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INTRODUCTION.

The object of this study is primarily to report the results of graphic tracings of uterine motility in the human subject, in vivo, during the later weeks of pregnancy, during labour and the first five days of the puerperium.

Once a personal skill was developed in conducting satisfactory recordings by an external hysterographic method, an investigation on the effect and action of morphine sulphate, as compared to that of pethidine hydrochloride, on myometrial activity during the above three periods was carried out.

Sixty normal primigravidae composed the total number of cases employed for this study.
REVIEW of LITERATURE.

PART I.
HISTORICAL REVIEW.

The phases through which our present knowledge of uterine motility has evolved, form a most fascinating study in the history of Obstetrics.

Hippocrates (460 - 370 B.C.) (1, 2.) failed to attribute a rôle to the uterine musculature. He believed that a child in seeking better source of nutrition brings itself forth to this world by forcing its way through the birth passages - pressing its feet hard against the fundus to accomplish such a feat. Thus presentations other than a vertex proved to be dangerous giving rise to difficult labours.

The first to assign definite function to the myometrium was Galen (131 - 201 A.D.) (1.). He described "retentive faculty" of the uterus during pregnancy and its "propulsive faculty" in labour. He believed that labour was the result of gradual dilatation of the cervix brought about by pressure of the presenting part (3).

Fabricius (1537 - 1619) (2.) brought to light "factors of labour" emphasising the importance of gravity as well as abdominal and diaphragmatic musculature supplementing uterine action necessary for the expulsion of gestational products.

Mauriceau /
Mauriceau believed that uterine contractions were a sequelae to distention.

Credit may be given to Ruysch (1722) (2.) for being the first to describe uterine musculature and for being the first to observe and feel uterine contractions in labour.

E. Brown-Sequard (1853) (1, 3, 5.) was the first to perform experimental work on the subject. He believed that carbon dioxide in maternal blood acted as a stimulus to uterine contractions, adding that with advancement of pregnancy the myometrium becomes more sensitive and irritable to carbon dioxide - this stimulus in adequate concentration precipitates energetic uterine contractions and therefore labour.

Braxton-Hicks (1871) (4.) demonstrated by abdominal and vaginal palpation that the human uterus undergoes spontaneous intermittent contractions throughout pregnancy.

Many factors have directly or indirectly contributed to our knowledge of uterine function and of these changes in the cervix and the formation of the lower uterine segment have helped greatly the advancement of our knowledge of this subject. In 1872 a study by Braune of a uterus from a woman who died in her second stage of labour, brought to light that the interior of the uterus was divided into two parts, the line of demarcation being a projecting circular /.
circular ring above which the uterus was thicker than it was below. Braune concluded that the part below the ring had been derived from the cervix. Bandl (1875) provided another view. He believed that the internal os of the cervix was situated three centimetres above the external os, and that the remaining part of the "lower uterine segment" was formed from that portion of the uterine body situated immediately above the internal os. This problem, however, was not to be solved until 1906, when Aschoff described the isthmus uteri. Later it was found that the isthmus from the third month of gestation onward, under the influence of Antenatal uterine contractions, altered its tubular structure and formed the lower pole of the uterine cavity. In addition, the passive property of lower segment, as compared to the active upper segment, provided a significant clinical point in the explanation of Bandl's lower segment rupture in cases of obstructed labour.

A survey of our present knowledge regarding uterine action in its transitional phases from the Antenatal to the labour and finally puerperal contractions, will be dealt with at a later stage.

An excellent historical summary on the development of graphic records of uterine motility has been given by S. M. Dodek (6.) and M. P. Embrey (7) who /
METHODS EMPLOYED in RECORDING UTERINE ACTION.

The highly exaggerated powers of the uterus as described by Sterne in Tristan Shandy, who placed it at 470 pounds per square inch, (3.) and Haughton of 577 pounds per square inch (3.), were once and for all disproved by Matthew Duncan (6.), and others, e.g., Poppel, and Ribmont. Placing the subject on a more scientific basis, the force required in artificially rupturing membranes outside the body was calculated. The figures obtained by Matthew Duncan ranged between the two extremes of 4 and 37.58 pounds per square inch, giving an average of 16.73 pounds per square inch, which was considered to be the expulsive power of the uterus.

Joulin and others by interpolating a dynamometer between the operator's hands and the blades of the forceps applied to foetal head, demonstrated that 120 pounds' force was sufficient to tear a child's head off, and that 80 pounds was the usual upper limits of a normal tactile force.

The following methods have since been utilised for perfecting our knowledge regarding uterine force and action:-

**Internal Hysterography.**

During the later half of the Nineteenth Century the vogue of recording movements of various organs by employing manometers, tambours, and smoked/
smoked revolving drums, was widespread.

F. Schatz (1872) (8.) was the first to carry out internal hysterography introducing a rubber bulb of 70-80 c.c.s. capacity beyond the presenting part. He was able to record intra-uterine tension in millimeters of mercury. He also was the first to obtain graphic records of labour. F. Westmark (1893) (Quoted by 6.) modified this method by employing a 2 c.c.s. intra-uterine bag.

In 1927 A. Bourne and J. H. Burn (9.) employed a disc-shaped bag of 8 c.c.s. capacity inserted between foetal membranes and the uterine wall and carried out an investigation into the action of Ergot and Pituitary Extract. The intra-uterine bag was connected by water filled tubing to a mercury manometer which traced the variation of intra-uterine pressure on a slowly revolving drum. They also demonstrated the force and characteristics of the first and second stage labour pains. This latter research has been repeated by others, e.g., Chassar Moir, whose results were identical, recording that the intra-uterine tension in the first stage of labour was equivalent to 35-60 mm. of mercury, 45 mm. being regarded as an average figure for first stage contractions. In the second stage the tension was noted to rise to as much as 90 mm. of mercury, the /
the additional pressure of 40-50 mm. of mercury being the result of the secondary expulsive powers, i.e., the bearing down efforts of the patient.

Internal hysterography is one of the most widely used methods, being employed during labour, puerperium, and in the non-gravid uterus. Among the pioneers in this work were:-

A. Bourne, J. H. Burn, C. Moir and Adair.

The following are the disadvantages encountered with this method:-

(a) Cervix needs to be over 2 fingers dilated.

(b) Anaesthetic is required for introduction of the bag.

(c) Intra-uterine bag acts as a foreign body and is liable to modify the contractions of the uterus.

(d) The required intra-uterine manipulation increases the liability to sepsis.

(e) Among other disadvantages are:-

- Requirement of one or more assistants,
- Difficulty of sterilising the apparatus,
- Possibility of rupturing the bag of membranes,
- Likelihood of separating a low-lying placenta, and
- The frequent incidence in the bursting of the intra-uterine bag.

External Hysterography.

All instruments constructed for this purpose are based on the fact that with each contraction the uterus rears itself forward, its walls increase in thickness, and corresponding change in shape of the /
the uterus gives rise to an increase in its anteroposterior diameter - all this becomes revealed externally by a simultaneous displacement of the anterior abdominal wall - (Fig. 1.)

Fig. 1. Composite Picture showing the Uterus before and during Contraction.

