INDUCTION OF LABOUR

AN ANALYSIS OF 1,877 CASES DONE IN THE MATERNITY HOSPITALS UNDER THE AEGIS OF THE UNIVERSITY OF CAPE TOWN DURING THE YEARS 1952—1956 (INCLUSIVE)

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Attempts to induce labour have been made since times as remote as the 6th century, when Aetius used sponge tents to dilate the cervix where the foetus was dead *in utero*. Surgical induction by dilatation of the cervix and rupture of the forewaters was introduced into English obstetrics by Macaulay in 1756 but Soranus of Ephesus was known to have employed the method in A.D. 138. Ecbolics have been used since times immemorial and ergot, first discovered in 1596, was used correctly in 1807 by Stearns. In 1909 the posterior pituitary extract was found by Blair Bell[1] to have an effect on the uterus and has been used in increasing amounts since that time, at first as Pituitrin and later as Pitocin.

In spite of the many advances in endocrinology and our knowledge of the physiology of the onset of labour, we still cannot by any of the methods at our disposal, produce the same excellent results as nature does.

METHODS OF INDUCTION

The methods available at the present time are:

1. *Pharmacological:*

Drugs: (*a*) Castor oil, (*b*) quinine.

Hormones: (*a*) Oestrogens, (*b*) extract of the posterior pituitary.

2. *Operative:*

(*a*) Stretching of the cervix

(*b*) Separation of the membranes

(*c*) Rupture of the membranes (i) high, (ii) low

(*d*) Introduction of foreign bodies into the uterus.

The method of induction used at the Cape Town group of teaching hospitals is as follows:

1. The intravenous injection of 10 ml. of a 10% solution of calcium gluconate. This is not invariably given in the initial induction but is always the commencing point should subsequent inductions be necessary.

2. At 2-hourly intervals thereafter a hot bath is given and 2 fl. oz. of castor oil and an enema are administered.

3. Rupture of the membranes is performed a further 2 hours later; usually the forewaters are punctured.

4. Pitocin is administered by the 'drip' method if labour has not commenced 12 hours after rupture of the membranes; 5 units of Pitocin in 1,000 ml. of 5% dextrose water is used and this solution is given by the double drip method at the rate of 15 drops per minute in the first instance, the subsequent rate being adjusted according to the uterine response obtained. During the time that Pitocin is being administered the patient is under the constant observation of a person well versed in obstetrics.

The operative methods employed in the series of cases reported in this article were as follows:

	Cases
Low puncture of the membranes	1,736
High puncture of the membranes	138
Stomach tube	2
Sea-tangle tent	1

Low puncture of the membranes was the method used in the vast majority of cases, because it is considered the safest and best procedure. The value of the rupture of the membranes appears to be enhanced if as much liquor amnii as possible is allowed to drain at the time of operation.

INDICATIONS FOR INDUCTION

The indications for which labour was induced in the present series were as follows:

Pre-eclampsia, hypertensive group	1,446	76·8%
Prolonged pregnancy (i.e. beyond 42 weeks)	157	8·5%
Eclampsia	83	4·5%
Diabetes mellitus	46	2·4%
Accidental haemorrhage	48	2·4%
Placenta praevia	21	1·1%
Disproportion	6	·4%
Hydramnios	10	·7%
Rhesus incompatibility	8	·4%
Others	52	2·8%
	1,877	100%

Convenience, or 'the baby by appointment' scheme, which is reported by writers from the United States, e.g. Erving and Kentwick[1] and Ratzan and Shulman,[2] we do not consider an indication for the induction of labour. It will be shown that there are definite dangers to both mother and foetus, albeit small, which preclude this practice from being adopted in our school.

The ideal conditions for the performance of induction are as follows:

(*a*) The vertex should be presenting and should be engaged in the pelvis.

(*b*) The patient should be as near to term as possible.

(*c*) The patient should be a multigravida.

