed in terms of predicting weight difference and the results are shown in Table X.

TABLE X

THE DIFFERENCE IN ULTRASONICALLY MEASURED BIPARIETAL DIAMETERS WITHIN TWO WEEKS OF DELIVERY AND THE WEIGHT DIFFERENCE OF THE TWINS

BIPARIETAL DIAMETER DIFFERENCE (mm)	WEIGHT DIFFERENCE (kg)	S.D.	S.E.
<3 (N = 83)	0.21	0.16	0.02
3 - 5 (N = 37)	0.56	0.31	0.05
>5 (N = 9)	0.73	0.42	0.14

These results are highly significant ($p = <0.001$), the greater the difference in biparietal diameter the greater the expected weight discrepancy between the twins.

FINAL BIPARIETAL DIAMETER DIFFERENCE AND THE INCIDENCE OF FETAL GROWTH RETARDATION

The relationship between the biparietal diameter difference and the incidence of growth retardation is shown in Table XI.

TABLE XI

BIPARIETAL DIAMETER DIFFERENCE (ULTRASONIC) AND THE
INCIDENCE OF SINGLE OR DUAL GROWTH RETARDATION

BIPARIETAL DIAMETER DIFFERENCE (mm)	GROWTH RETARDATION	NO GROWTH RETARDATION
<3	14	69
3 - 5	17	20
>5	6	3

There is a highly significant relationship between a final

biparietal diameter difference of 3 or more millimetres and

the incidence of single or dual growth retardation (p = <0.001).

When this difference occurred 50% of the pregnancies had

fetal growth retardation as gainst 17% when the difference

was less than 3 millimetres.

DIVERGING BIPARIETAL DIAMETER GROWTH RATES AND THE INCIDENCE
OF FETAL GROWTH RETARDATION

Divergent biparietal diameter growth rates were defined

as an increase in difference of equal to or more than

3 millimetres occurring over a 2 week period or longer.

The results are shown in Table XII.

TABLE XII

DIVERGENT BIPARIETAL DIAMETER GROWTH RATES AND SINGLE OR
DUAL GROWTH RETARDATION

BIPARIETAL DIAMETER GROWTH RATE	GROWTH RETARDATION	NO GROWTH RETARDATION
Divergent	24	7
Equal	10	77

In addition to the 2 pregnancies with a fetus papyraceous and the pregnancy where there was failure to measure one of the biparietal diameters 11 patients were excluded because ultrasonic examination was only carried out on one occasion.

The difference in distribution is highly significant (p = <0.001).   When the difference is divergent the risk of fetal growth retardation is 77% and when the difference is static the risk is 9%.

FINAL BIPARIETAL DIAMETER DIFFERENCE (ULTRASONIC) AND DIFFERENCE IN NEONATAL HEAD CIRCUMFERENCE

In order to determine whether a final biparietal diameter difference of 3 or more millimetres occurring with neither baby growth retarded was due to head shape rather than head volume difference, the final biparietal diameter difference was related to the difference in head circumference in the pregnancies with fetal growth retardation and those without. The results are shown in Table XIII.

TABLE XIII

FINAL ULTRASONIC BIPARIETAL DIAMETER DIFFERENCE AND THE DIFFERENCE IN HEAD CIRCUMFERENCE

| | | HEAD CIRCUMFERENCE DIFFERENCE (cm) | |
		GROWTH RETARDATION	NO GROWTH RETARDATION
BIPARIETAL	Mean	4.17	2.89
DIAMETER	SD	1.08	1.6
DIFFERENCE	SE	0.23	0.33
⩾3.0 mm	N	23	23

There is a significant difference between the two means
(p = <0.01) which is strongly suggestive that when there
is a difference in biparietal diameter and neither baby
is growth retarded that the difference is attributable to
head shape rather than volume.

WEIGHT DIFFERENCE AND DIFFERENCE IN HEAD CIRCUMFERENCE

Weight discrepancy in a pair of twins might be attributable
to a differing genetic growth potential or intra-uterine
compromise of one fetus.   If the difference in weight is
attributable to fetal compromise it would be expected that
the difference in head circumference in this group would
be less than the difference in the group with a differing
growth potential because of the head sparing effect in
the initial stages of fetal compromise of placental
vascular aetiology.

To determine whether this hypothesis holds the pregnancies
with a weight difference of 0.5 kilograms or more were
compared in terms of head circumference difference.
The results are shown in Table XIV.

TABLE XIV

WEIGHT DISPARITY OF EQUAL TO OR MORE THAN 0.5 kg AND THE
DIFFERENCE IN HEAD CIRCUMFERENCE.

| | | HEAD CIRCUMFERENCE DIFFERENCE (cm) | |
		GROWTH RETARDATION	NO GROWTH RETARDATION
WEIGHT	MEAN	4.59	4.00
DIFFERENCE	S.D.	0.83	0.93
>0.5 kg.	S.E.	0.20	0.23
	N	18	16

There is no significant difference between the two means.

DISCUSSION

In discussion regarding the biochemical tests of placental function reference is made only to the pregnancies with one or both babies growth retarded as there was no absolute correlation between any of the investigations and a low combined fetal weight where the risk of single or dual growth retardation is 57%.

Only 100% predictions of this degree of risk would be of value particularly if there were no false positive predictions.

THE BIOCHEMICAL PLACENTAL FUNCTION TESTS

The placenta has many functions but in this context the function to be considered is that of nutrition and oxygenation of the individual fetus.

Biochemical tests of placental function are a very indirect method of assessing this particular function and even in singleton pregnancies there is a large overlap between truly predictive and falsely predictive results.

In a twin pregnancy with compromise of only one fetus the predictive value of these biochemical tests might be expected to be less than the value in singleton pregnancies because a fall in level or low levels, attributable to one fetus or placenta, could be masked by increasing levels from the other fetus or placenta.

THE CHOICE OF THE BIOCHEMICAL TESTS

Plasma oestriol as measured by radioimmunoassay was chosen for the following reasons:-

1. The involvement of the placenta, the fetal adrenal and the fetal liver, in the metabolic pathway for the production of oestriol in maternal plasma.

2. The small (6%) methodological error involved in radioimmunoassay.

3. Unlike urinary oestriol excretion plasma oestriol levels are not influenced by glomerular filtration rate with its diurnal variation.

4. The diurnal variation in plasma oestriol levels is small in ambulant patients[2].

5. The ready availability of the assay in the chemical Pathology laboratory at King Edward VIII Hospital.

Placental lactogen as measured by radioimmunoassay was chosen for the following reasons:-

1. MacMillan et al[3] demonstrated a lower concentration of placental lactogen in the placentae of low birthweight and birth length twins when compared to their normally grown co-twins suggesting that placental lactogen may have an influence on fetal growth that is independent of general placental function in determining the weight of the babies.

2. The small (6%) methodological error.

3. The ready availability of the assay.

NORMAL LEVELS OF PLASMA OESTRIOL AND PLACENTAL LACTOGEN

No reference could be found for normal levels of placental lactogen in twins and the only reference to plasma oestriol level in twins was that of Masson[4] although 2 references could be found on urinary oestriol levels in twin pregnancy[5] [6].

It was felt that the normal levels for these assays should be established for this population group and the levels from 30 to 39 weeks gestation for both assays are shown in Figures 6 and 7 in Chapter II (tabulated data in appendix I).

The plasma oestriol values for the series are compared to Massons[4] figures for twin and singletons and McCourt et al[4] figures for singletons in Table XV. The values of placental lactogen in the series are compared to Letchworth and Chard's[7] values for singletons in Table XVI.

It can be seen that with plasma oestriol the range of values for gestation is greater in twins than in singletons and set at a higher level whereas with placental lactogen levels the range is very much the same but set at a higher level than twins.

In twins the mean placental lactogen levels plateau at 34 - 35 weeks with a slight fall thereafter whereas the plateau in singleton pregnancies occurs at 37 - 38 weeks.

The difference in the plasma oestriol levels in twins between this series and Masson's[4] confirms the necessity for laboratories to determine their own standards.

TABLE XV

PLASMA OESTRIOL LEVELS (ug/ml) IN TWINS AND SINGLETONS

	GESTATION (WEEKS)		
	30	34	38
Twins - This series (10th - 90th centiles)	73 - 163	97 - 339	154 - 415
Twins[4] (-2 S.D. - +2 S.D.)	86 - 154	132 - 198	183 - 343
Singletons[4] (-2 S.D. - +2 S.D.)	54 - 130	94 - 166	95 - 205
Singletons[2] (5th - 95th centiles)	38 - 240	49 - 300	82 - 400

TABLE XVI

PLACENTAL LACTOGEN LEVELS (ug/ml) IN TWINS AND SINGLETONS

	GESTATION (WEEKS)		
	30	34	38
Twins - This Series (10th - 90th centiles)	5.7 - 9.7	5.9 - 10.9	5.4 - 11.2
Singletons[7] (-2 S.D. - +2 S.D.)	3.2 - 7.0	3.5 - 8.8	4.0 - 10.2

The Clinical value of the Biochemical tests of Placental Function

Duff and Brown[6] have questioned the value of urinary oestriol in twin pregnancy on the basis that in their series in five twin pregnancies in which a stillbirth occurred, four had 24 hour urinary oestrogen levels above the 10th centile for twins.

Although no reference can be found to plasma oestriol levels in compromised twin pregnancies the author would agree that the actual level of oestriol production has little predictive value (Table I) for either antepartum fetal death or single or dual growth retardation.

The predictive value of plasma oestriol is dependant on the trend rather than levels.

When plasma oestriol levels were static or falling over 3 consecutive weekly assessments the risk of that particular pregnancy having one or both babies growth retarded was 60% compared to an overall risk of 28.5%.   All 4 of the antepartum deaths attributable to growth retardation showed an abnormal trend in plasma oestriol levels.

The trend in placental lactogen levels had a similar predictive value in that falling placental lactogen levels indicated a 60% risk of single or dual growth retardation but this trend occurred in more of the pregnancies with fetal growth retardation (18) than an abnormal plasma oestriol trend (14).

It has been suggested by Letchworth and Chard[7] that actual values of placental lactogen in singletons are predictive of fetal distress which is intimately linked with growth compromise in many pregnancies.

This same premise holds true in twin pregnancies where 19 of the pregnancies with a growth retarded fetus had 2 or more values recorded as equal to or less than 8.0 ug/ml

after 30 weeks gestation, including the 4 relevant antepartum deaths.

Although this abnormal parameter occurred more frequently than a falling trend of placental lactogen the false positive predictive rate was higher as abnormally low levels occurred in 44 pregnancies of which only 19 (44%) had fetal growth retardation.

When values of equal to or less than 7.0 µg/ml were taken as being abnormal the frequency of the abnormal finding in pregnancies with fetal growth retardation became unacceptably low (appendix IV).

It would appear that placental lactogen assay is of greater benefit than plasma oestriol assay in that the frequency of occurrence of an abnormal parameter is higher in the pregnancies with growth retardation although the predictive value of the trend is the same for each assay.

The pregnancies were analysed individually to determine whether abnormalities of plasma oestriol and placental lactogen occur together in pregnancies with fetal growth retardation. It is apparent that the 2 assays are not mutually exclusive in that when the plasma oestriol trend is static or falling and either the placental lactogen levels are falling or low the risk of single or dual growth is 23 out of 33 or (70%), 23 out of 37 pregnancies (62%) with growth retardation of one or both fetuses would have been diagnosed and 10 out of 93 pregnancies (11%) would

have been incorrectly predicted as having single or dual growth retardation.

THE BIPARIETAL DIAMETERS

With combined A + B scan an accurate reproduceable measurement can be made on each fetus.

The measurements can be allotted to an individual fetus if the difference between the two values is greater than the methodological error. The larger measurement can then be said to be occurring on the same twin on consecutive measurements because if this was not so one would have to either postulate an actual decrease in biparietal diameter of the larger head or a non-physiological increase in the biparietal diameter of the smaller head.

The difference between actual biparietal diameter and the ultrasonic assessment of biparietal diameter within a week of delivery was assessed and a difference of 3 millimetres between the measurements was found in only 8 out of 154 babies. From these figures the methodological error was assessed as 2 millimetres when the difference between 2 biparietal diameters was being assessed.

THE BIPARIETAL DIAMETER GROWTH RATE OF THE TWINS

The biparietal diameters of the twin pairs were assessed on 295 occasions between 30 and 40 weeks gestation giving 590 recordings of biparietal diameter of individual twins. The mean and 2 standard deviations are compared with Campbell and Newman's figures for singletons (430 measurements at the corresponding gestations) in Figure 7.

The trend is for the mean to deviate from the mean of singletons soon after 30 weeks and to equate to -2 S.D. for singletons from 35 - 36 weeks. This terminal flattening in biparietal diameter growth rate is indicative of a general trend towards placental vascular insufficiency. (Campbell[8]) rather than diminished fetal growth potential.

When the mean growth rate of the larger biparietal diameter is compared to the mean growth rate of the smaller biparietal diameter (Figure 8) it is apparent that the larger twin grows according to the mean for singletons until 34 to 35 weeks gestation whereas the smaller twin is deviating from this mean as early as 31 to 32 weeks gestation.

The difference between the biparietal diameter growth rate of twins without growth retardation and with growth retardation is clearly shown by comparing the means of biparietal diameter growth rate of the two groups (Figure 9). When the mean for the growth retarded twins is compared to the mean and 2 S.D. for all the twins (Figure 10) it can be clearly seen that the growth retarded twins consistently grow more slowly than twins in general from as early as 30 to 32 weeks gestation.

When the mean for growth retarded twins is compared to the figures for singletons the shape of the curve flattens at 35 to 36 weeks and from then on is lower than -2 S.D. for singletons with little or no growth (Figure 11).

Comparisons with singletons in terms of actual measurements may not be valid as the equivalent singleton figures for the local population group have not been established, though comparisons of shapes of curves may indicate underlying pathological growth patterns.