Hirschwald and later Rubsamen of Dresden (1913) (6, 10.) were the first to attempt this method. Rubsamen employed a cumbersome apparatus placed on a special stand on the pregnant abdomen, which recorded movements on a nearby revolving drum.

Dodek (1932) (6.) introduced a more practical and
and fairly accurate instrument - a sensitive plunger applied to a rubber diaphragm which is supported on a stand. This stand is strapped to the abdomen. An airtight system of tubing transmits any change of pressure to a second rubber tambour, which supports a writing point.

Lorands (1936) (11.) adjusted the whole recording apparatus into a compact single highly mechanical piece of clockwork, which, when strapped to the abdomen, is capable, with the aid of lever action, of recording on revolving graduated strip of paper all movements of the abdominal wall. A description of this same instrument is given by D. P. Murphy, (12, 13.).

With the aid of Lorands tocograph, Murphy investigated a large series of cases and his elaborate study was subsequently published in "Surgery, Gynaecology and Obstetrics" from 1940 to 1944, (12, 13, 14, 15, 16, 17, 18, 19,). The results of his work will be duly discussed later.

Dodek's apparatus has been modified by C. Moir (20.) and Embrey (7.). The former modification has been employed for this study and a full description of the method will be discussed in due course.

Indirect External Hysterographic Method.

Fenning et al (21.) introduced a highly sensitive /
sensitive electrical recorder. It details abdominal wall movements without being directly in contact with the patient. This is an ideal method for the study of uterine contractions in that no external factor is introduced, which, in itself might modify the contractions. Unfortunately, the apparatus is so complex, expensive, and highly technical, that it will require a great deal of modification to simplify it for general use.

Simultaneous Kinetic and Radiological Method.

This method is employed for the study of uterine and tubal motility. The apparatus includes a serial X-ray plant and a modified form of Rubin Insufflator. Its complexity makes the method purely for investigative procedure rather than for routine use - M. D. Meyer, H. Newman and A. M. Ginzler (1942) (22.).

Electrical Recordings.

Theilhaber (1910) (23.) was the first to demonstrate deflections in a string galvanometer attributable to the non-gravid uterine action. He placed one of the metal electrodes on the cervix and the other in the rectum. Other investigators followed in the same field, but all failed to obtain similar results. Bode, however, in 1931 (24.) obtained deflections with each contraction /
contraction of the uterus in labour on a string galvanometer. He employed metal electrodes, which were standardized for an electrocardiograph. The electrodes were attached to the patient's abdomen at the level of the umbilicus. This seems to be the earliest report of an attempt in recording changes in the electrical potential from the human uterus in labour.

In 1935 Falk and Nahon (25.) using an intra-uterine silver electrode obtained action currents from the non-gravid human uterus, and found that these currents could be correlated with the ovarian cycle. These findings were corroborated and extended by Jacobson and his associates in 1939 (26.). Later, Langmann, and Burr, in 1942 (27.) obtained similar results.

L. V. Dill and R. M. Maiden in 1946 (29) showed that changes in potential of low frequency and voltage accompanied labour contractions in the human uterus - the electrocardiograph, after some modification, was used for recording these changes. They stressed the many technical difficulties encountered, both in the recording and interpretation of the tracings.

Serial Radiological Hysterosalpingography.

Schultze (Quoted by 25.) was the first to employ this method. An opaque medium was injected /
injected into the uterine cavity and the latter screened. He demonstrated three functionally contracting segments — the main part being the fundus and the two horns. During maximal contraction all three segments were involved, a partial one included one or two segments. Waves were observed to be peristaltic in nature. This is a method applicable only to the non-gravid uterus.

**In Vitro.**

Strips of human uterine muscle demonstrating isolated muscle response have been studied by Adair and Haugen (1939) (31.) and C. S. Russell (1943) (32.). The former studied the activity and reactivity of 100 myometrial strips, 40 from gravid and 60 from non-gravid uteri. Action of ergonovine, adrenaline, pituitrin, and pitressin was investigated. Russell, on the other hand, investigated the reactions to pitressin and pitocin of muscle strips from the upper and lower segments of the human pregnant uterus, at, or shortly before term. He records that pitressin was approximately 25 times more powerful on the human uterus than pitocin, also that strips from lower uterine segments were more sensitive to posterior pituitary extract than strips from the upper segment. The study of the reactivity of uterine /
uterine strips in vitro is definitely helpful in advancing our physiological knowledge of the uterus although such a reaction does not simulate completely the true state of affairs encountered in vivo.

**Abdomino-Vaginal Palpation.**

R. L. Dickinson, in his discussion on the ovulation in primates (1936) (33.) states that in subjects with relaxed abdominal walls the uterine body, when seized between the fingers in the vagina and the abdominal hand goes into definite rhythmic contractions and relaxations which may be palpated. These contractions come at intervals from 2-20 minutes. With each contraction any flexion that may be present partially straightens out. The two periods of major activity correspond to the times prior to ovulation and menstruation.
REVIEW of the PRESENT KNOWLEDGE REGARDING UTERINE ACTIVITY.

Many obvious technical difficulties provided a barrier to the study of uterine motility during pre-natal, foetal life, causing the present poverty of our knowledge in this field. It will, therefore, be interesting to postulate that once the development of this organ is completed, i.e., shortly after the third month of intra-uterine life, the foetal uterus becomes exposed to the same hormonal influences as that of its mother and so may likewise be theoretically liable to undergo similar movements. An analogy to this statement may be found in the foetal breast, which is similarly exposed to the circulating maternal hormones. Whether such a state of affairs is ever existant is very much to be questioned, since the foetal uterus has a different morphology in comparison to that of its mother's. In the foetal uterus the cervix is equal in length to that of the body. Further, the one is a pregnant, uterus, while the other is not.

The period from birth to puberty, the pre-menstrual period, presents another blank phase in our knowledge on this subject. However, it is during this interval that the immature uterus gradually attains maturity so that by the time puberty/
puberty sets in the uterus is found to have more or less reached the adult configuration - the cervix will be found equal to a third of the whole organ. As a whole, this period may be taken to be a quiescent phase, resembling in some ways the inactive post-menopausal uterus.

The post-menopausal activity may be described in Leo Wilson's words - "The ovaries cease function-ing, the myometrium becomes inactive and undergoes atrophy".

The motility of the human uterus during its reproductive period, both in the non-gravid and gravid state has been thoroughly investigated by many. Their results and conclusions will now be summarised under two headings:

(a) Cycle of Myometrial Activity in the Non-Gravid Uterus.

Our present knowledge in this field is quite recent. In 1922 F. H. A. Marshall in the "Physiology of Reproduction" states that the uterus of a virgin animal is non-motile as compared with the parous uterus, and that the stimulus for uterine activity is pregnancy. Once a uterus becomes pregnant it is stimulated into activity and will retain this property for the rest of the reproductive life of that animal. The demon-stration of the oestrus cycle in 1920-1922 by Long /
Long and Evans, following on the description of the oestrus changes in vaginal smears of guinea pigs in 1917 by Stockard and Papanicoloau, focused the attention of all those working in these fields on the activity of the uterus. Years later, motility records of the human uterus began to appear in the literature. Among the many investigators into the activity of the non-gravid uterus, were C. Moir, (35, 36.), L. Wilson and R. Kurzrok (37.), and E. M. Robertson (30.).