(*d*) It is stated that the cervix should be soft and well taken up, i.e. 'ripe'. Many authorities are of the opinion that the state of the cervix is an important consideration before inducing labour and that a 'ripe' cervix is a prerequisite to successful induction. At no time, however, was the 'ripeness' or 'unripeness' considered as a prerequisite in our cases. Van Dongen,[3] with many other authors, believes that an 'unripe' cervix can be converted into a 'ripe' cervix with repeated medicinal and Pitocin inductions. To this, as to all generalizations, there are exceptions, and the 'unripe' cervix which responds well to induction, as well as the

opposite, occasionally occurs. If induction is essential, the state of the cervix should not be seriously considered. The position of the cervix is also of importance. Cocks[4] claims that he is able to predict the course of labour with reasonable accuracy from the cervix. The long uneffaced cervix in the sacral position is the least favourable, for it is often associated with a long latent interval, although labour, when established, is of average duration.

1. *The Pre-Eclamptic, Hypertensive Group.* This was the operative indication in the great majority (76·8%) of cases. The time of induction and the reasons therefor are fairly well defined and do not as a rule present a problem. More often the problem arises after induction, when it becomes necessary to consider whether the induction is a success and whether more radical steps should be taken to effect delivery. The problem patient is the one with severe pre-eclampsia who is not in labour 24 hours after induction and 12 hours after the commencement of the Pitocin drip and in whose condition no deterioration is evident. A comparison between McIntosh Marshall's[5] figures for Caesarean section and the present figures for induction of labour suggest that induction should be more frequently practised before resort to abdominal delivery.

	Caesarean Section	*Induction*	
		Guy's 1928—52	*Cape Town 1952—56*
	%	%	%
Maternal deaths	1·61	1·1	·1
Stillbirths and Neonatal deaths	17·1	14·6 (3·1)*	7 (3·2)*

* Corrected.

Townsend[6] found that when labour was induced for pre-eclampsia, 97% of cases were in labour within 48 hours, and he suggests that the pre-eclamptic patient may have an irritable uterus which responds readily to induction. This view is to some extent supported by the work of Parker,[7] who, although his results are not as good, suggests a 'trial induction' or 'trial of puncture' in pre-eclampsia.

2. *Postmaturity.* 'The risk of anoxia to the foetus *in utero* after term and the risk of intra-uterine death or unexpected death in labour becomes considerable at or about 43 weeks.'[8] This statement, made by Walker[8] in 1954, has given rise to considerable controversy. The facts upon which it was based were deduced from the measurement of the oxygen saturation in cord blood, at the moment of birth and at 40, 41, 42 and 43 weeks. The normal oxygen saturation was found to be 50-60% and the distress level 30%; distress is indicated by the passage of meconium. At 40 weeks the cord blood is well oxygenated but this level falls rapidly thereafter until at 43 weeks, even before the onset of labour, the level is 30%. The term 'obstetrical deaths' was coined, standing for all stillbirths and neonatal deaths during the first week after delivery, and the obstetrical death rate was found to be 1·5% at 40 weeks, 1·2% at 41 weeks, 2·1% at 42 weeks, 3·9% at 43 weeks and 6·5% at 44 weeks. Before deciding that a patient is postmature, all available evidence should be considered, and in particular the date of the last menstrual period and the reliability of the patient's observations are important. The dates of quickening and lightening and the clinical findings at antenatal clinic, particularly in the earlier weeks of pregnancy, must all be taken into account. A medical induction is considered by some to be a diagnostic test, failure of induction indicating an incorrect diagnosis of postmaturity. This view is condemned by Arnold and Wrigley.[9] In the final analysis, however, the foetal risk in postmaturity must be weighed against the foetal risk associated with induction of labour (in this series 7%-3·2% corrected) before a decision is made. At present the reports of Racker, Burgess and Mauly,[10] and Tennent and Black[11] do not suggest that the results after induction are worse than when a policy of expectant treatment is adopted. Parker[7] states that, in a case of genuine postmaturity, delivery should always be completed within 48 hours of induction.