BIPARIETAL DIAMETER GROWTH RATE AND THE PREDICTION OF GROWTH RETARDATION

There are significant differences between the final biparietal diameter measurement in the growth retarded babies and the babies without growth retardation as can be seen in Table VI.

The predictive value is limited to a finding of a biparietal less than -1 S.D. for normally grown twins which was found on 52 occasions and 22 of these babies were growth retarded (42%) compared to an overall risk of fetal growth retardation of 17%.

THE WEEKLY INCREMENTAL BIPARIETAL DIAMETER GROWTH RATE AND GROWTH RETARDATION

The mean weekly growth rate of the twins is less than that of singletons from 30 weeks onwards.

In the growth retarded twins the mean weekly rate falls to 1.5 millimetres or less from 33 weeks gestation. Using the parameter of a growth rate after 33 weeks of 1.0 millimetre or less there is a significant difference between the normally grown twins and growth retarded twins.

/Despite the ....

Despite the fact that this pattern was found in 71 babies of whom 25 (35%) were growth retarded this represents an increase in risk of individual growth retardation from 17% to 35%.

FINAL BIPARIETAL DIAMETER DIFFERENCE AND GROWTH RETARDATION

Using 2 millimetres as the methodological error a difference was defined as being present when it was 3 millimetres or more. There was a highly significant correlation between the frequency of a difference of 3 millimetres or more measured ultrasonically within 2 weeks of delivery between the pregnancies with fetal growth retardation and those without (Table XI). Of the 37 pregnancies with single or dual growth retardation 23 (62%) had this difference.

This difference occurred in 56 patients of whom 23 (50%) had growth retarded pregnancies, although a difference of 3 millimetres or more occurred in 23 out of 92 pregnancies (25%) where neither fetus was growth retarded.

This relationship between a difference in final biparietal diameter and the incidence of fetal growth retardation has been reported previously[9][10].

DIVERGING BIPARIETAL DIAMETER GROWTH RATE AND FETAL GROWTH RETARDATION

Divergent growth rates are defined as a difference that increases by 3 millimetres or more over a period of 2 or more weeks.

There is a highly significant difference between the incidence of divergent diameters in pregnancies with fetal growth retardation and those with normally grown twins as can be seen in Table XII.

In the 34 pregnancies with fetal growth retardation in which this parameter could be assessed 24 (71%) showed divergent biparietal diameter growth rates.

Divergence occurred in 31 pregnancies of which 24 (77%) had single or dual growth retardation.

Divergence occurred in 7 out of 77 pregnancies (9%) when neither fetus was growth retarded.

This high correlation between divergence and fetal growth retardation with the lesser correlation between final biparietal diameter difference raises the possibility that when the biparietal diameters prior to delivery differ by 3 millimetres or more and neither fetus is growth retarded the difference might be attributable to head shape rather than head volume.

Table XIII shows the relationship between head circumference difference and biparietal diameter difference in the pregnancies with fetal growth retardation and those where neither fetus was growth retarded.

The head circumference difference between a pair of twins with different biparietal diameters is significantly lower when neither baby is growth retarded which supports

strongly the hypothesis that the difference is attributable to head shape in this group rather than volume.

FINAL BIPARIETAL DIAMETER DIFFERENCE AND WEIGHT DISCREPANCY

The improtance of this prediction of weight discrepancy is twofold.

Firstly that a marked discrepancy might indicate the need to do dual sac amniocentesis for the determination of lung surfactant levels[11] and secondly in terms of the delivery when the second twin is much larger than the first.

Table X shows the highly significant relationship between a final biparietal diameter difference and an increasing weight discrepancy.

WEIGHT DIFFERENCE AND HEAD CIRCUMFERENCE DIFFERENCES

A difference in head circumference and body weight between a pair of twins might be attributable to differing growth potentials or actual growth compromise of one fetus. If this hypothesis holds the head circumference might be relatively larger in the compromised fetus because of the head sparing effect in the early stages of compromise induced by a reduced placental vascular circulation.

There was no significant difference between pregnancies with fetal growth retardation and those without when the head circumference difference is related to a difference in body weight of equal to a greater than 0.5 kilograms.

/This does ....

This does not negate the hypothesis of head sparing effect but suggests that when actual fetal compromise occurs it commences in the second trimester or early third trimester and as the degree of compromise increases the head sparing effect is lost.

CONCLUSIONS

THE BIOCHEMICAL PLACENTAL FUNCTION TESTS

Weekly assay of Plasma Oestriol and Placental Lactogen levels are of value in twin pregnancy in the prediction of single or dual fetal growth retardation and consequently antepartum death attributable to this cause.

The abnormal parameters are:-

1. A plasma oestriol level that is static or falling by 10 ug/ml per week over at least 3 assays.

2. A placental lactogen level falling by 0.5 ug/ml per week over at least 3 assays.

3. Two or more placental lactogen values of equal to or less than 8.0 ug/ml after 30 weeks gestation.

The two investigations are not mutually exclusive in that if an abnormality occurs in both plasma oestriol and placental lactogen the predictive rate is high and the false positive rate is low.

If only one assay is available placental lactogen has the advantage that the abnormalities occur in more of the pregnancies with fetal growth retardation.

With one assay only the false positive prediction rate is high.

BIPARIETAL DIAMETER MEASUREMENTS

The mean growth rate of the biparietal diameters of twins is less than the mean for singletons from soon after 30 weeks gestation and equates with minus 2 standard deviations for singletons from 34 to 35 weeks onwards.

There is a tendency for one of a pair of twins to have a diminished biparietal diameter growth rate compared to its co-twin, from as early as 31 to 32 weeks gestation.

The weekly incremental growth rate is lower than that of singletons from 33 weeks gestation a growth rate of equal to or less than 1.0 millimetre a week gives approximately double the risk of individual growth retardation.

When the biparietal diameters measured within two weeks of delivery differ by 3 millimetres or more there is a significant increased risk of one or both babies being growth retarded.

If the difference between two biparietal diameters is increasing over 2 or more weeks the risk of single to dual fetal growth retardation is markedly increased with a low false positive rate.

A maintained static difference is suggestive of a difference in head shape rather than head volume.

Weight discrepancy between a pair of twins can usually be predicted by a disparity between biparietal diameters. The greater the disparity the greater the weight difference.

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CHAPTER VI

SCORING SYSTEMS FOR THE DIAGNOSIS OF FETAL

GROWTH RETARDATION

INTRODUCTION

SCORING SYSTEMS AND PREDICTIVE VALUES

　　　1.　Factors ascertainable at one visit.

　　　2.　Clinical factors after 3 or more weekly visits.

　　　3.　All factors after 3 or more weekly visits.

DISCUSSION

Discriminant analysis was applied to all the factors considered in Chapters IV and V that were found individually to have a significant relationship with a twin pregnancy where one or both babies were growth retarded.

The factors that were considered to be predictive of individual or dual fetal growth retardation and were consequently analysed were the following:-

1. Maternal age - greater than 30 years.

2. Parity - either primipara or women of a parity of more than 3.

3. Maternal Height - less than the mean (154 cm).

4. Obstetric History - a history of stillbirth or neonatal death.

5. Incremental weight change - weight static or loss over 3 visits at weekly intervals.

6. Incremental girth change - an increase of less than 1.0 centimetres per week or loss over 3 visits at weekly intervals.

7. Height to weight ratio - in 3 sub-groups <2.0, 2.0 - 2.5, >2.5.

8. The product of height to weight ratio and girth in 3 sub-groups <200, 200 - 240, >240.

9.   Static or falling levels of plasma oestriol over
     3 weekly assessments.

10. Falling levels of placental lactogen or 2 or more
     values of equal to or less than 8.0 ug/ml over 3
     assessments at weekly intervals.

11. An abnormality in both plasma oestriol values and
     placental lactogen values.

12. Divergent biparietal diameter growth rates.

13. Biparietal diameter disparity of 3 or more millimetres
     within 2 weeks of delivery.

14. One or both biparietal diameters growing at 1.0
     millimetre or less a week after 32 weeks gestation.

THE DISCRIMINANT ANALYSIS

The relative importance of the factors selected by discriminant
analysis is given by the discriminant coefficients.

Scoring systems were derived from these coefficients by
allocating a score appropriate to the relative importance
of a given factor.   By applying the scoring systems to
the individual patients in the series the predictive rates
at various score levels were calculated.

Scoring systems were derived for three circumstances that
could be applied to twin pregnancies.

1. Factors ascertainable at the first visit after diagnosis.

2. Factors ascertainable after 3 visits at weekly intervals using only clinical methods of assessing fetal growth.

3. Factors ascertainable after 3 visits at weekly intervals using clinical parameters, plasma oestriol, placental lactogen and ultrasonic assessment of biparietal diameters.

KEY TO ABBREVIATIONS

The prognostic factors for fetal growth retardation.

HT	= Height mean (154cm).
P	= Parity 0 or >3.
P.O.H.	= History of stillbirth or neonatal death.
WT CH	= Static weight or weight loss over 3 weekly visits.
G. CH	= Gain and girth of <1.0 cm/week.
HT : WT x G	= Height to weight ratio x girth (cm - kg x cm) - divided into 2 sub-groups 200 - 240, >240.
H.P.L.	= Placental lactogen, 2 or more values <8.0 ug/ml and/or fall of 0.5 ug/ml per week over 3 weekly assessments.
OEST	= Plasma oestriol levels static or falling over 3 weekly assessments.
OEST/HPL	= Static or falling plasma oestriol levels and abnormality of HPL (vide supra).

P.P.D. DIFF   . . .

B.P.D. DIFF   =   Biparietal diameter difference of 3.0

                    millimetres within 2 weeks of delivery.

B.P.D. DIV   =   Biparietal diameter difference increasing

                    by 3.0 mm over a period of 2 or more weeks.

THE SELECTION OF THE SCORING SYSTEMS (TABULATED DATA APPENDIX V)

The scoring system for each of the clinical situations was selected by comparing the false positive predictive rate with the true positive predictive rate between the various possible scoring systems and choosing the simplest system balanced against the predictive accuracy.

FACTORS ASCERTAINABLE AT ONE VISIT

The scoring system derived from the simplified standardised discriminant coefficients had as good a predictive rate as either of the more complicated systems and better than that of the simplified unstandardised coefficients (Appendix V).

The points allocation was as follows:-

P	=	2
HT	=	4
P.O.H.	=	3
HT : WT x G (200 - 240)	=	2
HT : WT x G (240)	=	4
B.P.D. DIFF	=	3

/When a particular ......

When a particular factor is not present no score is allocated.

Using this scoring system the risks of single or dual growth retardation for particular scores were as follows.

SCORE	RISK OF GROWTH RETARDATION
0 - 1	0%
2 - 3	10%
4 - 5	20%
6 - 7	30%
8 - 10	65%
>10	100%

The percentage risk is given to the nearest 5%, the exact risk is shown in Appendix V.

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS - CLINICAL VARIABLES ONLY

The scoring system derived from the simplified standardised discriminant coefficients had as high predictive rates as either of the more complex systems and a higher rate than the system derived from the simplified unstandardised discriminant coefficients.

The points allocation was as follows:-

HT	=	3
P.O.H.	=	2
WT. CH.	=	3
G. CH.	=	3
HT : WT x G (200 - 240)	=	2
HT : WT x G (240)	=	4

Using this scoring system the predictive rates were
as follows:-

SCORE	RISK OF GROWTH RETARDATION
0 - 3	5%
4 - 6	25%
7 - 9	40%
10	70%
>10	100%

The percentage risk is given to the nearest 5%, the
exact risk is shown in Appendix V.

FACTORS ASCERTAINABLE AFTER 3 VISITS USING ALL VARIABLES

The scoring system derived from the standardised
discriminant coefficients was simple in its own right
and had as good predictive rates as the complicated
formula derived from the unstandardised discriminant
coefficients and better rates than the formula derived
from the simplified unstandardised discriminant coefficients.

The points allocation was as follows:-

HT	=	2
P.O.H.	=	3
WT. CH.	=	2
G. CH.	=	2
HPL	=	2
OEST/HPL	=	3
B.P.D. DIV	=	6

The predictive rates for this scoring system were as follows:-

SCORE	RISK OF GROWTH RETARDATION
0 - 2	0%
3 - 5	5%
6 - 8	35%
9 - 11	70%
>11	100%

The percentage risk is given to the nearest 5%, the exact risk is shown in Appendix V.

COMPARISON BETWEEN THE SCORING SYSTEMS

The predictive rates of the scoring systems can be compared by taking the score level at which set percentages of normal patients fall below and calculating the percentage of patients with growth retardation that had a score equal to or higher than the chosen score. The greater the percentage of patients with growth retardation at or above this score the better the predictive rate.

This comparison is shown in Table I (full tabulated data in Appendix V).

TABLE I

COMPARISON BETWEEN THE PREDICTIVE RATES OF THE SCORING
SYSTEM

Factors ascertainable at one visit

Score	% normals < score	% IUGR > score
4	44%	84%
6	73%	68%
10	98%	27%

Factors ascertainable after 3 visits - clinical variables

Score	% normals < score	% IUGR > score
5	51%	92%
7	72%	78%
10	96%	41%

Factors ascertainable after 3 visits - all variables

Score	% normals < score	% IUGR > score
3	55%	97%
5	73%	95%
9	96%	70%
12	98%	51%

DISCUSSION

The predictive rate of the scoring system using all the

variables is considerably better than that using clinical

/variables only ....

variables only and markedly better than that for factors ascertainable at one visit only.

The clinical scoring systems will be of use in units where full investigatory facilities are not available in two ways.

1. By determining in the early third trimester which patients should be referred to units with full investigatory facilities.

2. Planning arbitrary early delivery after fetal maturity is established on the basis of predicted risk of fetal growth retardation.