With the beginning of a new normal menstrual cycle, about the third to the fifth day from the first day of menstruation, a graafian follicle in an ovary begins to enlarge. This maturing follicle secretes oestriol and finally ruptures between the eleventh and the fourteenth day casting the ovum free into the peritoneal cavity – ovulation marks the end of the follicular phase. Within 48 hours from the time of ovulation, progesterone and some oestrogenic hormones begin to be secreted by the corpus luteum. This is maintained until shortly prior to the onset of the next menstrual flow. The period from ovulation to the beginning of the flow is the luteal phase.

The follicular phase of each ovulatory menstrual cycle has been found associated with uterine contractions of small amplitude and short duration /
duration, coming on at the rate of 3-5 contractions per minute. A high uterine tonus has been recorded during this period. In the luteal phase, contractions were found to be larger in amplitude and longer in duration than those of the follicular phase. The former reach their maximum on the first or second day of menstruation, but their rate is slower—about 1-2 contractions being recorded per minute—C. Moir (35, 36.) The uterine tone is below that of the follicular phase. It has been stated by Wilson and Kurzrok (37.) that patients with anovular cycles, who usually possess a proliferative cystic endometrium, show only follicular phase contractions. In short, the myometrium possesses a changing cyclical rhythm which functions under the influence of the different ovarian hormones.

The general belief is, at present, that waves of contractions in the human uterus commence at both cornua, probably passing down from the tubes and travelling like a peristaltic wave towards the cervix. These facts have been amply confirmed in labour by various methods (vida infra), some having observed these directly after the opening of the abdomen, e.g. Malpas (28.). Schultze with the aid of his hysterosalpingography was the first to show the presence of similar peristaltic waves in the non-pregnant uterus. Such findings are not at all surprising as the uterus is, in a way, a modified tubal structure.
It is of interest, also, to note, that in the rabbit all uterine contractions were observed to cease during, and shortly after mating (38). A similar process may very likely take place in the human - nature's way in rendering help to the ascending spermatozoa.

It may be worth while, at this stage, to refer to the uterine "polarity" by which is meant "that when the body of the uterus is in a state of contraction the cervix is in a state of relaxation and vice versa". During pregnancy the uterine body may be regarded as in a state of relative relaxation (except during the transient waves of Alpha contractions) and the cervix is accordingly in a state of contraction. However, as term is approached, contractions become more frequent and their effects are well demonstrated in multiparae in which cases the external os under the influence of these contractions may be dilated to two or more fingers for some time prior to onset of labour.

(b) **Myometrial Activity in Pregnancy, Parturition and Puerperium.**

Structural and Chemical Alteration in the Uterus.

For the attainment of a more efficient muscular activity, the uterus during pregnancy undergoes a very extensive change in its structural make-up /
make-up. During the first half of pregnancy its enlargement is the result of hypertrophy and hyperplasia of the individual muscle cells.

The thickness of the non-pregnant uterine wall is 8 mm., but by the fourth month of gestation, it will be found that it has increased to 25 mm. and at term it is usually between 4 to 10 mm. The individual muscle fibres, however, increase in length from 50μ in the non-pregnant uterus to 200μ to 600μ in the full time pregnant uterus.

As far as the chemical contents go, there seems to be a larger store of glycogen in the myometrium of a pregnant uterus and there appears to be double the amount of phosphocreatin as in the non-pregnant uterus. There is also an increase in the glutathione and calcium (39.)

The augmentation of uterine action by the influence of increased calcium ions, its relative quiescence in calcium lack, and the influence of female sex hormones on calcium metabolism is well known — decline of calcium in pregnancy has been shown by Mull and Bill (1932) (40.) and Finola, Tremp, and Grinson (41.). Rises and decline of blood calcium with cyclical alteration in ovarian activity have been discussed by Matters (42.). Potassium lack was shown by Danforth and Ivy (43.) to /
to be just as potent a stimulus to the isolated uterus as excess of calcium ions is in the blood.

**Activity of the Pregnant Uterus.**

Activity of the pregnant human uterus has been most extensively investigated by D. P. Murphy. In one of his series (15.) 1800 cases were dealt with, and with the aid of Lorand's tocograph he obtained his earliest tracings on the 110th day of gestation, foetal movements on the 130th day, spontaneous uterine contractions on the 166th day, and he first recorded an increase in general uterine tone on the 222nd day. He also noted that rhythmic contractions appear several weeks before onset of clinical labour, and that shorter labours were to be found in patients experiencing spontaneous contractions prior to the 33rd week of gestation, and in those reacting during the last two months of pregnancy to posterior pituitary. Of those who reacted, those experiencing clonic form of contractions had shorter labours than those who experienced a tetanic form of reaction.

In summing-up, early in pregnancy the uterus is relatively quiescent, later, its activity becomes more definite until about one month before the onset of labour, when non-rhythmic contractions of great variability make their appearance. A few weeks prior to parturition, these non-rhythmic contractions /
contractions become replaced by rhythmic ones which gradually increase in intensity while retaining their frequency.

All tracings obtained in late pregnancy vary greatly from case to case, some showing only relative activity, while the motility in others are quite considerable; but the pattern of contractions noted during pregnancy form an index of the character of the future labour pains.

There are two kinds of contractions detected in the Antenatal period:—

(1) Large arrhythmic or Braxton Hick's contractions - which shall be referred to henceforth as Alpha ( ) Waves - (Fig. 2.)

Fig. 2. Diagram illustrating an Alpha Wave preceded by Beta Waves.

(2) Small /
(2) Small arrhythmic waves of one minute duration described first by D. P. Murphy (12.) - these will be referred to henceforth as Beta ( ) Waves - (Fig. 3.)

Fig. 3. Diagram illustrating Beta Waves.

**Alpha Waves.** These are usually palpable to the examiner and often noted subjectively - as a feeling of tightness. They may come on from 5 to 15 minutes' interval, but in some they are absent for over two hours. The following views on their function have been put forward:

(a) As suggested by Braxton Hicks (4.) they serve to aid the circulation of blood through uterine and placental sinuses and assist in adapting the foetus to the form of the uterus.

(b) In describing them, Leo Wilson (1942) (44.) states "it seems as though these contractions represent attempts by the uterus to vacate its contents, it is known that the uterus is capable of expelling the foetus at any stage of gestation /
"gestation. Why it does not do so is unknown, it may be assumed that some additional factor is necessary either to release the necessary energy of the uterus, or it may give the extra stimulus required for termination of pregnancy."

(c) During gestation muscle cells undergo enormous hypertrophy becoming from 7 to 11 times as long, and from 3 to 4 times as broad as in the non-pregnant organ (Williams). Further, it is believed that some degree of change in the arrangement of muscular element of the uterus takes place during pregnancy, an essential preparation for labour—these contractions help of promote such changes. Other associated points, are formation of lower uterine segment in primigravidae during the later weeks of pregnancy and some degree of effacement and dilatation of the cervix in multiparae.

(d) Alpha waves, by their contractions, assist in returning the blood to the foetal heart, which, in utero, is in a hypotonic state and therefore lacks the well developed mechanism to return its blood to the heart. — Greenhill (46).