3. *Rh. Incompatibility.* In the treatment of Rhesus sensitization the pendulum has recently swung from one extreme, premature induction, to the other, delivery at term. This alteration of opinion has been caused by the recent work which has shown that the degree of sensitization bears no relation to the antibody-titre level or the length of exposure to the antibodies. Pre-term rather than premature induction is advocated by Evans,[12] who by this method has raised the foetal survival rate from 3·6% to 91%. Pretorius,[13] however, has shown that delivery at term produces results as good, a foetal survival rate of 85% being obtained, and Armitage and Mollison[14] conclude that premature induction probably increases foetal mortality. A poor past history (i.e. where the mother has given birth to one or more infants with haemolytic disease), previous incompatible blood transfusions, or the appearance of antibodies for the first time late in pregnancy, are factors which would influence the medical attendant towards 'premature' induction.

4. *Disproportion.* This was the indication for induction in 25·5% of cases in the Guy's Hospital series 1928-52.[15] In our series disproportion was the reason for inducing labour in only 0·4% of cases. The reason for this vast difference is the present-day safety of Caesarean section and the universal acceptance of the concept of a trial of labour where a suspicion of cephalo-pelvic disproportion exists. Most obstetricians are of the opinion that disproportion is no longer an indication for the premature induction of labour.

5. *Diabetes Mellitus.* It is an accepted fact that pregnancy must be terminated at or about the 36th week, because of the dangers to the foetus *in utero* after that time.[16] In our institutions Caesarean section is performed as an elective procedure only for an obstetrical indication. Induction of labour is performed in the first instance in the majority of pregnant diabetics. Should labour not commence, or should labour be poor or prolonged, Caesarean section is performed.

METHODS OF DELIVERY

The methods of delivery in this series of inductions were as follows:

Spontaneous			1,691
Forceps deliveries			101
Breech deliveries			23
Caesarean section:			
(i) For failure of induction	68		
(ii) for other indications	10		
(iii) for failure of induction and cephalo-pelvic disproportion	1	79	
Destructive operations			3
			1,897 (20 twins)

Success of Induction

Labour was successfully induced in 96·1% of cases. The remaining cases were either terminated by Caesarean section or labour commenced spontaneously at a later date. This figure compares favourably with other reported series: e.g. Faris and Kohlenberg[17] 94·7% success rate and, Van Dongen[3] 100% success rate in the combined method. The induction-delivery interval was 37 hours 33 minutes with high rupture of the membranes and 24 hours 43 minutes with low rupture of the membranes.

It would appear that low puncture of the membranes produces delivery after a shorter interval but, owing to the small number of high ruptures performed, this conclusion would not be warranted on statistical grounds. Gibson[18] points out that rupture of the hindwaters is less effective than a forewater puncture and Parker's results[7] tend to support this evidence. On these grounds, therefore, the recommendation of a low puncture of the membranes seems justified.

THE HAZARDS OF INDUCTION OF LABOUR

Although a relatively simple procedure, the induction of labour carries certain definite risks to both mother and foetus.

1. *Maternal Deaths*

In this series of 1,877 inductions there were 11 maternal deaths and, since maternal deaths are always of the utmost interest, summaries of these are presented:

(i) Mrs. E.P., a 28-year-old Coloured grav. 5 para 4, was admitted as a non-booked case, at term, with severe pre-eclampsia. A medicinal and surgical induction of labour was performed with the delivery 7 hours later of a stillborn 9-lb. infant. The mother developed intrapartum and postpartum eclampsia and had a total of 4 fits. Death occurred 12 hours after delivery. Autopsy revealed a subarachnoid haemorrhage and eclamptic haemorrhages into the liver, adrenals and kidneys.