CHAPTER VII

THE TIMING OF DELIVERY OF TWIN PREGNANCIES

INTRODUCTION

The Gestation of Delivery with the lowest perinatal
    mortality - twins and singletons.

The Gestation of spontaneous labour - twins and singletons.

The Growth Rate of twins and singletons.

The Biparietal Diameter Growth Rate - twins and singletons.

Trends in Plasma Oestriol and placental lactogen - twins
    and singletons.

The Timing of fetal pulmonary maturity in the series.

DISCUSSION

The purpose of this chapter is to elucidate what gestational period represents "physiological term" for twin pregnancies. The factors that will be considered are :-

1. The perinatal mortality rate for gestation of delivery in both twins and singletons using data from the literature. The number of perinatal deaths in this series is too small to make similar comparison valid in epidemiological terms.

2. The gestation of spontaneous labour in twins and singletons using both data from the literature and data from the series.

3. Intra-uterine growth rates of twins and singletons using data from the literature and the series; the considerations being a) weight for gestation, b) the growth of the biparietal diameter, c) biochemical indices of placental function and d) the gestation of pulmonary maturation.

Term for a pregnancy has been defined in many ways:-

1. The modal gestation of spontaneous labour.

2. The gestational period at which the majority of spontaneous labours occur.

3. The gestational period of delivery at which the perinatal mortality is the lowest.

The author's definition of "term" is as follows:-

Term is that gestational period by which time fetal system

maturity has been established and before the gestational age at which there is failure of growth support of the fetus.

Term defined as above can be regarded as physiological if it can be demonstrated that the majority of spontaneous labours occur during that period.

PERINATAL MORTALITY

Butler and Alberman[1] define term in singleton pregnancies as 37 to 41 weeks on the basis that it is in this period that the perinatal mortality is the lowest.

When the perinatal mortality rates for singletons and twins are represented graphically together using Butler and Alberman's[1] data (Figure 1).

It can be seen that the period with the lowest perinatal mortality for twins is 37 - 39 weeks compared to that for singletons of 39 - 41 weeks and that the rise in perinatal mortality with advancing gestation that occurs in singletons after 41 weeks commences at 39 weeks in twins.

This is highly suggestive that the growth support of twins fails after 39 weeks. This will be referred to later when considering fetal growth in twins and singletons. This observation in twins has been commented on by among other authors, Dunn[2] who states that the onset of post-maturity in twins appears to be at 40 weeks rather than at 42 weeks as in singletons and Law[3] who suggests that little benefit is to be gained from allowing a twin pregnancy to proceed beyond 38 weeks.

Fig. 1

THE PERINATAL MORTALITY OF TWINS AND SINGLETONS FOR

GESTATION OF DELIVERY (BUTLER and ALBERMAN[1])
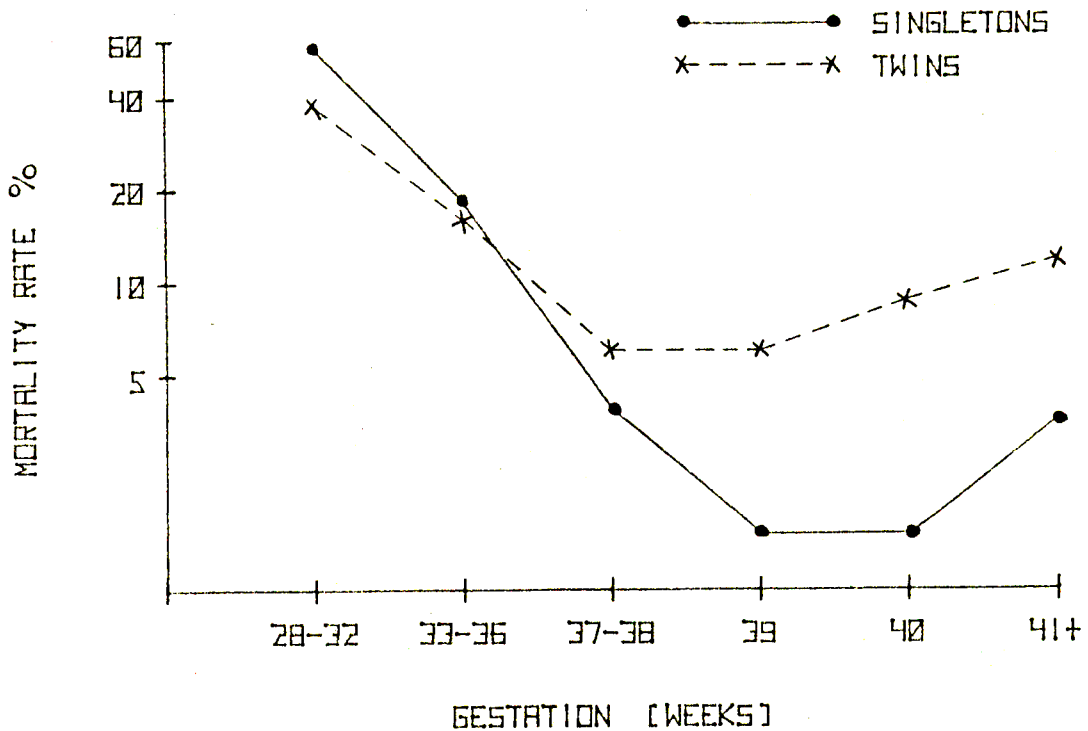
It would therefore appear that the optimum time for
delivery of twins is 37 to 39 weeks as compared to 39
to 41 weeks in singletons.

THE GESTATION OF ONSET OF LABOUR

If the optimal time for delivery in terms of perinatal
mortality rates coincides with the period at which most
spontaneous labours occur this can be regarded as
"physiological term".

The gestation of onset of spontaneous labour of twins and
singletons from Butler and Alberman's[1] data is shown in
Figure 2 and from this series in Figure 3.

Fig. 2

THE GESTATION OF ONSET OF LABOUR OF TWINS AND SINGLETONS

(BUTLER and ALBERMAN[1])
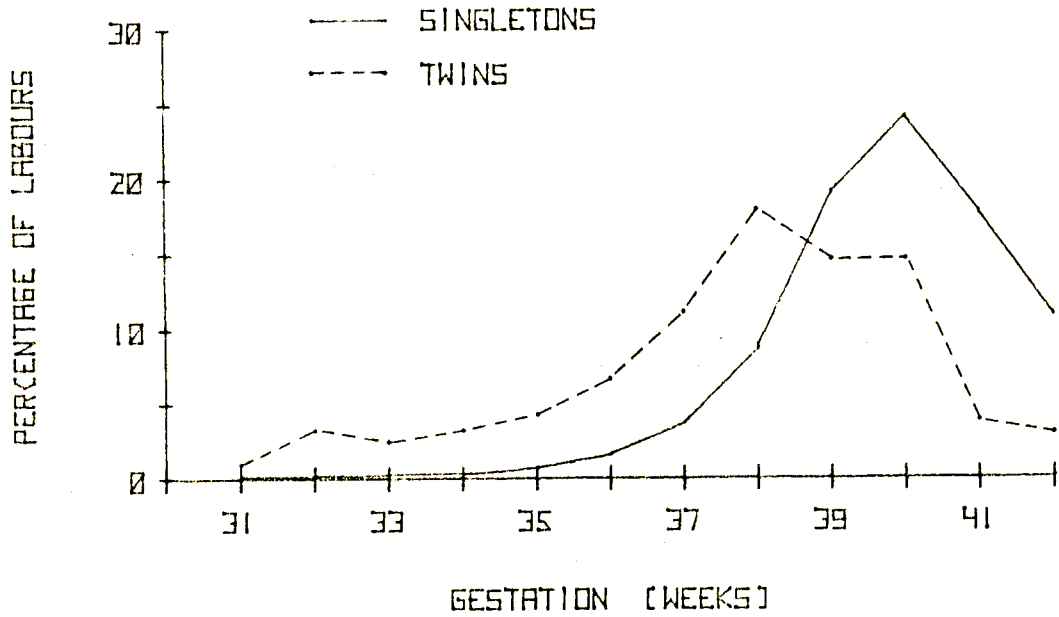
Fig. 3

THE GESTATION OF ONSET OF SPONTANEOUS LABOUR IN TWINS

AND SINGLETONS IN THE SERIES
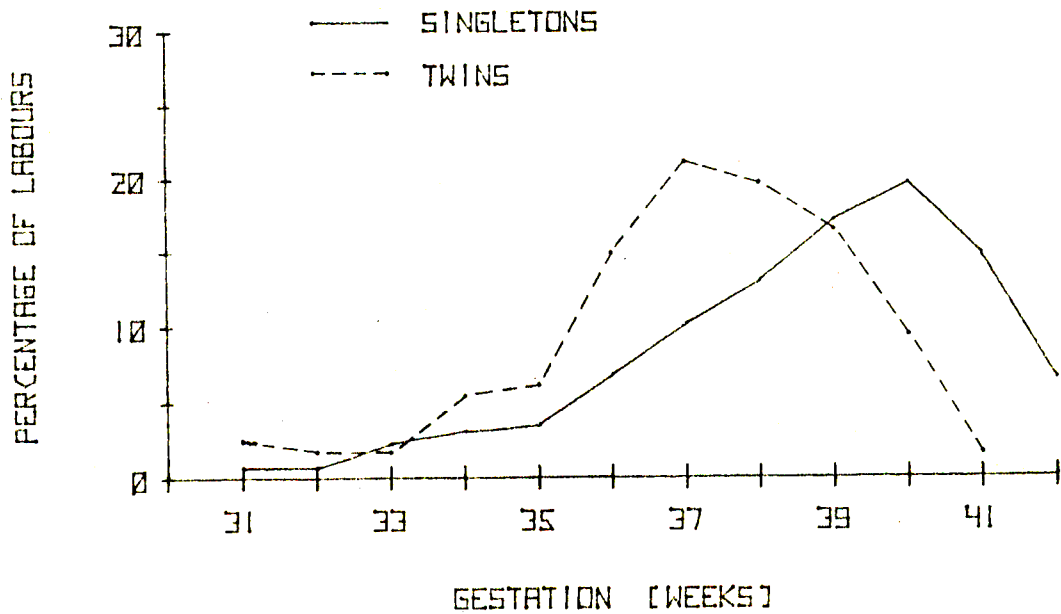
During the period with the lowest perinatal mortality
the percentages of spontaneous deliveries that occur
are shown in Table I.

TABLE I

THE PERCENTAGE OF SPONTANEOUS DELIVERIES IN THE GESTATIONAL
PERIOD DURING WHICH THE PERINATAL MORTALITY IS LOWEST

	PERCENTAGE OF DELIVERIES
TWINS (Butler and Alberman[1])	43
TWINS (The Series)	57
SINGLETONS (Butler and Alberman[1])	53
SINGLETONS (The Series)	52

Taking Butler and Alberman's definition of "term" (37-41
weeks) 66% of all the deliveries in their series occurred
in that period.

If "term" for twins is defined as 35 to 39 weeks, 54%
of twin deliveries occurred in that gestational period
in their series.

It is clearly apparent that the peak incidence of onset
of spontaneous labour in both twins and singletons
corresponds with the gestational period at which the
perinatal mortality is the lowest, consequently the
shortening of mean gestation in twins is unlikely to be
a pathological process but is probably a physiological
response to what is potentially a pathological pregnancy.
The increased prematurity rate is possibly an exaggeration
of this physiological response.

Further support for the term period occurring earlier in twins is the finding by Butler and Alberman[1] that the ratio of stillbirths to neonatal deaths for given gestational periods in the third trimester differs between twins and singletons. The ratio for singletons is highest at 35 - 37 weeks whereas that for twins is highest from 38 weeks onwards and they make the comment that this is "presumably because the limitation of the supply line is more critical in twins than in singletons".

The evidence presented so far that "term" for twin pregnancy occurs 2 weeks earlier than in singletons is purely epidemiological. Further support for this hypothesis can be found in this series from growth rates, placental function tests and the early appearance of adequate lung surfactant.

THE GROWTH RATE OF TWINS COMPARED TO SINGLETONS

The increase in fetal mass in twins with advancing gestation does not parallel that of singletons.

In Figure 4 the growth rate of the larger and smaller twins as assessed by birthweight for gestation is shown in relation to the growth rate of singletons.

/Figure 4 ....