Beta Waves. These are small arrhythmic waves neither palpable to the examiner nor perceptible to the patient, and as has already been mentioned, Murphy was the first to describe them. He referred to these waves as "regional myometrial activity". They are often seen in the Antenatal tracings but are seldom present during labour. In the series investigated they were noted in 90% of the Antenatal tracings and only in 15% of the Labour tracings. Their function is unknown.
It has always been taken for granted that as pregnancy approaches term Braxton Hicks' contractions for one reason or another become transformed into labour contractions. These labour contractions differ from the Braxton Hicks' ones in that they are painful, large in amplitude, of a higher frequency and rhythmicity, and further they possess the ability to expel gestational products.

The mode of transformation of the Alpha to the Delta Waves, i.e., Braxton Hicks to labour contractions, has not been described in detail. If such a transformation does really occur, then the following is probably what takes place. To begin with, it is quite feasible to postulate that an Alpha Wave is the product of several Beta Waves amalgamated together. Further, although hystero-graphically, both Alpha and Delta Waves resemble each other they are functionally different - Delta Waves are peristaltic in nature, and it is by reason of such a property that they are capable of terminating pregnancy. On the other hand an Alpha Wave is a non-peristaltic contraction, mainly representing the total sum of simultaneous contractions of several adjacent segments of myometrium.

As pregnancy approaches term, irritability of the myometrium becomes markedly pronounced as shown by the corresponding increase in the number of Alpha /
Alpha Waves. If, as it may happen on occasions, an Alpha Wave should coincide with a wave progressing down a fallopian tube, a peristaltic characteristic is imparted on to such a wave, i.e., an Alpha wave has changed into a Delta wave. These occasional Antenatal peristaltic, labour-like contractions, during the later weeks of pregnancy, may be the responsible factor in the development of the lower segment and the effacement of the cervix in some multiparae. Such changes have been, so far, believed to be the result of Alpha contractions. As the expected date of labour is approached the incidence of these labour-like contractions increases. Labour usually commences once a certain percentage of Alpha Waves becomes transformed into Delta Waves. With the establishment of labour, Alpha waves progressively disappear. In primary uterine inertia, even though labour appears to have started, Alpha Waves, for some reason or other, seem to persist, giving rise to delay in cervical dilatation and prolonging the duration of labour.

Labour Contractions - Delta Waves.

In the light of our present knowledge, precipitation of labour at term is not due to any one factor, but results from a combination of many.
Amongst these are:

(1) **Nervous mechanism:** Profound emotional disturbances, have on occasions been noted to bring on labour - Gibbons (1927). E. M. Robertson demonstrated the effect of emotional stress and control of the higher centres on the contractions of the human uterus.

(2) **Hormonal Influences:** This field is so complex and divergent in its results that one can only formulate a hypothesis as to the role of hormones in the termination of pregnancy. Oestrogens are known to be capable of sensitising the uterine musculature to the action of pituitrin. It is believed, therefore, that these hormones may be responsible directly or indirectly for the onset of labour contractions. Progesterone, on the other hand, if used for long, may give rise to post-maturity and it is on these findings that the lowering in the quantity of this hormone in the circulation may play some part in the onset of labour. The role of gonadotrophic hormone and posterior lobe pituitary is not yet completely understood.

(3) **Changes in the Metabolism:** This, plus the alteration in the blood mineral ions, as well as changes in the blood proteins, blood volume, and acid-base balance, have on occasions, been held responsible for the onset of labour.

(4) **Increased uterine distention:** In support of this theory, is the frequency with which premature labour occurs in hydramnios and twin pregnancy.

(5) **Senility of the Placenta:** Frequent occurrence of infarction in the placenta at term is regarded by a few as the cause of diminution in the active placental volume and therefore interferes with nutrition of the baby. Any metabolic products thus elaborated, as a result of infarction may act as a stimulus to the onset of labour.

(6) **Nature's /**
(6) **Nature's selective habit:** Children born on the 40th week of gestation have the best chance of survival.

(7) Amongst other theories that have been raised on this subject were, e.g., progressive pelvic congestion as term approached, also increased irritibility of the uterus, being "greatest at times which correspond to the suppressed menstrual periods". At these times there seems to be a tendency for the uterus to cast off the superficial part of its lining membrane. This, in the case of pregnancy, means the separation of the decidua.

However, whatever is the cause of onset of labour, the painless intermittent Alpha contractions seen in pregnancy, are progressively replaced by Delta contractions with subsequent dilatation of the birth passages and expulsion of gestational products.

Prior to the onset of labour, the uterus will be found composed of a larger and thicker upper segment as compared with the smaller and thinner lower segment. The latter may be continuous with the canal of the succulent soft cervix. In the majority of primigravidae, however, the cervical canal at this stage is fusiform in shape, 3-4 cms. in length and filled with a thick tenacious mucus. The internal os in these cases dilates only after the onset of first stage contractions. In contrast, the external os, in the big majority of multiparae will be found gaping and admits 1-2 fingers.
The forces of uterine contractions in the first stage are transmitted to the foetus as a general fluid pressure. Each contraction begins slowly (increment) reaching an acme and then declining. Each active phase is followed by an interval, the duration of which progressively diminishes as the second stage is approached. The basic level of intra-uterine pressure in labour fluctuates round about 5-15 mm. of mercury, rising with each first stage contraction to 30-60 mm. of mercury, - Richard Torphin (1947) (92.). With the upper segment becoming progressively smaller, due to subsequent contractions and retractions, the cervix and lower segment constituting the areas of least resistance become subjected to more tension and therefore distends. The "mucous plug" of the cervical canal having been expelled at the onset of labour, carries with it most of the cervical mucosa, leaving a wide canal. This happening is undoubtedly a help in directing the action of the dilating forces.

Dilatation of the cervix is accomplished in two stages. The first consists of effacement of the canal; and the second, dilatation of the external os. Amongst the contributing factors in cervical dilatation are:- the wedge shaped bag of membranes, the presenting part, traction on the edges/
edges of the cervix by the longitudinal contracting fibres of the uterus, and the uterine polarity. Rupture of the membranes usually occurs once complete cervical dilatation is accomplished.

In the second stage of labour the active and thick upper uterine segment is well demarcated from the thin walled passive lower segment and cervix by the retraction ring. The descent of the presenting part continues steadily during this stage until complete expulsion of the child is accomplished. Uterine contractions in the second stage may reach a maximum of 110 mm. of mercury, while the intercontraction tone averages between 10 and 15 mm. of mercury, about 5-7 mm. higher than that of the first stage. With the aid of the secondary forces e.g., abdominal muscles, intra-uterine pressure may reach up to 260 mm. of mercury, (the highest recorded) - Richard Torphin (1947). These latter forces are, to begin with, under the voluntary control but later become completely automatic and involuntary. Further, second stage contractions are so powerful that with each of them a pint of blood is squeezed out from the uterus into the general circulation - mainly into the vena cava; but occasionally regurgitating into the aorta. The corresponding rise in the intravenous pressure of 10 mm. of mercury with each second stage contraction constitutes one of the dangers of labour in/
in decompensated cardiac cases.