(ii) Mrs. P. de L., a 26-year-old Coloured primigravida, was admitted at term with severe pre-eclampsia as a booked case. On admission the patient had 4 eclamptic fits in rapid succession and an induction of labour was performed. The spontaneous delivery of a live 6-lb. infant occurred 14 hours after induction, but in the postnatal period the mother developed oliguria followed by anuria, and death occurred on the 3rd postnatal day. Autopsy showed bilateral cortical necrosis with zonal necrosis of the liver.

(iii) Mrs. A. van R., a non-booked 17-year-old Coloured primigravida, was admitted comatose, having had 30 fits before admission. Induction of labour was performed but the patient's condition deteriorated rapidly and she died 5 hours after admission. Autopsy findings were those typical of eclampsia with associated pulmonary oedema.

(iv) Mrs. M.D., a non-booked 30-year-old Coloured grav. 4 para 3, was admitted at 34 weeks having had 4 eclamptic fits. Induction of labour was performed immediately but the patient died undelivered 3 hours after admission. Autopsy revealed the typical changes of eclampsia with a haemoperitoneum from a ruptured hepatic haematoma.

(v) Mrs. V.W. a non-booked 26-year-old African grav. 4 para 2, was admitted at 38 weeks with a severe pre-eclampsia. Induction of labour was performed, with a spontaneous delivery 5 hours later. After delivery the patient had 10 eclamptic fits in 18 hours and subsequently developed anuria, with death on the 2nd postnatal day. Autopsy revealed bilateral cortical necrosis and haemorrhage into the liver and suprarenals, associated with the typical findings of eclampsia.

(vi) Mrs. R. le R., a non-booked 28-year-old Coloured grav. 10 para 5, was admitted at 32 weeks with severe hypertension, B.P. 190/110 mm. Hg. Albuminuria with a blood urea of 372 mg.%. Induction of labour was performed, with spontaneous delivery 16 hours later. After delivery oliguria developed and the patient died on the 12th postnatal day. The clinical diagnosis was chronic pyelonephritis, aggravated by pregnancy. Consent for autopsy was refused.

(vii) Mrs. M.S. a 22-year-old Malay grav. 3 para 2, was admitted as a non-booked case at 34 weeks, having had 5 eclamptic fits and a severe accidental antepartum haemorrhage. Induction of labour was performed, with a spontaneous delivery 8 hours later. Anuria followed delivery and the patient died on the 10th postpartum day. Consent for autopsy was refused.

(viii) Mrs. G.C., a Coloured 40-year-old grav. 21 para 9, was admitted as a non-booked case at 36 weeks with severe pre-eclampsia. Induction of labour was performed, with the delivery 12 hours later of a live infant. A severe postpartum haemorrhage followed, for which a hysterectomy was eventually performed. Post-operatively, anuria developed and the blood urea rose from 182 mg.% to 260 mg.%. The patient died on the 7th post-operative day and autopsy revealed bilateral chronic pyelonephritis with dilated ureters, pulmonary oedema and septic infarcts of the lungs, and a septic grey spleen.

(ix) Mrs. C.F., a 33-year-old Coloured grav. 7 para 6, was admitted at term as a non-booked case, having had 9 eclamptic fits. Surgical induction of labour was performed and was followed by spontaneous delivery 3 hours later. Death occurred with an associated temperature of 107°F 8 hours later. Autopsy revealed the typical changes of eclampsia with haemorrhages into the pons and midbrain and into the liver.

(x) Mrs. W.D., a 42-year-old European grav. 4 para 3, was admitted at 28 weeks as a non-booked case. Three weeks previously she had undergone mastectomy for a cancer of the breast. Labour was induced, with a spontaneous live birth 3 hours later. On the 3rd postpartum day the patient collapsed and died very suddenly, either from a pulmonary embolus or secondary malignant deposits. Consent for autopsy was refused.

(xi) Mrs. S.B., a 30-year-old Coloured primigravida, was admitted at 30 weeks gestation as a grade-IV cardiac. In spite of intensive and prolonged therapy there was no improvement in the cardiac status and labour was induced, with a spontaneous live birth 12 hours later. The patient suddenly collapsed 12 hours after delivery and died in acute cor pulmonale. Consent for autopsy was refused.