Fig. 4

THE BIRTHWEIGHTS OF THE TWINS COMPARED TO SINGLETON STANDARDS
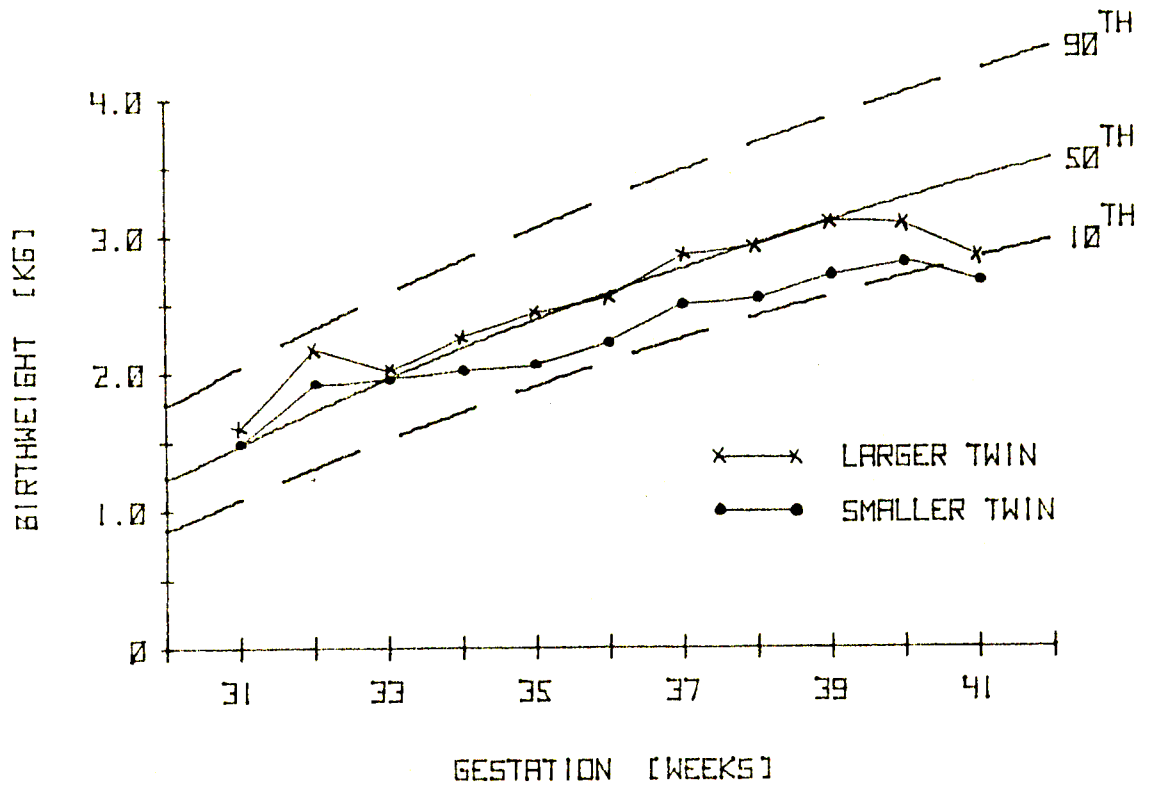
It can be seen that in general terms the growth rate of the larger twin deviates from the mean for singletons at 38 to 39 weeks and that of the smaller twin as early as 34 weeks. This supports Butler and Alberman's[1] finding that the reduction in growth rate in the third trimester, taking into account all twins, occurs at 36 weeks whereas a reduction in growth rate in singletons occurs at 38 weeks. This terminal reduction in rate can be regarded as a deviation of fetal growth rate from fetal growth potential, the deviation being caused by limited growth support from the mother and placenta (Butler and Alberman[1]).

This observation on reduction in growth rate of twins occurring earlier in the third trimester than singletons is supported by the rate of biparietal diameter growth in twins as can be seen in Figure 5.

Fig. 5

THE RATE OF BIPARIETAL DIAMETER GROWTH OF THE TWINS

COMPARED TO RATES FOR SINGLETONS
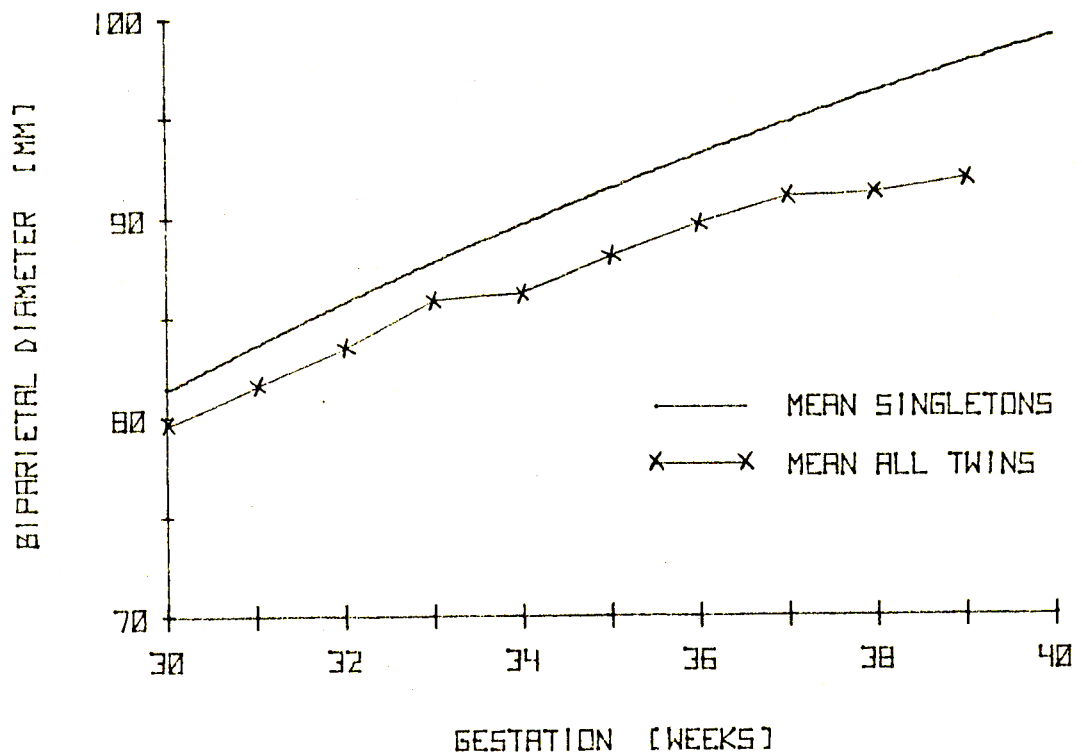
The reduction in biparietal diameter growth rate appears

not to occur at the same gestation in both twins but

often affects one twin as early as 32 weeks gestation

whereas the biparietal diameter of the larger twin

grows at the mean rate for singletons until 34 - 35

weeks gestation.

Fig. 6

THE MEAN GROWTH RATE OF THE LARGER BIPARIETAL DIAMETER
AND THE SMALLER BIPARIETAL DIAMETER COMPARED TO THE
MEAN FOR SINGLETONS

GESTATION [WEEKS]
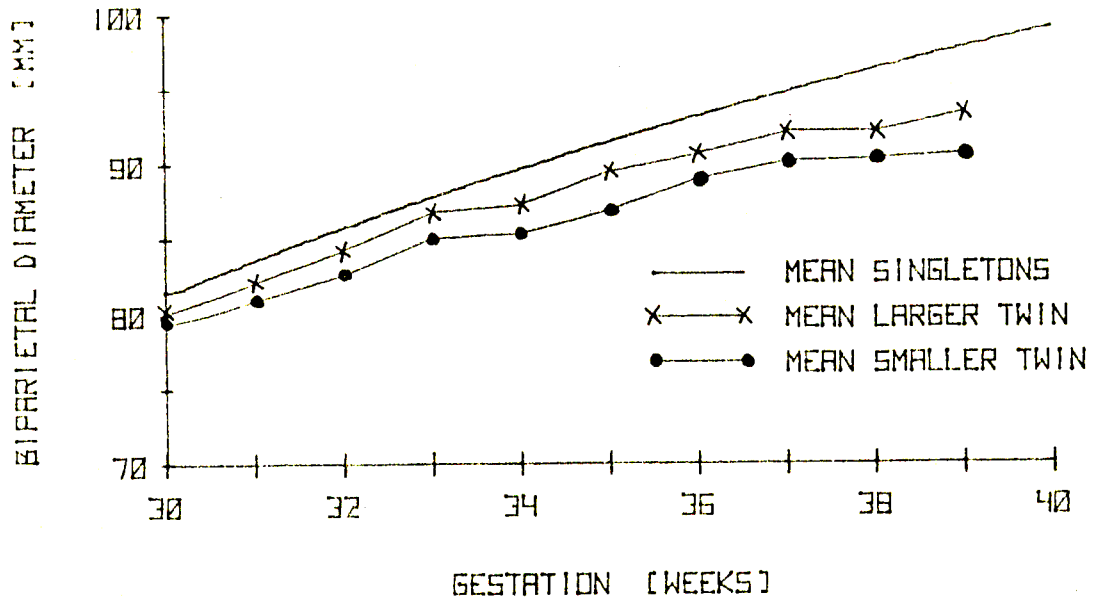
PLACENTAL FUNCTION IN TWINS COMPARED TO SINGLETONS

The biochemical indices of placental function used are at

the best an indirect reflection of placental function as

has been mentioned in Chapter V.

The normal values for singletons for plasma oestriol and

placental lactogen levels have been established by, among

many workers, plasma oestriol[4] [5]and placental lactogen[6] [7].

The actual values for gestation found by the many workers

vary slightly for both assays probably due to laboratory

method but the shapes of the curves are the same.

When the mean values for plasma oestriol found in these

twins are compared with the mean values for singletons

found by Masson[5] (Figure 7) it can be seen that the terminal

flattening in rate occurs approximately 2 weeks earlier in

the twins.

Fig. 7

PLASMA OESTRIOL VALUES IN TWINS AND SINGLETONS
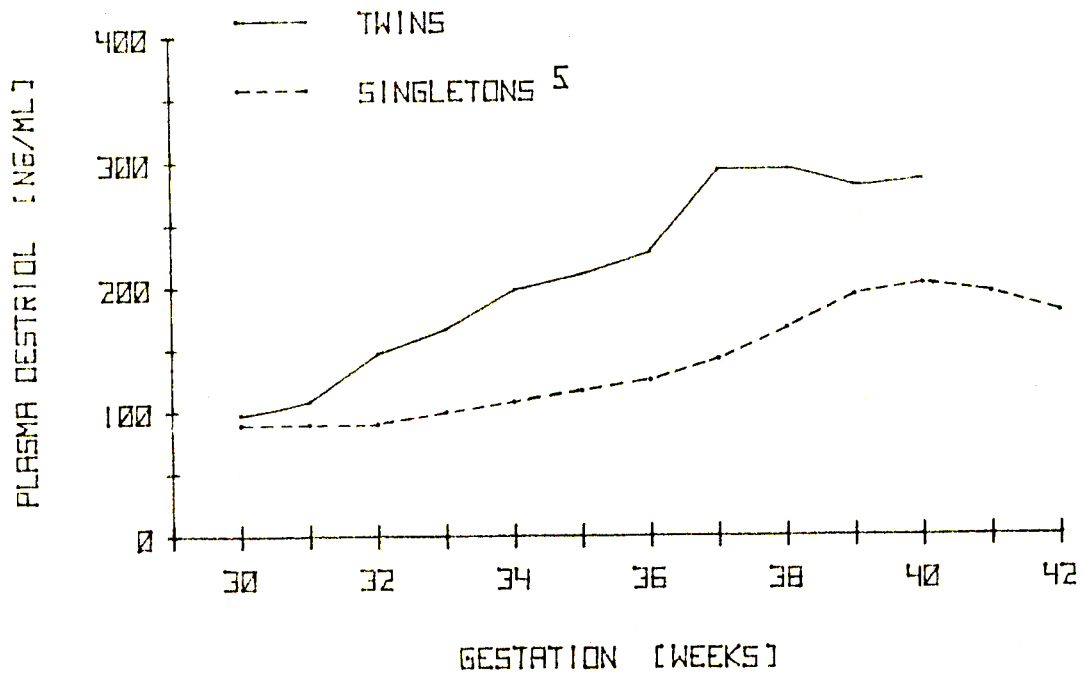
In the same way with placental lactogen the peak values in twins occur at 35 weeks compared to the peak in singletons found at 37 weeks by Teoh et al[6]. (Figure 8).

Fig. 8

PLACENTAL LACTOGEN LEVELS IN TWINS AND SINGLETONS
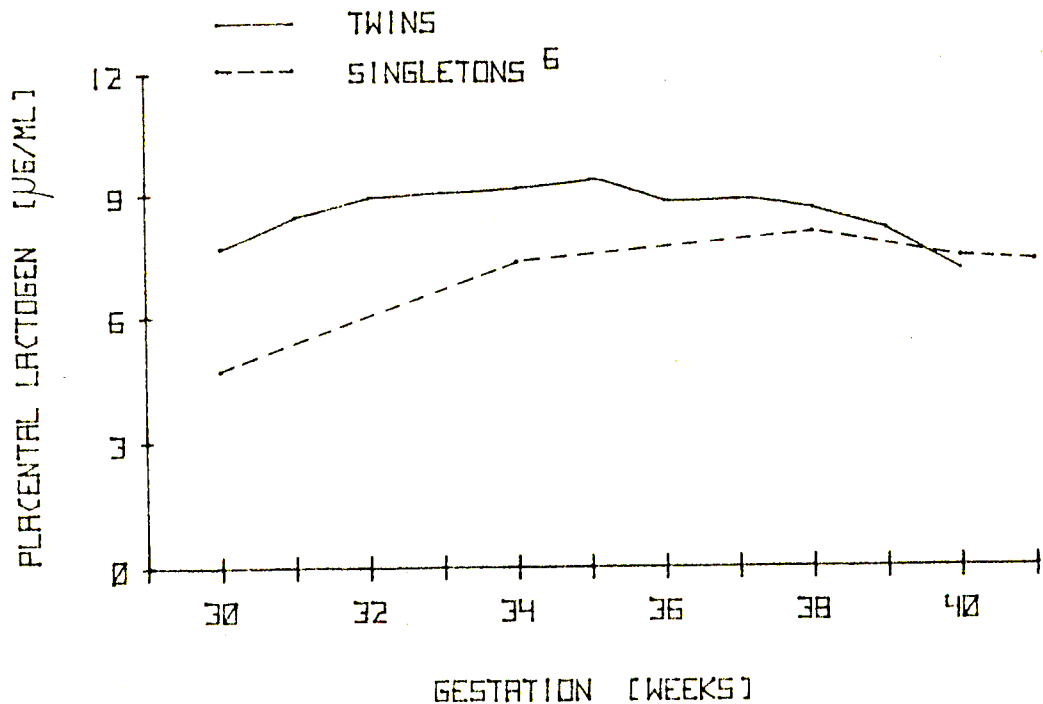
This trend for the change to occur 2 weeks earlier in both
these biochemical placental function tests suggests a
failure of the ability of the mother and placenta to
provide optimum growth support at a gestational period
2 weeks earlier in twins than in singletons.