A short lull usually follows on the birth of the child after which third stage contractions and retraction contractions commence. The decrease in size of the uterine cavity produces marked disproportion between placental site and the placenta. This results in the detachment of the latter, the separation taking place at the spongy layer of the decidua basalis. The retroplacental blood and clot are no longer believed to be the cause of separation and are only considered an accessory factor in the process of placental separation. The mode of placental expulsion is either by the Schultze's or Duncan's method. After this, uterine contractions persist, coming at three minutes' intervals and by the fifth to the seventh day of the puerperium there is a considerable reduction in their amplitude, frequency and duration - W. Bickers (1942) (48.) and C. Moir (23.). Bicker also states that by the tenth day of the puerperium uterine motility is practically absent in all cases and on the fifteenth day the uterus is found atonic and contractions can not be elicited by the internal hysterographic technique, even after stimulating the uterus by massage. This decline in activity, Bicker believes, is related to the corresponding fall in the oestrin titre in the maternal blood.
REVIEW of LITERATURE.

PART II.

MORPHINE and "PETHIDINE" - SURVEY and COMPARISON.
MORPHINE.

Morphine is the most potent alkaloid of opium.

HISTORICAL REVIEW.

The soporific and analgesic effects of opium have been known from time immemorial. The ancient Babylonians, Egyptians, and Chinese appreciated the great value of this narcotic agent and employed it in the treatment of a large variety of ailments. Their source of opium was the dried juice of Papaver Somniferum, Poppy.

In the Odyssey of Homer it is recorded that the daughter of Zeus, Helen, prepared the drug dissolved in wine, to sleep off grief and danger, and to forget pain, "now, elsewhere Helen turned her head, "the child of Zeus, straight-way she cast into the wine of which they drank, a drug which quenches pain "and strife and brings forgetfulness of every ill". That drug was most probably opium.

In describing opium, Sydenham, in the 17th Century, said, "among the remedies which has pleased "Almighty God to give to man to relieve his sufferings, none is so universal and so efficacious as "opium".

Morphine was not isolated until Fredrick Wilhelm Sertturner of Paderborn, Westphalia, (1803), a Chemist, poured amonia over opium and obtained the white /
white crystalline residue which he later termed "morphium", after the Greek God of Dreams, Morpheus.

Dr. Alexander Wood of Edinburgh, (1843) was the first to inject a solution of morphine under the skin in the vicinity of a painful part, affording relief from pain.

Among the first to popularise the use of morphine in Obstetrics was Von Steinbuchel (1902). He also experimented on the effect of combined morphine and scopolamine analgesia and amnesia. However, both foetal and maternal complications were so frequent in the inexperienced hands that the vogue of "twilight sleep" has gradually lost its favour.

One may say that morphine has played an important rôle in the history of Obstetrical analgesia and in spite of its few disadvantages, e.g., depressant effect on the respiratory centres, especially that of the baby, with subsequent delay in respiration and anoxaemia at birth, one can safely state that it is still employed, in one form or another, in most Obstetric centres.

What is it that made this drug stand the test of time and retain a permanent place in the armamentarium of the Obstetrician? The reply to such a question most probably depends on one or more of the following /
following points:—

(a) The advantages of the drug outweighs its disadvantages.

(b) Evidence from the Obstetrical point of view are varied and incomplete.

(c) Lack of any better drug.

(d) The certainty of morphine action in the relief of pain and anxiety, and therefore, diminishing contributing factors that may aggravate shock.

PHARMACOLOGY.

Opium owes its activity to a large number of alkaloids of which morphine is the most potent. Codeine and Papaverine come next, but other less important alkaloids are also to be found, e.g., Narcotine, Theabine and Narcine.

Morphine depends for its action upon the interruption of pain paths within the brain, being mainly depressant, with selective action on respiration, cough and pain centres. Vomiting centre and the vagal centres in the medulla are stimulated.

Metabolism is decreased by 8-10% and the oxygen consumption is lowered by 10-15% for one hour after the administration of an average dose.

The /
The increase in the intestinal tone, the stimulation of all the sphincters and the corresponding decrease in peristalsis are collectively the contributing factors in the production of constipation. All secretory glands, with the exception of the sweat glands, are rendered inactive. Pin-point pupils and Cheyne-Stoke respiration are among the toxic signs of morphine poisoning. Morphine is an addict-producing drug if employed for too long.

The foetal brain, respiratory centre and lungs are definitely depressed by the trans-placental migration of morphine sulphate. Hence the advice being given, that morphine must never be administered within from 30 minutes to 4 hours of delivery.

Most people agree now that the effects of morphine given in average doses on well established contractions are very slight. There is usually a prolongation in the interval and occasional diminution in the amplitude of contractions. The uterine tone is diminished in a few cases, but the relief of pain is dramatic in most cases.

A comparison of morphine and "pethidine" will be discussed later.
ACTION of MORPHINE on LABOUR.

To nearly all patients in labour, morphine sulphate affords temporary relief from pains. Most of them sleep soundly from 1 to 2 hours after injection, with a further 2 hours of comparative restfulness. Some in whom the rest is not just as complete, sleep between pains and are aroused with each contraction. Clinically, the influence of morphine on uterine contractions has long been shown to be variable. In some hardly any alteration, either in the frequency or duration is noted. In others labour is hastened, while in a third group, complete cessation of contractions or diminution in the frequency and duration for over 2 hours, or longer, has been recorded. However, when contractions recur in the latter cases, they are frequently of a better quality than what they were previously. Hensen's view is still widely held that in a well established labour, morphine in moderate doses, has no effect on contractions.

Hensen (1898) (79.) was probably the first to experiment with parturient women as regards the action of morphine on their uteri. Employing internal hysterography, he found that 5–20 mgm. of morphine sulphate produced no marked effect upon well established uterine contractions.

Kehrer /
Kehrer (1907) (80.) experimenting on strips of uterine musculature found that morphine exercised a stimulating effect on them, but when used in larger doses, it depressed their action.

Barbour and Copenhaven (1915) (81.), and later Gruber et al (1935) (82.), contradicted the findings of Kehrer. They found that in the decerebrate cat, morphine caused an inconstant increase in uterine tone. They failed to detect any depressant effect. Tetanic spasm was noted on occasions when high concentrations of morphine were employed. They also noted, on occasions, that a rise in tone was associated with an acceleration in the rate of contractions. Fall, Lackner, and Krohn (1936) (93.) found that morphine diminished the frequency, but augmented actual individual contractions.

D. Slaughter and E. Gross (1937) (83.) found that morphine in the unanaesthetised bitches and rabbits produced after a latent period of 10-15 minutes a decrease in rate of contractions and a fall in uterine tonus. They endeavoured to explain these findings in terms of a possible indirect effect of morphine acting through the central nervous system. An example of direct action of this drug is seen in the immediate sharp rise in tonus of the unanaesthetised dogs' intestine which occurs after morphine. They concluded that Barbour /
Barbour and later Gruber's observation, already referred to of increased uterine tonus, may be attributed to peripheral effects of morphine, since their experiments were carried out on decerebrate animals.

Bourne and Burn in 1930 (84.) found that there was no change in uterine contractions during the first fifteen minutes after administration of morphine, thereafter relaxation of each contraction was much slowed. There was also a corresponding diminution in the frequency of contractions. They thus concluded that the work done by the uterus is just as great, if not greater, than before, despite the lessened frequency - two such tracings were recorded for this purpose by internal hysterography.