The cases in which induction of labour may be indicated as a factor in the maternal death are cases (x) and (xi), but this is certainly not the only operative factor. Accepting that the induction of labour is partly responsible for these maternal deaths the maternal mortality rate would be 0·1%.

A striking fact evident from this analysis, which serves to emphasize the importance of antenatal care, is that 9 of the deaths occurred in patients who had not previously sought care at an antenatal clinic.

2. *Infant Mortality*

In this series of cases 1,897 infants were delivered, including 20 sets of twins. Stillbirths accounted for 86 foetal deaths, and neonatal deaths for 47, representing a total foetal loss of 133 (7%).

The details of the foetal deaths are as follows:

STILLBIRTHS 86

1. *Premature Infants*

(*a*) *Under* 3 *lb.*

5 associated with pre-eclampsia
3 associated with eclampsia
4 associated with accidental haemorrhage 12

(*b*) *Under* 4 *lb.*

5 associated with pre-eclampsia
3 associated with accidental haemorrhage
1 macerated foetus
1 congenitally deformed infant
1 associated with placenta praevia
1 associated with eclampsia 12

(*c*) *Under* 5 *lb.*

4 associated with accidental and unclassified APH
3 associated with pre-eclampsia
3 associated with eclampsia
2 anencephalics
2 internal versions and breech extractions
1 macerated foetus 15

(*d*) *Under* 5½ *lb.*

3 associated with pre-eclampsia
1 associated with accidental APH 4

Total stillbirths of premature infants 43

2. *Mature Infants*

17 associated with accidental and unclassified APH
11 associated with pre-eclampsia (including 2 breech extractions)
7 associated with eclampsia (1 embryotomy; 2 forceps deliveries)
2 associated with placenta praevia
2 associated with diabetes (macerated infants)
1 associated with a prolapsed cord
1 associated with cardiac disease and an unclassified APH
2 breech deliveries

43 Total stillbirths of mature infants.

NEONATAL DEATHS 47

1. *Premature Infants*

(*a*) *Under* 3 *lb.*

8 associated with pre-eclampsia
1 associated with accidental APH 9

(*b*) *Under* 4 *lb.*

7 associated with pre-eclampsia
3 associated with accidental APH
1 associated with cardiac disease
1 associated with eclampsia
1 associated with Rh incompatibility
1 died of intra-uterine pneumonia 14

(*c*) *Under* 5 *lb.*

9 associated with pre-eclampsia
2 died of intra-uterine pneumonia 11

(*d*) *Under* 5½ *lb.*

1 associated with pre-eclampsia
1 anencephalic
1 with congenital cardiac disease
1 associated with diabetes (macerated) 4

2. *Mature Infants*

4 associated with pre-eclampsia (including 1 forceps delivery)
2 associated with eclampsia (both forceps deliveries)
1 associated with accidental APH
1 twin pregnancy with pre-eclampsia (delivery by Caesarean section)
1 twin pregnancy with postmaturity 9

Total Neonatal Deaths 47

The unavoidable foetal deaths are those with no foetal heart sounds on admission, macerated infants, congenital malformations incompatible with life, and infants under 3 lb. When these are deducted from the total foetal loss, a corrected foetal mortality rate of 3·2%, composed of 43 stillbirths and 16 neonatal deaths, is obtained. The number of premature infants delivered, i.e. under 5½ lb., which were either stillborn or died subsequently, was 81. This means that 61·4% of the total foetal loss were premature infants. In addition, the total number of premature infants delivered in this series was 601, which means that 32% of all infants delivered were premature. These findings support the fact that where a large number of inductions of labour are performed all facilities should be available for dealing with premature infants.