FETAL LUNG MATURITY

Neonatal deaths from immaturity are usually attributable
to Hyaline Membrane Disease and its associated complications.
Adequate amounts of lung surfactant in the liquor in
pregnancies where Diabetes Mellitus is excluded indicate
that the neonate will not suffer from the Idiopathic
Respiratory Distress syndrome although when the levels
of lung surfactant are only just adequate birth asphyxia
may precipitate this condition[1].

Delivery at a gestation where lung maturity is not
established must be regarded as pathological.

In this series there were 2 neonatal deaths attributable
to immaturity one at 31 weeks gestation and the other at
33 weeks gestation.   None of the infants delivered after
35 weeks developed the Idiopathic Respiratory Distress
Syndrome.   This relationship between delivery at 35 weeks
or less and twin neonatal mortality has been reported
previously[8,9,10].

Measurement of liquor surfactant was undertaken in 76 of
the twin pregnancies in this series 48 hours or less before
delivery.

The simple one tube foam test was carried out on liquor taken by suprapubic trans-abdominal amniocentesis as follows;   one millilitre of clear liquor was shaken with 1 millilitre of 96.5% ethanol for 15 seconds in a glass test tube and immediately inspected, a film of bubbles covering the surface was regarded as indicating adequate lung surfactant levels.

If the foam test suggested immaturity the liquor was sent for formal lecithin, splingomyelin area ratio (L.S.A.R.), a ratio of 2 : 1 or more indicating maturity.

The results are presented in Table II.

TABLE II

LIQUOR SURFACTANT LEVELS IN THE TWINS IN THE SERIES

GESTATION AMNIOCENTESIS	FOAM TEST POSITIVE	FOAM TEST NEGATIVE	L.S.A.R. <2 : 1
31 to 34 weeks (N = 15)	12	3	1
35 to 40 weeks (N = 61)	41	14	NIL

Meconium stained liquor - 2 patients

Blood   stained liquor - 4 patients

Neither of the twin pregnancies from which a neonatal death occurred had an amniocentesis performed.

/In the one ....

In the one pregnancy where foam test was negative and
the L.S.A.R. was less than 2 : 1 (1.6 : 1) neither
neonate showed evidence of the Idiopathic Respiratory
Syndrome.

At least in this population group lung maturity in twins
appears to be established from 35 weeks gestation onwards
though this may be a peculiarity of African black patients
as Olowe and Akingube[12] have suggested that pulmonary
maturity occurs earlier in African babies when compared
to North American babies.

DISCUSSION

Evidence from this series and the literature shows that
the ideal time for delivery in "normal" twins is 37 to
39 weeks gestation as compared to 39 to 41 weeks gestation
in singletons when the following criteria are used:-

1. The gestation of delivery at which the perinatal
    mortality is the lowest.

2. The rate at which fetal mass increases.

3. The rate of growth of the biparietal diameters.

4. The biochemical indices of placental function.

5. The timing of fetal pulmonary maturity.

The fetal growth rate in twins from 37 weeks onwards is
markedly less than that of singletons and the risk of
stillbirth judged by the stillbirth to neonatal death

ratio pregressively increases in twins, unlike singletons where the ratio decreases from 37 weeks gestation suggesting that there is no value in allowing twins to progress beyond 39 weeks gestation and that the risk of "post maturity" increases beyond this gestation.

Intra-uterine growth retardation is a major factor in the causation of ante and intrapartum deaths in twins (Chapter I). When the risk of intra-uterine growth retardation is high (Chapter VI) elective delivery can be carried out as early as 35 weeks gestation without having to confirm pulmonary maturity in this population group.

The fairly acute fetal compromise that can occur in previously normally grown babies in association with "post-maturity" can usually be detected in singleton pregnancies with frequent cardiotocography. Unfortunately cardio-tocography is not reliable in twin pregnancy because of problems with the identification of the individual twin fetus.

I would therefore suggest that in twin pregnancies where there is apparently normal growth of both babies the pregnancy be terminated at or soon after 39 weeks gestation. The method of delivery is outside the scope of this study but will obviously depend among other factors on parity, the state of the cervix, the presentation of the leading twin and the pelvic size.

Spontaneous labour in twins after 35 weeks gestation probably represents a physiological response to a failure of growth support from the mother and placenta and the "term" period in twins appears to be 35 to 39 weeks as compared to 37 to 41 weeks in singletons.

R_E_F_E_R_E_N_C_E_S

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CHAPTER VIII

A SCHEME FOR THE ANTENATAL MANAGEMENT OF THE TWIN FETUS

AUTHOR'S NOTES

A PROBLEM ORIENTATED ANTENATAL RECORD CARD

In this chapter the author presents a detailed scheme for the antenatal management of the twin fetus from 30 weeks gestation.

TIMING OF VISITS - weekly

THE FIRST VISIT

1. Age recorded.

2. Height is recorded to the nearest centimetre.

3. Weight in standard clinic gown to the nearest 0.5 kgs.

4. Obstetric History with particular reference to parity, a history of stillbirth or neonatal death and the method of delivery of previous pregnancies.

5. The date of the last menstrual period with details of the patients normal cycle and whether or not hormonal contraceptives were used.

6. The minimum girth to the nearest centimetre at the umbilicus on normal expiration.

7. Palpation to determine the lie and presentation of each fetus.

8. Vaginal examination with assessment of the cervix in terms of length of cervical canal and dilation of the internal cervical os to the nearest centimetre. The

cervical score is then derived by subtracting the dilation from the length.

9.   If the cervical score is more than O and the gestation is under 36 weeks, or the patient is primiparous a uterine sensitivity test is carried out.   Six units of oxytocin are added to 1 litre of 5% dextrose and a bolus intravenous dose of 1 millilitre is given over one minute followed by a 4 minute interval before infusing 2 millilitres over one minute followed by a 4 minute interval and similarly with 3 and 4 millilitres.

A positive response is recorded when an uncomfortable contraction is palpably sustained for 30 seconds or more. The test is then discontinued.

10.   Ultrasonic combined A and B scan with measurement of both biparietal diameters.

11.   Blood is taken for routine haematological testing, plasma oestriol and placental lactogen.

12.   Calculate the Height : Weight x Girth value.

THE PREDICTION OF IMPENDING LABOUR

Labour is likely to occur within 14 days if :-

1.   The cervical score is O or less (52% of labours predicted with an 11% false positive rate).

2.   The uterine sensitivity test is positive at a bolus
of 18 milliunits per minute or less (95% of labours
predicted with a 28% false positive rate).

SINGLE OR DUAL FETAL GROWTH RETARDATION

The prediction of individual fetal growth retardation with
the attendant risk of ante or intrapartum death is based
on scoring systems which allocate points for the
appropriate risk factors.   If a risk factor is absent no
score is allocated.

At this first visit the "Growth Retardation Scoring
System for the First Visit" is used.   The points
allocation and risk levels for particular total scores
are given in the "Problem orientated Antenatal Record
Card", appended to this chapter.

Disposal and Management of the Patient at the First Visit

Less than 37 weeks gestation

1.   Impending labour predicted:-

          Admit for bed rest and oral beta-sympathomimetic

          therapy.

2.   Single or dual fetal growth retardation predicted.

          a.   admit for bed rest and oral beta-

               sympathomimetic therapy.

          b.   if more than 35 weeks - confirm lung maturity

               and deliver.

c. if less than 35 weeks

continue fetal monitoring as for subsequent

antenatal visits (see below).

37 to 39 Weeks Gestation:

1. Admit to hospital irrespective of cervical score.

2. Single or dual fetal growth retardation predicted -
    deliver.

39 Weeks Gestation or More:

Admit to hospital and deliver.

Uncertain Gestation - Clinically Less than 37 Weeks:

Proceed as if the gestation was known to be less than
37 weeks.

Uncertain Gestation - Clinically 37 Weeks or More:

Admit to hospital for continued fetal monitoring.
Allow spontaneous labour unless fetal growth retardation
predicted in which case amniocentesis and deliver if
lung maturity is confirmed.

SECOND VISIT

Assessment of the patient as detailed for the first visit
excluding the measurement of height, ultrasonic

examination and uterine sensitivity testing. Recalculate the height : weight x girth value.

When assessing the likelihood of labour within 14 days the finding of a cervical score of 0 or less or a decrease in cervical score predicts 60% of labour with a 20% false positive prediction rate.

Disposal and Management of the Patient at the Second Visit

Proceed as for the first visit.

THIRD AND SUBSEQUENT VISITS

Patient assessment as at first visit excluding the measurement of height.

Ultrasonic examination at third visit and then alternate visits.

Uterine sensitivity testing is carried out in primipara or if the cervical score assessment does not suggest impending labour, every two weeks to 36 weeks gestation.

The prediction of single or dual fetal growth retardation can now be made using the scoring system for clinical variables only or the scoring system for all variables. The details of these scoring systems are appended in the Problem Orientated Antenatal Record Cards.

The system using all the variables has a marked advantage in terms of actual predictive rates.

The system using Clinical Variables has a better predictive rate than the system for the First Visit.

The basal score refers to the score derived from height and obstetric history. The total score is arrived at by summating the basal score and the points derived from the changeable factors as assessed over the 3 previous weekly visits.

DISPOSAL AND MANAGEMENT OF THE PATIENT

Less than 37 Weeks Gestation

1. Impending labour predicted

    a. admit for bed rest and oral beta-sympathomimetic therapy.

    b. if more than 35 weeks gestation confirm fetal lung maturity and allow spontaneous labour.

2. Single or dual fetal growth retardation predicted.

    a. admit for bed rest and oral beta-sympathomimetic therapy.

    b. if more than 35 weeks gestation confirm fetal lung maturity and deliver if mature.

37 to 39 Weeks Gestation

1. Admit to hospital irrespective of cervical score.

2. Single or dual fetal growth retardation predicted - deliver.

39 Weeks Gestation or More:

Admit to hospital and deliver.

Uncertain Gestation - Clinically Less than 37 Weeks

Proceed as if gestation known to be less than 37 weeks.

Uncertain Gestation - Clinically 37 Weeks or More

a. admit to hospital.

b. allow spontaneous labour unless fetal growth retardation predicted, in which case amniocentesis and deliver if fetal lung maturity is confirmed.

AUTHOR'S NOTES

This study was designed to produce a practical guide to the antenatal management of the twin fetus with particular reference to African blacks with their high twinning rate and limited hospital facilities.

The recommendations are necessarily arbitrary as much of the obstetrics practised in this part of Africa is supervised by medical personnel not specifically specialised in the practice of obstetrics.

The scheme of management proposed is designed to reduce the perinatal mortality of twins with delivery of live, though small, potentially viable neonates.   In terms of prediction of fetal growth retardation the availability of ultrasonic and biochemical facilities markedly improves the predictive rate.   These facilities are not available to many of the medical teams working in this part of Africa who will have to use clinical parameters alone to either manage the patients or select patients with twin pregnancies for referral to major centres.

The immediate challenge in achieving this objective is to the neonatologists in that, for survival of these babies with minimal initial morbidity, well equipped neonatal intensive care units are required staffed by medical personnel trained in effective neonatal resuscitation and intensive nursing.

The infant survival rate of twins in this community is less than that of their singleton counterparts.   This decrease in survival rate is partly due to mythology and partly due to socio-economic conditions where a family is suddenly burdened with two extra mouths to feed in a situation where a balanced diet is at a premium and hygiene education and facilities are poor.

In order to put this low survival rate in rough perspective the author studied the antenatal record cards of

/of approximately .....

of approximately 500 women currently attending the Antenatal Clinic at King Edward VIII Hospital. The singleton survival rate (excluding neonatal deaths) to four years of age was approximately 74% whereas that for twins was approximately 61%. These figures are likely to be lower than that of the community as a whole as the patients at this hospital are mainly selected and referred patients but this does not alter the fact that fewer twins than singletons survive infant life.

The delivery of more live twins surviving the neonatal period therefore offers a challenge to the paediatricians who could reduce the number of infant deaths by increasing and improving their infant follow-up facilities in order that extensive vaccination programmes could be carried out and the problems of malnutritian be detected and corrected at an early stage.

Further improvement in the antenatal care of the twin fetus will be achieved in a number of different ways. In the present situation at King Edward VIII Hospital and the associated Community Obstetric Polyclinics two major factors would be an increase in the antenatal booking rate earlier in pregnancy than is the current trend and an increased awareness of the twin problem. These objectives could be achieved by education programmes for medical personnel and the patients themselved both at school and via the broadcasting media.

/Further study ....

Further study on the initiation of labour may eventually allow a greater proportion of labours to be predicted and potentially inhibited if the babies are destined to be born too soon.

Compromise of fetal somatic growth in twins may be better detected by ultrasonic measurement of such parameters as abdominal or thoracic girth.   The author would suggest that detection of either impairment of brain growth or a degree of fetal compromise likely to cause antepartum or intrapartum death is often of more value in twins because somatic growth in some twins may virtually cease at gestations that are too early for neonatal survival if the pregnancy is delivered.

The other major source of perinatal loss in twin pregnancy is during delivery and a multiphase study on the method of delivery in twin pregnancy is currently in progress at King Edward VIII Hospital.

APPENDIX TO CHAPTER II

TABLE I   The Maternal Height of the Twins.

TABLE II   The Maternal Age of the Twins.

TABLE III   The Maternal Age of Singletons.

TABLE IV   The Parity of the Twin Mothers.

TABLE V   The Parity of Singleton Mothers.

TABLE VI   The Gestation of Spontaneous Labour in the Twins.

TABLE VII   The Gestation of Spontaneous Labour in Singletons.

TABLE VIII   The Birthweights of the Twins.

TABLE IX   The Birthweight for Gestation of Singletons.

TABLE X   Plasma Oestriol in Twins.

TABLE XI   Placental Lactogen in Twins.

T A B L E   I

M A T E R N A L   H E I G H T   O F   T H E   T W I N S

HEIGHT	NUMBER OF PATIENTS
Less than 150 cm	5
150 to 153 cm	17
154 to 157 cm	47
158 to 161 cm	46
162 to 165 cm	14
More than 165 cm	3
	132

Range 142 to 169 centimetres.