Dodek in 1932 (6.) and 1933 (85.) contradicting Bourne and Burn's conclusions, states, "it is not "the tightly contracting organ which is of value "from the mechanical stand-point, but it is the "period of increase or the increment of contraction, "which is effective". His findings on the other hand, for ½ gr. of morphine given early in the first stage, more or less resembles Bourne and Burn's tracings. He recorded that the patient became drowsy at the end of the first fifteen minutes after morphine was administered. In the second fifteen minutes /
41.

minutes the intensity of contractions became less, but the frequency was unaltered, while in the next forty-five minutes, there was an increase in the interval between contractions, and a prolongation of the relaxation phase with a rise in the uterine tone. After one hour and fifteen minutes, contractions returned to the status found prior to the administration of the narcotic. The one and a half hours rest, the psychic tranquility and the uninterrupted progress of labour with a relaxed cervix, most likely accounted for the success encountered with morphine in labour.

M. P. Embrey (1940) (7.) found that the first effect of the drug appeared twenty minutes after the injection - there was an increase in the uterine tone lasting for forty minutes, a decrease in the frequency of contractions, but only a little alteration in the intensity and duration was noted in each contraction. In another case prolongation in the decrement of contractions were noted.

Snyder and Geiling (1943) (86.), also Franklin, Snyder and Lim (87.) experimented with morphine on labouring rabbits with the following findings:

(1) After the administration of 15 times the analgesic dose of morphine to labouring rabbits, the rhythmicity of foetal breathing was unaltered, this being observed through the unopened uterus, after opening of abdominal wall.

(2) Only /
(2) Only one foetus was still-born out of 45 foetuses delivered by hysterotomy. Operation was carried out at intervals of 12 minutes to 15 hours after the injection of 13 mgm. of morphine I.V. per kilogram of body weight had been given.

(3) Spontaneous delivery in similarly treated rabbits showed 70% of stillbirths amongst the 92 foetuses delivered by the vaginal route.

Their conclusion was contrary to the general belief. They contended that the Asphyxia Neonatorum did not result from the narcotic effect of morphine on the foetus, but that the chief damage of the drug was on the labour mechanism, as was indicated in the markedly prolonged labour of all heavily morphinised mothers. Such an interpretation would explain the higher risks of morphine on premature infants, where trauma of labour is relatively severe.

McIlroy (1930) describes opium and its derivatives as an ideal sedative from the patient’s point of view, inducing restful sleep, arousing no anxiety or discomfort, aiding cervical dilatation, and exercising beneficial effect on the progress of labour. It rests a tired uterus and contractions begin again with renewed energy. Later in 1933 McIlroy and Rodway (89.) described morphine as the most valuable sedative and analgesic drug in use in labour. In a series of 560 cases they found that
that only a few did not benefit from its analgesic property. Uterine contractions remained unaltered in many cases, few had diminished frequency although the character of pain remained unaltered, but some had complete cessation of pains for a period from 2-3 hours, returning later with renewed vigour. Most patients slept for 3-4 hours. Vomiting occurred only in a small percentage. There was a slight change in maternal respiration and pulse with a slight slowing of the foetal heart rate. A careful comparison of the condition of infants at birth, delivered from half an hour to four hours after administration of the drug, revealed that in the majority spontaneous respiration occurred at birth.

Adair and Pearl in 1938 (90) after failing to obtain results from an apparatus similar to that of Dodek (6.) employed internal hysterography on uteri from the sixth to the eighth day of the puerperium. Their recordings as to the inactivity of the uterus after an initial period of observation are contrary to what is seen in some of their published tracings, where definite waves of uterine contractions could be identified. They gave 1/4 gr. of morphine after stimulating the puerperal uterii with 0.2 to 0.4 mgm. of Ergometrine and concluded that in a great number of cases both uterine tone and amplitude were un-

affected /
unaffected, while in a similar group there was an obvious increase in the height of each contraction with a corresponding diminution in the frequency, - the activity of a post partum uterus is not affected by morphine.

One cannot help but criticise such a conclusion. These observers obviously were not recording the effect of morphine on a normally contracting puerperal myometrium, but on a uterus that had been stimulated, and so the true effect of the morphine was probably altered with the presence of the stimulating effect of Ergometrine.

Mengert (1942) (91.) states that the main risks of morphine sulphate as an obstetrical analgesic is the high incidence of respiratory and circulatory difficulties in the new-born, especially in the premature. Although he stressed the danger of its use in the 2-3 hours preceding delivery, he later concluded that, while keeping in mind the limitation of the uses of this drug, there is no good reason for its complete discontinuance as an analgesic. His survey of obstetrical analgesia in 807 patients found in those receiving morphine alone or in combination, a high percentage of foetal respiratory and circulatory difficulty at birth, and of foetal death. Instruments were required three times oftener than in those receiving other analgesics and nine /
nine times oftener than in the control group which received no analgesics. He records an instance where a child lived and prospered following an administration of 2 grs. of morphine to its mother in the twenty two hours preceding its birth.

R. Torphin (1947) (92.) describes morphine as the only drug having the ability to abolish abnormal labour contractions and relieving the high uterine tension between contractions so commonly found in dystocia-dystrophia syndrome.
"PETHIDINE".

"Pethidine" or "Isonipecaine", the ethyl ester of 1-methylpiperidine-4-phenyl-4-carboxylic acid, discovered by Eisteb and Schaumann in 1939.

HISTORICAL REVIEW.

Eisteb and Schaumann (1939) (49.) while searching for atropine derivatives discovered "pethidine". Later they were the first to synthesise and introduce it under the name of Dolantin. Dolantal is the other name given to this compound by some continental workers. Amongst other early German contributors were, Dietrich (1939) (49E.), Schafer (49C.), Rosenthal (49D.) and Sonnek (49E.).

In the United States and Canada the drug was termed Demerol by Gruber, Hart and Gruber (1941) (50.). These workers carried out a most intensive investigation into the pharmacological and toxicological properties. Some of the other American papers published on Demerol were, (51, 52, 53, 54, 55, 56, 57, 58, 59, 60.). References and results of some of these publications will be dealt with later on.

In Great Britain, amongst the first to investigate this drug's pharmacological properties were A. M. E. Duguid, and R. A. Heathcoate (1940) (61.). In 1941 the General Medical Council conferred the name /
name of "pethidine" on this drug. Other articles published on this subject in Great Britain were, (62, 63, 64, 65, 66, 67, 68, 69, 70, 71.). Here again references will be made to individual articles in due course.

PHARMACOLOGY.
(With a comparison between "Pethidine" and Morphine).

"Pethidine", a derivative of coal tar, is chemically related to atropine as shown by the proximity of its structural formula to that drug. Unlike morphine, however, "pethidine" is a simple compound; but piperidine ring is common to both.

STRUCTURAL /
STRUCTURAL FORMULAE
- of -
"PETHIDINE," MORPHINE and ATROPINE.

"PETHIDINE."

("Pethidine" = Dolantin = Dolantal = Demerol = Insonipecaine = S-140 = D-140.)

MORPHINE.

ATROPINE.
The hydrochloride salt of "pethidine" is employed, both experimentally and clinically, the reason being that "pethidine" as such is highly alkaline in reaction while the hydrochloride is a crystalline powder readily soluble in water, making a solution slightly acid and with a bitter taste.