A glance at the analysis of the foetal deaths in this series emphasizes that the infants lost are all subjected to an extra burden in pregnancy and labour in that there is in all cases a complicating maternal factor, usually of a severe nature. In the vast majority of cases this factor provides the indication for the induction of labour.

3. *Maternal Morbidity*

The morbidity rate in this series was 3·9%, as compared with a total morbidity rate in spontaneous delivery of 3·7%. In Blaikley's series[19] these figures were 10·8% and 4·3% respectively. It was shown in the Guy's Hospital series,[15] where the morbidity rate associated with induction was 5·3%, that there was a direct correlation between the length of labour and maternal morbidity. Thus, if labour lasted less than 48 hours the rate of morbidity was 6·6%, whereas if labour lasted 96 hours or longer, the morbidity rate was 20·7%. A great deal of the infection is introduced by the vaginal manipulations if the standard of asepsis and antisepsis is not maintained at the highest levels. Too frequently today aseptic and antiseptic techniques are not rigidly observed because of the reliance placed on the antibiotic cover. This attitude can only be condemned. Obviously, however, these great aids must be fully utilized, and the morbidity rate can be reduced by the routine administration of the antibiotics when the membranes have been ruptured for 12 hours or longer, or even earlier in potentially infected cases.

4. *Prolapse of the Umbilical Cord* (Incidence 0·5%)

This is a complication of surgical induction which is greatly feared by all obstetricians but is luckily a rare occurrence. In this series there were 9 cases in which the umbilical cord preceded the presenting part after the membranes had been ruptured; 8 occurred with low ruptures and 1 in high puncture. This fact is of no significance in view of the small number of high ruptures performed and it appears that the incidence of prolapse of the umbilical cord is not influenced by the type of rupture performed.[19]

A fact of considerable importance that emerges from this analysis is that this complication occurred 8 times in multigravidae and only once in a primigravida. The risk to the foetus would thus appear to be much greater in multiparae, possibly due to the greater frequency of non-engagement of the presenting part. This, too, is the reason why some obstetricians consider it inadvisable to rupture the membranes in a breech presentation and are content with stripping the membranes off the cervix only.

5. *Postpartum Haemorrhage*

No increase in the incidence of postpartum haemorrhage appears to be associated with induced labours. This fact is supported by the work of Theobald[20] and of Freedman, Taffen and Harris.[21] The over-all postpartum haemorrhage rate was 11·8%, and the use of the Pitocin drip appears to diminish it slightly; the incidence in these cases was 9·3%. This is in agreement with van Dongen's report,[3] in which the postpartum haemorrhage rate in this type of case is 7·2%, the lowest in his series of published cases.

A further reduction in the postpartum haemorrhage rate

is to be expected if the Pitocin drip, where used, is not removed at the start of the second stage so that, if necessary, it is available during, and possibly beyond, the third stage of labour.

6. *Separation of the Placenta*

This is a rare complication of induction of labour, having occurred only once in the present series. In point of fact an accidental haemorrhage results and treatment should be prompt and efficient. Parker[7] suggests that accidental haemorrhage is very often associated with an excess of liquor amnii and that this type of case would be better treated by transabdominal paracentesis uteri—a practice not used in our institutions.

CONCLUSIONS

1. Induction of labour performed in well-selected cases does not on its own endanger the life of the mother or foetus.

2. Induction does not appear to increase the postpartum haemorrhage rate.

3. A large number of the infants will be premature at birth, and for this reason adequate facilities should be available for nursing premature infants after delivery.

4. Maternal morbidity can be reduced to very small proportions by attention to asepsis and antisepsis and by the timely use of antibiotics.

5. Prolapse of the cord occurs more commonly in multigravidae, possibly owing to non-engagement of the presenting part—a factor to be considered before undertaking the procedure.

6. The foetal mortality rate in postmaturity must always be weighed against the foetal risk inherent in the induction of labour, before deciding what course to adopt.

7. Evidence available at present suggests that low rupture of the membranes is the procedure of choice in the surgical induction of labour.

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