Mean height 157.35 centimetres (from actual heights).

T A B L E   II

M A T E R N A L   A G E   O F   T H E   T W I N S

AGE	NUMBER OF PATIENTS
Less than 20 years	10
20 to 25 years	50
26 to 30 years	45
31 to 35 years	14
More than 35 years	13
	132

Range 16 to 48 years.

Mean age 26.7 years (from actual ages).

T A B L E   III

THE   MATERNAL   AGE   OF   575
CONSECUTIVE   SINGLETONS

AGE	NUMBER OF PATIENTS
Less than 20 years	180
20 to 25 years	214
26 to 30 years	106
31 to 35 years	43
More than 35 years	32
	575

Range 14 to 47 years.

Mean age 23.12 years (from actual ages).

At less than 20 years difference between twins
and singletons significant at p = <0.001.

At more than 25 years difference significant
at p = <0.001.

T A B L E   IV

THE   PARITY   OF   THE   TWIN   MOTHERS

PARITY	NUMBER OF PATIENTS
Nil	15
One	28
Two	27
Three	20
Four	12
Five	12
More than five	18
	132

Range nil to nine.

Mean parity 2.90.

T A B L E   V

THE PARITY OF 575 CONSECUTIVE SINGLETON MOTHERS

PARITY	NUMBER OF PATIENTS
Nil	196
One	114
Two	105
Three	93
Four	22
Five	16
More than five	29
	575

Range nil to eleven.

Mean parity 1.69.

Difference between means of twins and singletons significant at $p = <0,001$

Difference at parity 0 significant at $p = <0,001$.

Difference at parity 4 or more significant at $p = <0,001$.

T A B L E   VI

THE GESTATION OF SPONTANEOUS LABOUR IN THE TWINS

GESTATION (WEEKS)	NUMBER OF PATIENTS
31	3
32	2
33	2
34	7
35	8
36	19
37	27
38	25
39	21
40	12
41	2
	128

<u>T A B L E   VII</u>

THE   GESTATION   OF   SPONTANEOUS
LABOUR   IN   1892   LIVE   BORN
SINGLETONS   WEIGHING   OVER   0.8 KG

GESTATION (WEEKS)	NUMBER OF PATIENTS
30	11
31	15
32	16
33	46
34	62
35	69
36	130
37	194
38	248
39	326
40	374
41	279
42	122
	1892

Mean gestation of spontaneous labour 38.51 weeks labour at
less than 37 weeks gestation 349 out of 1892 (19%) (data
taken from 2000 consecutive live born singleton pregnancies
of which 108 pregnancies were electively delivered either
by induction of labour or elective caesarean section).

Difference between means of twins and singletons significant
at $p = <0,0005$.

T A B L E   VIII

T H E   B I R T H W E I G H T S   O F   T H E   T W I N S   (KG)

THE LARGER TWIN

GESTATION (WEEKS)	NUMBER	MEAN	RANGE
31	2	1.58	1.55 - 1.6
32	2	2.17	1.85 - 2.5
33	2	2.0	1.9 - 2.3
34	7	2.26	1.8 - 2.95
35	8	2.45	1.8 - 2.9
36	22	2.56	2.1 - 3.25
37	26	2.87	2.55 - 3.15
38	26	2.94	2.2 - 3.45
39	21	3.11	2.3 - 4.5
40	12	3.07	2.7 - 3.35
41	2	2.83	2.6 - 3.05

THE SMALLER TWIN

GESTATION (WEEKS)	NUMBER	MEAN	RANGE
31	2	1.47	1.45 - 1.5
32	2	1.92	1.6 - 2.25
33	2	1.97	1.75 - 2.2
34	7	2.03	1.55 - 2.6
35	8	2.07	1.55 - 2.65
36	22	2.23	1.15 - 2.9
37	26	2.51	1.8 - 3.0
38	26	2.55	1.95 - 3.15
39	21	2.72	2.1 - 3.45
40	12	2.82	2.3 - 3.7
41	2	2.65	2.5 - 2.8

(The two twin pregnancies with a fetus papyraceous are excluded).

Total number of babies weighing less than 2.5 kg - 83. Low birthweight incidence 83 out of 260 - 32%. Seventy-two percent (60) of the low birthweight babies were born before 37 weeks gestation.

T A B L E   IX

THE   BIRTHWEIGHT   OF   2000

CONSECUTIVE   LIVE   BORN

SINGLETONS   WEIGHING   OVER   0.8 KG.

GESTATION (WEEKS)	NUMBER	10th CENTILE	50th CENTILE	90th CENTILE
30	11	0.09	1.19	1.57
31	15	1.15	1.50	1.80
32	16	1.30	1.80	2.29
33	46	1.50	1.90	2.74
34	62	1.86	2.38	2.94
35	69	1.76	2.38	3.05
36	133	1.98	2.66	3.20
37	201	2.25	2.94	3.77
38	257	2.10	3.09	3.68
39	350	2.58	3.23	3.83
40	400	2.59	3.24	3.85
41	306	2.83	3.46	4.23
42	133	2.75	3.47	4.3

Total number of babies weighing less than 2.5 kg - 356.

Low birthweight incidence 356 out of 2000 - 18%.

Eighty-one percent (288) of the low birthweight babies were born before 37 weeks gestation.

T A B L E   X

P L A S M A   O E S T R I O L   V A L U E S

F O R   T H E   T W I N S

GESTATION (WEEKS)	NUMBER OF ASSAYS	PLASMA OESTRIOL (NG/ML)		
		10th CENTILE	50th CENTILE	90th CENTILE
30	31	73.5	97.5	163
31	44	72	110	223
32	57	86	148	262
33	55	84	168	342
34	63	97	199	340
35	69	101	212	400
36	65	126	229	397
37	45	143	294	401
38	31	154	295	415
39	10	–	279	–
40	8	–	287	–

Total number of assays – 478.

(The plasma oestriol values were allocated to gestation according to the Dubowitz assessment of gestational age of the neonate).

TABLE XI

T A B L E   XI

P L A C E N T A L   L A C T O G E N   V A L U E S

F O R   T H E   T W I N S

GESTATION (WEEKS)	NUMBER OF ASSAYS	10th CENTILE	50th CENTILE	90th CENTILE
30	33	5.7	7.7	9.7
31	45	6.2	8.5	10.7
32	53	6.2	9.0	11.1
33	58	6.1	9.1	10.7
34	64	5.9	9.2	10.9
35	71	6.3	9.4	10.9
36	66	5.8	8.8	10.9
37	46	5.9	8.9	11.7
38	31	5.4	8.6	11.2
39	16	6.2	8.1	9.8
40	8	–	7.1	–

Total number of assays – 491.

(The placental lactogen values were allocated to gestation according to the Dubowitz assessment of Gestational age).

APPENDIX II

TABLE I

THE EFFECT OF MATERNAL AGE ON THE INCIDENCE OF PRE-TERM LABOUR

AGE : (YEARS)	PRE-TERM LABOUR	TERM LABOUR
Less than 20	6	4
20 to 25	18	31
26 to 30	10	33
31 to 35	5	9
More than 35	3	10

(Excludes the 3 elective pre-term deliveries).

Less than 20 years - incidence pre-term labour 60%.
20 years or more   - incidence pre-term labour 30.25%.

TABLE II

THE EFFECT OF PARITY ON THE INCIDENCE OF PRE-TERM LABOUR

PARITY	PRE-TERM LABOUR	TERM LABOUR
0	8	6
1	8	19
2	8	19
3	8	11
4	3	9
5	2	10
>5	5	13

(Excludes the 3 elective pre-term deliveries).

Primipara	=	incidence pre-term labour 57%
Para 1 - 4	=	incidence pre-term labour 31.8%
Para 5 or more	=	incidence pre-term labour 23.3%

TABLE III

THE EFFECT OF MATERNAL HEIGHT ON THE INCIDENCE OF PRE-TERM LABOUR

HEIGHT (CM)	PRE-TERM LABOUR	TERM LABOUR
Less than 150	2	3
150 to 153	4	13
154 to 157	15	30
158 to 160	18	28
161 to 165	2	11
More than 165	1	2

(Excludes the 3 elective pre-term deliveries).

161 cm or more   - incidence pre-term labour 18.75%

Less than 161 cm - incidence pre-term labour 34.5 %

TABLE IV

INCREMENTAL WEIGHT CHANGE PRECEDING PRE-TERM LABOUR AND TERM LABOUR (MEAN OVER 3 ASSESSMENTS)

WEIGHT CHANGE (KG/WEEK)	PRE-TERM LABOUR	TERM LABOUR
Loss >0.5	2	1
Loss <0.5	5	7
Static	5	12
Gain <0.5	8	17
Gain 0.5 to 1.0	12	29
Gain >1.0	10	20

(Excludes the 4 elective deliveries)

There is no significant difference in the distribution between the two groups.

TABLE V

MATERNAL HEIGHT TO WEIGHT RATIO PRECEDING PRE-TERM LABOUR
AND TERM LABOUR

RATIO	PRE-TERM LABOUR	TERM LABOUR
1.5 to 1.75	3	5
1.751 to 2.0	5	26
2.001 to 2.25	17	26
2.251 to 2.5	10	22
2.501 to 2.75	5	4
More than 2.75	2	3

(Excludes the 4 elective deliveries)

Obese (Ratio 2.0)   - incidence pre-term labour 20.5%
Others (Ratio 2.0)   - incidence pre-term labour 38.2%

TABLE VI

INCREMENTAL GIRTH CHANGE PRECEDING PRE-TERM LABOUR AND
TERM LABOUR (MEAN OVER 3 ASSESSMENTS)

GIRTH CHANGE (CM/WEEK)	PRE-TERM LABOUR	TERM LABOUR
Loss 1.0	3	3
Loss 1.0	4	9
Static	3	11
Gain 1.0	13	22
Gain 1.0 to 2.0	10	29
Gain 2.0	9	12

(Excludes the 4 elective deliveries)

There is no significant difference in the distribution between
the two groups.

TABLE VII

THE GIRTH MEASURED PRIOR TO PRE-TERM LABOUR AND TERM LABOUR
(WITHIN 7 DAYS)

GIRTH (CM)	PRE-TERM LABOUR	TERM LABOUR
85 to 95	6	5
96 to 105	25	41
106 to 115	8	31
>115	3	9

(Excludes the 4 elective deliveries)

TABLE VIII

THE PRODUCT OF HEIGHT/WEIGHT RATIO AND GIRTH PRECEDING
PRE-TERM LABOUR AND TERM LABOUR (WITHIN 7 DAYS)

PRODUCT	PRE-TERM LABOUR	TERM LABOUR
<180	2	2
180 to 200	3	7
201 to 220	12	30
221 to 240	16	25
241 to 260	6	14
>260	3	8

(Excludes the 4 elective deliveries)

Product less than 200 - 10.9% labour within 7 days.

TABLE IX

THE PLASMA OESTRIOL VALUES OF THE PRE-TERM LABOUR GROUP COMPARED TO THE VALUES FOR ALL THE TWINS

PRE-TERM LABOUR

GESTATION (WEEKS)	PLASMA OESTRIOL (NG/ML) CENTILES	
	50th	
31	145	N=19
32	175	N=27
33	201	N=27
34	218	N=28
35	218	N=20
36	256	N=8

(Excludes the 3 elective pre-term deliveries)

ALL TWINS

	50th	
31	110	N=44
32	148	N=57
33	168	N=55
34	199	N=63
35	212	N=69
36	229	N=65

TABLE X

THE PLACENTAL LACTOGEN VALUES OF THE PRE-TERM LABOUR GROUP COMPARED TO THE VALUES FOR ALL THE TWINS

PRE-TERM LABOUR

GESTATION (WEEKS)	PLACENTAL LACTOGEN (MG/ML) CENTILES	
	50th	
31	9.2	N=21
32	8.9	N=28
33	9.0	N=28
34	9.4	N=28
35	9.0	N=20
36	9.3	N= 8

(Excludes the 3 elective pre-term deliveries)

ALL TWINS

	50th	
31	8.5	N=45
32	9.0	N=53
33	9.1	N=58
34	9.2	N=64
35	9.4	N=71
36	9.8	N=66

TABLE XI

THE CHANGE IN CERVICAL LENGTH PRECEDING PRE-TERM

LABOUR AND TERM LABOUR

CHANGE (CM) WEEK 1 TO WEEK O	PRE-TERM LABOUR	TERM LABOUR
3	-	1
2	1	8
1	8	21
O	33	56

(Excludes the 4 elective deliveries)

CHANGE (CM) WEEK 2 TO WEEK 1	PRE-TERM LABOUR	TERM LABOUR
3	-	-
2	1	-
1	3	4
O	38	82

(Excludes the 4 elective deliveries)

There is no significant difference in distribution between
the two groups.

A change noted at weekly assessments was found in 47 patients
of these 39 (82.9%) went into labour within 7 days.

Labour within 7 days would have been predicted in 39 out
of 128 patients (30.5%)

TABLE

TABLE XII

THE CHANGE IN CERVICAL DILATION PRECEDING PRE-TERM LABOUR

AND TERM LABOUR

CHANGE (CM) WEEK 1 TO WEEK O	PRE-TERM LABOUR	TERM LABOUR
4	2	-
3	1	2
2	5	12
1	12	26
O	22	46

CHANGE (CM) WEEK 2 TO WEEK 1	PRE-TERM LABOUR	TERM LABOUR
2	-	2
1	3	7
O	39	77

(Excludes the 4 elective deliveries)

There is no significant difference in distribution between the two groups.

A change noted at weekly assessments was found in 79 patients of these 60 (75.9%) went into labour within 7 days.

Labour within 7 days would have been predicted in 60 out of 128 (46.8%).