"Pethidine" like Papaverine has a spasmolytic action on blood vessels and intestine; it resembles morphine in its analgesic, sedative and euphoric properties. On the central nervous system, "pethidine" exercises a generalised depressant effect. The cough centre is little affected with average doses of 100 mgm., while the respiratory depression is never as marked as with morphine.

In ordinary doses both the circulation and respiration in the human are negligibly affected, but there are occasional sensitive cases who develop some vaso dilatation in flush areas and slight slowing in their heart rate. In dogs, however, marked lowering in blood pressure and decrease in depth of respiration were demonstrated by Gruber et al (50.).

Differing from morphine, "pethidine" relaxes the stomach, small and large intestine, and bronchi; it therefore produces no constipation and is helpful in asthmatic cases. In large doses, "pethidine" (up to 400 mgm.) produces no change in the tonus of the
the uterus, Cushny (94.).

No metabolic disturbances are produced by the administration of "pethidine". It antagonises the action of histamine on bronchioles, epinephrine on the kidney vessels, and the spasms of smooth muscles stimulated by the action of barium chloride, - Eisteb and Schaumann (49.) and Duguid and Heath-coate (61.).

The incidence of "pethidine" addiction is less marked than that of morphine on account of its more rapid destruction and excretion. The treatment for the former is simpler and more effective. Tolerance to "pethidine" is said to be maximal in eight weeks - Andrews (76.). Side reactions have been noted in 25% of cases, e.g., vomiting in 4-8%, dizziness 22%, and sweating. In toxic doses the drug may produce convulsions due to cerebral irritation and respiratory depression. A word of caution has been given regarding the combination of "pethidine" with the barbiturates since the latter increase the depressant properties of the former.

"Pethidine" is destroyed in the liver by the action of an enzyme, which hydrolyses this compound - this was shown to be the case in vitro.

(a) General. In testing the efficiency of "pethidine" in the relief of pain, Hardy, Wolff, and /
and Goodall (1940) (72.) and later, Slaughter, and Wright (1944) employed heating of the skin as a source of pain. Glazebrook and Bramwood (1945) (70.) in comparing the effect of "pethidine" and betapethidine used a mechanical method, pain being produced by pressure. All three articles confirmed that "pethidine" raised, in the majority of cases, the level of pain threshold.

Barlow (1943) was able to prove that with 100 mgm. of "pethidine" the pain threshold was raised by 50% for six hours. Batterman and Himmelsbach (1943) (52.) showed that 50 mgm. of "pethidine" had the same analgesic effect as twice the dose of 22 mgm. of codeine, also that 100 mgm. were equal in action to 1/6th given of morphine.

Batterman and Ronenstein (1943) came to the conclusion that 100 mgm. of "pethidine" in a few cases was equivalent to 2 gr. of morphine. Summarising this drug's properties they stated "Demerol appears to provide psychic sedation not surpassed by morphine, it does not depress respiration or other vital functions to the same degree as morphine does, it facilitates the induction of anaesthesia as does morphine, it is more effective in drying secretions than morphine, it has fewer unfavourable side effects and it reduces the usual amount of anaesthetic agent".

Antispasmodic /
Antispasmodic effect of "pethidine" on the ureter of animal and man has been demonstrated by Climenko and Berg (1943) (73.). They strongly recommended the drug in cases of renal calculi.

Hori and Gold (60.) showed that "pethidine" had no effect on the pulse, size of the pupil, occular accommodation or the basal metabolic rate.

The associated fall in blood pressure after the administration of the drug in certain cases has been shown to be due to a preliminary vaso-dilatation. A depression in the depth and frequency of respiration, when high doses were given I.V., has been shown by Gruber et al (50.) also Rothschild (1941) (74.) and Batterman (1943) (75.).

(b) Effect of "Pethidine" on the Uterus.

Gruber et al (1943) (50.) stated: "on the "intact and excised uterus it seems obvious that "this chemical is of no value as a uterine sedative "- the stimulant action, which is the most common "finding is much less potent than that of pituitrin". Yonkman et al (1943) (77.) share the above opinion. Previous to this N. Dreyer (1943) (Quoted by 52.) concluded that "pethidine" produced conflicting results on uterine muscle, obtaining relaxation in both the intact and excised uterus.

Solomon and Widdess (1943) (66.) found that "pethidine" acted as a stimulus to guinea pig and rabbit /
rabbit uterus in vivo and in vitro. Later, the same authors, experimenting on the human uterus with the aid of intra-uterine bags, as well as excised strips of myometrium, were in no doubt that there was an increase in the force and frequency of uterine contractions. Woodbury, on the other hand, (Quoted by 52.) using similar internal hysterographic technique, failed to demonstrate any effect of "pethidine" on the human uterus. Thorp, in a personal communication to Gallen and Prescott, (1944) (67.) said that contractions of the rabbit uterus treated with pituitary extract were enhanced when "pethidine" was given in the oestrogenic phase, but had no effect during the progestrine phase.

**ACTION of "PETHIDINE" on LABOUR.**

In Germany, Sonnek (1941), Benthin (1940 and 1942) and Fuchs (1941) were the first to describe excellent results with "pethidine" in relieving labour pains.

Spitzer (1944) (68.), giving 25 mgm. of "pethidine" orally, found it took effect in 20-30 minutes and lasted from 1-4 hours. The drug was repeated half hourly. As his results were not very satisfactory he increased the dose to 50 mgm. and /
and he was able to obtain the following results:-

17.5% greatly relieved and 72.5% had good relief.

Schumann (1944) (59.) in his review of 1000 cases, stated that the drug was unsatisfactory when administered orally. Gallan and Prescott (1944) (67.) confirmed Schumann's findings. They later administered the drug intravenously, giving 100 mgm. to begin with and noted that its effect became evident from 5-10 minutes, lasting from 3-4 hours. The only disadvantage of this method was the frequent occurrence of undesirable side effect, e.g., vomiting, temporary rise in blood pressure, tingling of limbs and dry throat. These, however, were abolished when the drug was given slowly over a period of six minutes. They obtained complete satisfactory analgesia in 60% of their 150 cases, and only 5% failed to obtain any relief. Later they employed the intramuscular route giving an initial dose of 100 mgm. when the cervix was two fingers dilated and contractions were occurring regularly. A second dose of 100 mgm. was followed in an hour's time. This second dose was either given alone or in combination with Chloral, Bromide, and Opium mixture (a total of 400 mgm. of pethidine was given in 24 hours in prolonged labours). They suggested that the drug was dangerous when given two /
two and three quarter hours before delivery of the child on account of the liability to foetal asphyxia. Fitzgerald and McArdle (64.) added that other undesirable points were encountered when this route of administration was employed, e.g., pallor, fainting, sweating, blurring of vision, tremor, and anxiety. J. Barnes (1947) (71.) described a case who felt "fighting mad" after the drug was administered. Roby and Schumann (1943) (56.) administered "pethidine" intramuscularly, alone and in combination with scopolamine.

Schumann in 1944 (78.) in a series of 1000 cases reported 70.5% satisfactory amnesia, 14% of the babies needing resuscitation.