TABLE XIII

THE CERVICAL SCORE WITHIN 7 DAYS OF PRE-TERM LABOUR AND TERM LABOUR

CERVICAL SCORE	PRE-TERM LABOUR	TERM LABOUR
3	7	8
2	8	18
1	8	12
0	10	18
Minus 1	4	14
Minus 2	3	6
Minus 3	2	8
Minus 4	–	2

(Excludes the 4 elective deliveries)

There is no significant difference in distribution between the two groups.

TABLE XIV

THE CERVICAL SCORE ASSESSED AT ALL ASSESSMENTS OTHER THAN THOSE IN TABLE XIII

CERVICAL SCORE	PRE-TERM LABOUR	TERM LABOUR
3	45	95
2	81	129
1	22	91
0	6	30
Minus 1	1	10
Minus 2	1	8

(Excludes the 4 elective deliveries)

There is no significant difference in distribution between the two groups.

Cervical score 0 or less and labour within 7 days, 67 out of 128 patients (52.3%)

Cervical score 0 or less and no labour within 7 days 56 out of 519 assessments (10.8%).

TABLE   XV

THE CHANGE IN CERVICAL SCORE PRECEDING PRE-TERM LABOUR AND
TERM LABOUR

SCORE CHANGE

WEEK 1 TO WEEK O	PRE-TERM LABOUR	TERM LABOUR
4	2	4
3	1	3
2	8	22
1	9	17
O	22	40

SCORE CHANGE

WEEK 2 TO WEEK 1	PRE-TERM LABOUR	TERM LABOUR
2	2	2
1	3	14
O	37	70

(Excludes the 4 elective deliveries)

There is no significant difference in distribution between
the two groups.

Score change of 1 or more noted on 88 occasions of these
66 went into labour within 7 days (75%).

Labour within 7 days would have been predicted in 66 out
of 128 patients (51.6%).

TABLE XVI

THE CERVICAL SCORE WITHIN 7 DAYS OF LABOUR IN PRIMIPARA

CERVICAL SCORE	NUMBER OF PATIENTS
2	6
1	4
O	—
Minus 1	3
Minus 2	1

A cervical score of O or less found in 4 out of the 14 patients within 7 days of labour (28.6%).

TABLE XVII

THE CHANGE IN CERVICAL SCORE PRECEDING LABOUR IN PRIMIPARA

SCORE CHANGE WEEK 1 TO WEEK O	NUMBER OF PATIENTS
2	1
1	4
O	9

SCORE CHANGE WEEK 2 TO WEEK 1	NUMBER OF PATIENTS
2	—
1	2
O	12

Score change of 1 or more noted within 7 days of labour in 5 out of 14 patients (35.7%).

Score change of 1 or more and no labour within 7 days 2 out of 14 patients (14.3%).

TABLE XVIII

THE TIME RELATIONSHIP BETWEEN A NOTED CHANGE IN CERVICAL

SCORE AND THE ONSET OF LABOUR

DAYS TO LABOUR	NUMBER OF PATIENTS
1	9
2	10
3	11
4	9
5	12
6	8
7	7

TABLE XIX

THE RELATIONSHIP OF UTERINE SENSITIVITY TO OXYTOCIN AND

SPONTANEOUS LABOUR IN THE SUBSEQUENT 14 DAYS

BOLUS DOSE REQUIRED FOR A POSITIVE RESPONSE (MU)	LABOUR WITHIN 14 DAYS	NOT LABOURING WITHIN 14 DAYS
6	3	0
12	10	1
18	4	6
24	1	12
24	0	18

Positive response at bolus of 18 mu or less 17 out of 24 patients laboured within 14 days (70.8%).

Positive response at bolus of 24 mu or more 1 out of 31 patients laboured within 14 days (4.5%).

(Chi-squared - P = 0.0001)

APPENDIX III

(In all comparisons, unless otherwise stated, the two
pregnancies with a fetus papyraceous are excluded).

TABLE I

THE COMBINED WEIGHT FOR GESTATION OF THE TWINS

GESTATION (WEEKS)	COMBINED WEIGHT (KG)		
	NUMBER	MEAN	S.D.
31	2	3.06	-
32	2	4.10	-
33	2	4.08	-
34	7	4.3	0.72
35	8	4.52	0.72
36	22	4.8	0.75
37	26	5.38	0.78
38	26	5.48	0.63
39	21	5.83	0.79
40	12	5.89	0.72
41	2	5.48	-

TABLE II

THE GESTATION OF SPONTANEOUS LABOUR IN THE PREGNANCIES
WITH FETAL GROWTH RETARDATION

GESTATION (WEEKS)	GROWTH RETARDATION	ALL TWINS
31	-	3
32	-	2
33	-	2
34	1	7
35	2	8
36	5	19
37	6	27
38	10	25
39	8	21
40	5	12
41	-	2

(Excludes the four elective deliveries).

Mean gestation for all twins - 36.85 weeks.
Mean gestation with growth retardation - 37.81 weeks.

TABLE   III

MATERNAL AGE AND THE INCIDENCE OF SINGLE OR DUAL FETAL

GROWTH   RETARDATION

AGE (YEARS)	GROWTH RETARDATION	NO GROWTH RETARDATION
<20	2	6
20 - 25	12+	37
26 - 30	13+	33
31 - 35	5	8
>35	5+	9

+Denotes antepartum death attributable to growth retardation.

TABLE   IV

MATERNAL AGE AND THE INCIDENCE OF PREGNANCY GROWTH

RETARDATION

AGE (YEARS)	COMBINED WEIGHT (KG)	
	≤MEAN	>MEAN
<20	2	7
20 - 25	25	25
26 - 30	18	27
31 - 35	11	2
>35	7	6

/TABLE V ....

TABLE V

PARITY AND THE INCIDENCE OF SINGLE OR DUAL FETAL GROWTH
RETARDATION

PARITY	GROWTH RETARDATION	NO GROWTH RETARDATION
O	5+	9
1	7	21
2	3	24
3	5+	15
4	6+	6
5	4+	7
>5	7	11

+Denotes antepartum death attributable to growth
retardation.

TABLE VI

PARITY AND THE INCIDENCE OF PREGNANCY GROWTH RETARDATION

PARITY	COMBINED WEIGHT (KG)	
	<MEAN	>MEAN
O	6	8
1	12	16
2	12	15
3	9	11
4	8	4
5	5	6
>5	11	7

TABLE VII

MATERNAL HEIGHT AND THE INCIDENCE OF SINGLE OR DUAL FETAL
GROWTH RETARDATION

HEIGHT (CM)	GROWTH RETARDATION	NO GROWTH RETARDATION
<150	3	1
150 - 153	11++++	6
154 - 157	10	36
158 - 161	8	38
162 - 165	5	9
>165	-	3

+Denotes antepartum death attributable to growth retardation.

TABLE VIII

MATERNAL HEIGHT AND THE INCIDENCE OF PREGNANCY GROWTH
RETARDATION

HEIGHT (CM)	COMBINED WEIGHT (KG)	
	⩽MEAN	>MEAN
<150	3	1
150 - 153	10	7
154 - 157	24	22
158 - 161	19	27
162 - 165	6	8
>165	1	2

TABLE IX

INCREMENTAL WEIGHT CHANGE AND THE INCIDENCE OF SINGLE OR
DUAL FETAL GROWTH RETARDATION

INCREMENTAL CHANGE (KG/WEEK)	GROWTH RETARDATION	NO GROWTH RETARDATION
Loss >0.5	3	-
Loss <0.5	6++	6
Static	6	9
Gain <0.5	15+	10
Gain 0.5 - 1.0	5+	38
Gain >1.0	2	30

+Denotes antepartum death attributable to growth
retardation.

TABLE X

INCREMENTAL WEIGHT CHANGE AND THE INCIDENCE OF PREGNANCY
GROWTH RETARDATION

INCREMENTAL CHANGE (KG/WEEK)	COMBINED WEIGHT (KG)	
	<MEAN	>MEAN
Loss >0.5	3	-
Loss <0.5	10	2
Static	11	4
Gain <0.5	22	3
Gain 0.5 - 1.0	13	30
Gain >1.0	4	28

TABLE XI

HEIGHT TO WEIGHT RATIO WITHIN 7 DAYS OF DELIVERY AND THE
INCIDENCE OF SINGLE OR DUAL FETAL GROWTH RETARDATION

HEIGHT TO WEIGHT RATIO	GROWTH RETARDATION	NO GROWTH RETARDATION
<1.75	–	9
1.75 – 2.0	8	23
2.001 – 2.25	9+	34
2.251 – 2.5	13+	19
2.501 – 2.75	4++	5
>2.75	3	3

+Denotes antepartum death attributable to growth retardation.

TABLE XII

HEIGHT TO WEIGHT RATIO WITHIN 7 DAYS OF DELIVERY AND THE
INCIDENCE OF PREGNANCY GROWTH RETARDATION

	COMBINED WEIGHT	
HEIGHT TO WEIGHT RATIO	⩽MEAN	>MEAN
<1.75 –	–	9
1.75 – 2.0	16	15
2.001 – 2.25	19	24
2.251 – 2.5	20	12
2.501 – 2.75	5	4
>2.75	4	2

TABLE   XIII

INCREMENTAL GIRTH CHANGE AND THE INCIDENCE OF SINGLE OR
DUAL FETAL GROWTH RETARDATION

INCREMENTAL CHANGE (CM/WEEK)	GROWTH RETARDATION	NO GROWTH RETARDATION
Loss >1.O	2	4
Loss <1.O	3	8
Static	4+	1O
Gain <1.O	2O+	17
Gain 1.O - 2.O	6+	35
Gain >2.O	2+	19

+Denotes antepartum death attributable to growth retardation.

TABLE   XIV

INCREMENTAL GIRTH CHANGE AND THE INCIDENCE OF PREGNANCY
GROWTH RETARDATION

| INCREMENTAL CHANGE (CM/WEEK) | COMBINED WEIGHT (KG) | |
	<MEAN	>MEAN
Loss >1.O	5	1
Loss <1.O	7	4
Static	8	6
Gain <1.O	23	14
Gain >1.O - 2.O	15	26
Gain 2.O	5	16

TABLE XV

FINAL ACTUAL GIRTH (WITHIN 7 DAYS OF DELIVERY) AND THE
INCIDENCE OF SINGLE OR DUAL FETAL GROWTH RETARDATION

FINAL GIRTH (CM)	GROWTH RETARDATION	NO GROWTH RETARDATION
85 - 90	2	1
91 - 95	3	3
96 - 100	13++	15
101 - 105	9+	29
106 - 110	3	21
111 - 115	3	16
116 - 120	4+	4
>120	-	4

+Denotes antepartum death attributable to growth retardation.

TABLE XVI

FINAL ACTUAL GIRTH (WITHIN 7 DAYS OF DELIVERY) AND THE
INCIDENCE OF PREGNANCY GROWTH RETARDATION

FINAL GIRTH (CM)	COMBINED WEIGHT (KG)	
	$\leq$MEAN	>MEAN
85 - 90	2	1
91 - 95	4	2
96 - 100	16	12
101 - 105	18	20
106 - 110	12	12
111 - 115	6	13
116 - 120	5	3
>120	-	4

TABLE XVII

THE PRODUCT OF THE HEIGHT TO WEIGHT RATIO AND GIRTH
WITHIN 7 DAYS OF DELIVERY AND THE INCIDENCE OF SINGLE
OR DUAL FETAL GROWTH RETARDATION

PRODUCT	GROWTH RETARDATION	NO GROWTH RETARDATION
<180	O	4
180 - 200	1	10
201 - 220	12+	31
221 - 240	12	30
241 - 260	7+	12
>260	5++	6

+Denotes antepartum death attributable to growth
retardation.

TABLE XVIII

THE PRODUCT OF THE HEIGHT TO WEIGHT RATIO AND GIRTH
WITHIN 7 DAYS OF LABOUR AND THE INCIDENCE OF PREGNANCY
GROWTH RETARDATION

PRODUCT	COMBINED WEIGHT (KG)	
	≤MEAN	>MEAN
<180	O	4
180 - 200	3	8
201 - 220	22	21
221 - 240	22	20
241 - 260	11	8
>260	5	6

TABLE XIX

THE CERVICAL SCORE AND GROWTH RETARDATION

| | | CERVICAL SCORE (n) | |
GESTATION (WEEKS)	ALL TWINS	SINGLE OR DUAL GROWTH RETARDATION	PREGNANCY GROWTH RETARDATION
30	2.15 (35)	2.22 (9)	2.07 (15)
31	2.18 (45)	2.33 (9)	1.9 (20)
32	2.05 (61)	2.21 (14)	1.89 (27)
33	1.78 (66)	1.70 (20)	1.71 (35)
34	1.51 (77)	1.43 (21)	1.51 (39)
35	1.18 (83)	1.16 (26)	1.27 (40)
36	0.95 (81)	1.04 (25)	1.11 (44)
37	0.61 (59)	0.50 (16)	0.63 (30)
38	0.66 (35)	0.55 (9)	0.76 (17)
39	0.2 (16)	0.40 (5)	0.33 (9)
40	0 (4)	--	0.5 (3)

APPENDIX IV

TABLE I

THE INCREMENTAL WEEKLY CHANGE IN PLASMA OESTRIOL LEVELS
AND SINGLE OR DUAL GROWTH RETARDATION.

WEEKLY INCREMENT (ug/ml)	GROWTH RETARDATION	NO GROWTH RETARDATION
Loss > 50	3^x	2
Loss 26-50	6^{xx}	2
Loss 10-25	5^x	11
Static	12	12
Gain 10-25	4	15
Gain 26-50	4	20
Gain > 50	3	31

(x Denotes antepartum death attributable to growth retardation).

TABLE II

THE INCREMENTAL WEEKLY CHANGE IN PLASMA OESTRIOL LEVELS
AND PREGNANCY GROWTH RETARDATION

WEEKLY INCREMENT (ug/ml)	COMBINED WEIGHT	
	< MEAN	> MEAN
Loss > 50	3	2
Loss 26-50	6	2
Loss 10-25	7	9
Static	15	9
Gain 10-25	10	9
Gain 26-50	11	13
Gain > 50	11	23

TABLE III

WEEKLY INCREMENTAL CHANGE IN PLACENTAL LACTOGEN

LEVEL AND SINGLE OR DUAL GROWTH RETARDATION

INCREMENTAL CHANGE (ug/ml)	GROWTH RETARDATION	NO GROWTH RETARDATIO
Loss $>$ 1.0	6^x	1
Loss 0.5 – 1.0	12^x	11
Static	13^{xx}	46
Gain 0.5 – 1.0	5	20
Gain $>$ 1.0	1	15

(x Denotes antepartum death attributable to growth

retardation).

TABLE IV

WEEKLY INCREMENTAL CHANGE IN PLACENTAL LACTOGEN
LEVEL AND PREGNANCY GROWTH RETARDATION

INCREMENTAL CHANGE (ug/ml)	COMBINED WEIGHT	
	$<$ MEAN	$>$ MEAN
Loss $>$ 1.0	6	1
Loss 0.5 – 1.0	18	5
Static	27	32
Gain 0.5 – 1.0	10	15
Gain $>$ 1.0	2	14

TABLE V

PLACENTAL LACTOGEN VALUES AND SINGLE OR DUAL GROWTH
RETARDATION (AFTER 30 WEEKS GESTATION).

		LEVELS (ug/ml)				
NUMBER OF OCCASIONS	GROWTH RETARDATION			NO GROWTH RETARDATION		
	<6.0	<7.0	<8.0	<6.0	<7.0	<8.0
1	5	12^X	7	7	14	20
2	4^{XX}	2^{XX}	11^{XX}	6	2	7
>3	–	4	8	1	12	18

(^{X} Denotes antepartum death attributable to growth
retardation).

TABLE VI

PLACENTAL LACTOGEN VALUES AND PREGNANCY GROWTH RETARDATION
(AFTER 30 WEEKS GESTATION).

		LEVELS (ug/ml)				
		COMBINED WEIGHT				
NUMBER OF OCCASIONS	< MEAN			> MEAN		
	<6.0	<7.0	<8.0	<6.0	<7.0	<8.0
1	6	16	11	6	10	16
2	8	4	17	2	–	1
>3	–	9	18	–	7	8

TABLE VII

THE BIPARIETAL DIAMETER OF SINGLETONS   (31 - 39 WEEKS)

(Campbell and Newman[1]   Chapter V)

GESTATION WEEKS	MEAN BIPARIETAL DIAMETER	2 S.D.	NUMBER
30	81.3	4.0	30
31	83.3	3.4	53
32	85.8	4.2	47
33	88.6	3.6	35
34	90.0	4.0	39
35	92.0	4.8	44
36	93.2	3.8	41
37	95.0	4.4	48
38	96.3	4.8	52
39	97.4	5.6	41

TABLE VIII

THE BIPARIETAL DIAMETER OF ALL THE TWINS (30 - 39 WEEKS)

GESTATION (WEEKS)	MEAN BIPARIETAL DIAMETER	2 S.D.	NUMBER
30	79.6	6.8	44
31	81.7	7.8	42
32	83.6	7.0	72
33	86.0	5.8	64
34	86.4	7.6	80
35	88.2	7.2	80
36	89.9	5.0	90
37	91.2	6.8	68
38	91.4	7.6	30
39	92.1	6.0	20

TABLE IX

MEAN OF THE LARGER AND SMALLER BIPARIETAL DIAMETERS
(30 - 39 WEEKS)

GESTATION		BIPARIETAL DIAMETER						
		LARGER			SMALLER			
(WEEKS)	MEAN	S.D.	S.E.	MEAN	S.D.	S.E.	NUMBER
30	80.1	3.3	0.7	79.3	3.4	0.72	22
31	82.3	4.1	0.89	81.1	3.9	0.85	21
32	84.4	3.6	0.6	82.8	3.8	0.63	36
33	86.9	3.1	0.55	85.2	2.9	0.5	32
34	87.4	3.7	0.6	85.5	4.0	0.64	40
35	89.6	3.8	0.61	87.0	3.7	0.58	40
36	90.8	2.6	0.38	89.1	2.8	0.41	45
37	92.2	3.4	0.58	90.3	3.9	0.67	34
38	92.2	3.7	0.95	90.5	4.3	1.12	15
39	93.5	3.2	1.02	90.8	3.1	0.98	10

TABLE X

THE BIPARIETAL DIAMETER OF THE TWINS WHERE NEITHER BABY
WAS GROWTH RETARDED (30 - 39 WEEKS)

GESTATION (WEEKS)	BIPARIETAL DIAMETER			
	MEAN	S.D.	S.E.	NUMBER
30	79.4	3.5	0.85	34
31	81.9	4.3	1.11	30
32	83.7	3.6	0.67	58
33	85.9	2.8	0.63	44
34	86.8	3.3	0.58	64
35	88.9	3.0	0.59	52
36	90.0	2.6	0.45	68
37	91.6	2.5	0.51	50
38	91.8	3.7	1.18	22
39	93.2	3.0	1.24	12

TABLE XI

THE BIPARIETAL DIAMETER OF THE GROWTH RETARDED TWINS
(3O - 39 WEEKS)

| | BIPARIETAL DIAMETER | | | |
GESTATION (WEEKS)	MEAN	S.D.	S.E.	NUMBER
30	79.2	3.4	1.4	12
31	80.7	2.75	1.04	14
32	83.1	2.85	1.01	16
33	85.7	3.4	O.98	24
34	84.4	5.3	1.68	2O
35	86.5	4.3	1.06	32
36	88.7	2.8	O.84	22
37	88.6	5.1	1.42	26
38	89.2	5.17	2.31	1O
39	89.3	2.25	O.92	6

APPENDIX V

Discriminant Coefficients

The Scoring Systems and the percentage risk of fetal
growth retardation for given scores

The predictive value of the scoring systems

THE DISCRIMINANT COEFFICIENTS AND THE POTENTIAL SCORING

SYSTEMS

(Key to abbreviations in Chapter VI)

FACTORS ASCERTAINABLE AT ONE VISIT

DISCRIMINANT COEFFICIENTS

	STANDARDISED	UNSTANDARDISED
P	0.24219	0.50826
HT	0.54065	1.51113
P.O.H.	0.39980	1.40707
HT : WT x G	0.27384	0.47575
B.P.D. DIFF	0.37471	0.77739

(In the Tables the derivation of each scoring system
is given above the appropriate points allocation).

FACTORS ASCERTAINABLE AT ONE VISIT

POSSIBLE SCORING SYSTEMS - POINTS ALLOCATION (SCORE 0 IF FACTOR ABSENT) AND PERCENTAGE

RISK OF FETAL GROWTH RETARDATION

Standardised Coefficients

P = 10, HT = 22, POH = 17

HT : WT x G (200-240) = 11

HT : WT x G (>240) = 22

B.P.D. DIFF = 15

Score	% Risk IUGR
0-10	0
11-25	11
26-38	28
39-57	67
58+	100

Standardised Coefficients (Simplified)

P = 2, HT = 4, POH = 3

HT : WT x G (200-240) = 2

HT : WT x G (>240) = 4

B.P.D. DIFF = 3

Score	% Risk IUGR
0-1	0
2-3	10
4-5	18
6-7	29
8-10	64
11+	100

Unstandardised Coefficients

P = 5, HT = 15, POH = 14

HT : WT x G (200-240) = 5

HT : WT x G (>240) = 10

B.P.D. DIFF = 8

Score	% Risk IUGR
0-4	0
5-12	10
13-22	27
23-32	59
33+	100

Unstandardised Coefficients (Simplified)

P = 1, HT = 3, POH = 3

HT : WT x G (200-240) = 1

HT : WT x G (>240) = 2

B.P.D. DIFF = 2

Score	% Risk IUGR
0	0
1-2	10
3-4	28
5-7	70
8+	100

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS USING CLINICAL FACTORS ONLY

	DISCRIMINANT COEFFICIENTS	
	STANDARDISED	UNSTANDARDISED
HT	0.42205	1.17098
P.O.H.	0.29359	1.02497
WT. CH.	0.39625	0.81887
G. CH.	0.37813	0.75395
HT : WT x G	0.27367	0.47872

(In the Tables the derivation of each scoring system is given above the appropriate points allocation)

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS - CLINICAL FACTORS

POSSIBLE SCORING SYSTEMS - POINTS ALLOCATION (SCORE O IF FACTOR ABSENT) AND PERCENTAGE

RISK OF FETAL GROWTH RETARDATION

Standardised

Standardised Coefficients

HT = 15, P.O.H. = 11
WT. CH = 14, G. CH = 14
HT : WT x G (200-240) = 10
HT : WT x G (>240) = 20

Score	% Risk IUGR
0-20	2
21-37	24
38-49	55
50+	100

Coefficients (Simplified)

HT = 3, P.O.H. = 2
WT. CH. = 3, G. CH. = 3
HT : WT x G (200-240) = 2
HT : WT x G (>240) = 4

Score	% Risk IUGR
0-3	3
4-6	24
7-9	41
10	70
11+	100

Unstandardised

Unstandardised Coefficients

HT = 12, P.O.H. = 10
WT.CH. = 8, G. CH. = 8
HT : WT x G (200-240) = 5
HT : WT x G (>240) = 10

Score	% Risk IUGR
0-11	2
12-20	25
21-30	47
31+	100

Coefficients (Simplified)

HT = 3, P.O.H. = 3
WT. CH. = 2, G. CH. = 2
HT : WT x G (200-240) = 1
HT : WT x G (>240) = 2

Score	% Risk IUGR
0-2	4
3-4	25
5-7	44
8+	100

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS ALL VARIABLES

DISCRIMINANT COEFFICIENTS

	STANDARDISED	UNSTANDARDISED
HT.	0.17143	0.45743
P.O.H.	0.23637	0.82597
WT. CH.	0.16991	0.34850
G. CH.	0.17556	0.34917
HT : WT	0.07693	0.13448
H.P.L.	0.14524	0.28951
OEST/H.P.L.	0.25388	0.56367
B.P.D. DIV.	0.47794	1.04861

(In the Tables the derivation of each scoring system is given above the appropriate points allocation).

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS - ALL VARIABLES

POSSIBLE SCORING SYSTEMS - POINTS ALLOCATION (SCORE 0 IF FACTOR ABSENT) AND PERCENTAGE

RISK OF FETAL GROWTH RETARDATION

Standardised Coefficients

HT = 2, P.O.H. = 3, WT.CH = 2

G.CH = 2, HPL = 2, OEST/HPL = 3

B.P.D. DIV. = 6

Score	% Risk IUGR
0-2	0
3-5	7
6-8	37
9-11	69
12+	100

Unstandardised Coefficient

HT = 5, P.O.H. = 8, WT.CH = 3

G.CH = 3, HPL = 3, OEST/HPL = 6

B.P.D. DIV. = 10

Score	% Risk IUGR
0-4	0
5-6	12
7-14	24
15-21	62
22+	100

Unstandardised Coefficients (Simplified)

HT = 2, P.O.H. = 3, WT.CH = 1

G.CH = 1, HPL = 1, OEST/HPL = 2

B.P.D. DIV. = 3

Score	% Risk IUGR
0-2	3
3-4	23
5-7	65
8+	100

THE PREDICTIVE VALUES OF THE SCORING SYSTEMS

The predictive values are derived from the series.

Column "I.U.G.R." = single or dual fetal growth
retardation.

Column "normal" = no growth retardation.

FACTORS ASCERTAINABLE AT ONE VISIT

(Scoring system derived from simplified standardised coefficients)

PERCENTAGE PATIENTS AT OR ABOVE THE SCORE

SCORE	IUGR	NORMAL
0	100	100
1	100	94
2	89	59
3	89	56
4	84	35
5	73	27
6	68	19
7	51	5
8	41	3
9	27	2
10	27	0

PERCENTAGE PATIENTS AT OR BELOW THE SCORE

SCORE	IUGR	NORMAL
0	0	6
1	0	6
2	11	41
3	11	44
4	16	65
5	27	73
6	32	81
7	49	95
8	59	97
9	73	98
10	73	100
11	86	100
12	89	100
13	100	100

FACTORS ASCERTAINABLE AFTER 3 WEEKLY VISITS - CLINICAL VARIABLES

(Scoring system derived from simplified standardised coefficients)

PERCENTAGE PATIENTS AT OR ABOVE THE SCORE

SCORE	IUGR	NORMAL
0	100	100
1	100	92
2	97	65
3	97	59
4	92	49
5	78	28
6	78	25
7	70	16
8	41	4
9	41	3
10	22	0

PERCENTAGE PATIENTS AT OR BELOW THE SCORE

SCORE	IUGR	NORMAL
0	0	6
1	0	6
2	3	35
3	3	41
4	8	51
5	22	72
6	22	75
7	30	84
8	59	96
9	59	97
10	78	100
11	86	100
12	89	100
13	100	100

FACTORS ASCERTAINABLE AFTER 3 VISITS - ALL VARIABLES

(Scoring system derived from standardised coefficients)

PERCENTAGE PATIENTS AT OR ABOVE THE SCORE

SCORE	IUGR	NORMAL
0	100	100
1	100	72
2	100	45
3	97	42
4	95	27
5	95	16
6	89	13
7	76	8
8	76	4
9	70	4
10	57	2
11	51	0

PERCENTAGE PATIENTS AT OR BELOW THE SCORE

SCORE	IUGR	NORMAL
0	0	25
1	0	28
2	0	55
3	3	58
4	5	73
5	5	83
6	11	87
7	24	92
8	24	96
9	30	96
10	43	98
11/12	49	100
13	57	100
14	62	100
15/16	89	100
17	100	100