Gilbert and Dixon (1943) (54.) repeated the initial dose of 100 mgm. of "pethidine intramuscularly (I.M.) as required up to a dose of 400 mgm. and found that labour did not stop and contractions did not cease, but in no cases where the drug was used alone (even when up to a total of 650 mgm. was given) was amnesia, as distinct from analgesia obtained in any degree. Amnesia was insured, however, when seconal was added.

Cripps, Hall and Haultain (1944) (65.) gave 100 mgm. I.M. when the cervix was 3-4 fingers dilated and contractions occurring at 4-5 minutes' interval. The effect of the drug was felt within fifteen /
fifteen minutes. A further 100 mgm. were given in 45-60 minutes and another in 2 hours' time if necessary. Forty-seven cases out of the 102 had good analgesia, and 22 had a poor and unsatisfactory analgesia. The third stage of labour was not prolonged nor was there any undue tendency to post partum haemorrhage. There were, however, 21.6% forceps delivery (as compared to the hospital rate of 13.6%). No deleterious effect of the drug on any infant was noted. In 33 cases the average time from administration to delivery was noted to be 2.6 hours, therefore, hastening of delivery was evident.

J. Barnes (1947) (71.) obtained satisfactory analgesia in 55%, restfulness and relaxation in 87%, and no effect on uterine contraction in 67%. In 23.3% contractions appeared to increase while in 8.7% they were diminished.

Batterman stressed the advantages of "pethidine" as compared to morphine in that the former has a higher margin of safety if the drug needs to be repeated. Gilbert and Dixon, also Roby and Schumann, pointed out that "pethidine" tends to shorten labour.

Effect of "Pethidine" on the Foetus.

Almost all who investigated "pethidine" are impressed /
impressed by the freedom of respiratory depression in both the full time and premature foetus. Schumann stressed this point well in his conclusion on the advantages of this drug. Greenhill states "although Demerol is supposed to cause less respiratory depression to the infant than do opium derivatives, this possible adverse respiratory effect is considered its chief drawback".

Asphyxia was recorded by Gilbert and Dixon in babies delivered within two and three quarter hours from administration.
PERSONAL INVESTIGATION.
APPARATUS.

As has already been mentioned the apparatus adapted for this study is similar to that of Professor G. Moir's modification (20.) of Dodek's hysterograph (6.).

It is essentially made up of two parts (Figs. 4 A. and 4B.) connected to each other by means of water-filled pressure tubings. Part "A" consists of a small stand (s) supporting a container (c) filled with water, with a sensitive rubber diaphragm which covers its base. This diaphragm is indirectly in contact with the patient's abdomen through a piece of cork (k). An alteration in the shape of the abdomen associated with each uterine contraction causes displacement of the cork, and therefore the diaphragm, which in its turn gives rise to a corresponding alteration in the water pressure. This pressure is transmitted via the connecting tubings to part "B". Part "B" consists of a mercury manometer with a float carrying a recording point, which writes on a smoked glazed paper attached to a slowly revolving drum. The point thus records any transmitted alteration in pressure. Prior to each recording, side bottle (T) is raised, elevating the pressure in the system to the desired level. The connecting tube is then clamped at (t) and the apparatus is then ready for use. (M) is a mercury manometer /
manometer graduated in millimetres, included in part "B" for the purpose of recording the pressure in the system.

Fig. 4A. Photographic illustration of the Apparatus employed.
Fig. 4B. Illustration representing diagrammatically the Apparatus employed.
(s) Stand, (k) Cork, (c) Container, (T) Side bottle, (M) Graduated Mercury Manometer.
PROCE DURE.

As was mentioned before, the series investigated consists of sixty selected normal primigravidae, admitted to the Simpson Memorial Maternity Pavilion, Edinburgh, between November, 1946 and March, 1947. Twenty Antenatal, twenty in Labour and twenty Postnatal cases were chosen, and in all, the foetuses presented by the vertex.

Prior to conducting any of the recordings, the confidence of each patient was first secured. A short explanation as to the workings of the apparatus was then given. After a full examination had been made, all the relevant points checked, the bladder was then catheterised. The patient was made as comfortable as possible, and was placed in the recumbent position, which posture she had to maintain throughout. The recording was then commenced. The apparatus was allowed to record from fifteen minutes to one hour and this tracing was taken as the "normal" uninfluenced uterine motility forming the control in each case. The drug was then administered. Half the number of cases in each of the three groups received an intra-muscular injection of $\frac{1}{2}$ gr. of morphine into the vastus lateralis, after which the tracing was allowed to continue for a further two hours. The remaining /
remaining thirty cases were treated in a similar fashion, but were given instead 100 mgm. of pethidine hydrochloride.

Practically all sixty cases showed a great deal of interest in watching their recordings and were most co-operative in carrying out the instructions given.

In the majority of the labour tracings the signs (X and X') were marked on individual waves indicating respectively the points where the pain was first experienced and where it disappeared. A lag from 8-16 seconds marked the usual interval between commencement of a contraction and the perception of pain. The intensity of pain usually coincided with the attainment of maximal intra-uterine pressure.

I have given my personal attention to each recording in this series, and had to be in attendance throughout the whole time of the individual recordings in labour.
METHOD ADOPTED in ANALYSING INDIVIDUAL TRACINGS.

From the analytical point of view all tracings were divided into fifteen minute intervals, each of which were then investigated as follows:

(1) Type of Contraction:

(a) Simple: Illustrated in (Fig. 5) consisting mainly of an uninterrupted wave demonstrated by a curve with a straight rise and fall. This sub-type was then further divided into:

- (a) small simple type of contraction in which the amplitude of the curve did not exceed 10 mms.
- (b) large simple contraction in which the amplitude of the curve exceeded 10 mms.
- (c) mixed simple contractions where both large and small simple waves were to be found in a fifteen minute interval.

![Fig. 5. Tracing illustrating simple large contractions.](image)

(b) Compound: Illustrated in (Fig. 6). These do not possess the smooth increment and declining form of tracing as in the Simple type. A similar division to that of the Simple type was adopted, i.e., small, large and mixed.
Fig. 6. Tracing illustrating compound large contractions.

(2) **Frequency**: Frequency is taken as the number of contractions occurring in every fifteen minutes.

(3) **Duration of Contracting Phase**: 
   - *(Increment)*: This is taken as the interval from the time the curve leaves the abscissa to the highest point on the curve. This point provided the change over from the contraction to the relaxation phase in each wave.

(4) **Duration of Relaxation Phase**: 
   - *(Decline)*: This is taken from the time the curve is at its highest point until it returns to the level of the abscissa.

(5) **Total Duration of Uterine Action**: This is equal to the sum of the increment and decline phase, i.e., 3 and 4.

(6) **Amplitude**: Amplitude or strength of each individual contraction measured carefully in millimetres each being taken from the level of the abscissa to the highest point on the curve.

Apart from the routine analysis of uterine contractions the effect of morphine and pethidine have.
have also been investigated regarding their general action on the mother, as well as the foetus, in both the antenatal and labouring cases. In addition, the degree of increase in the pain threshold regarding the latter group has been recorded.
<table>
<thead>
<tr>
<th>No.</th>
<th>Rate</th>
<th>Type</th>
<th>Amplitude</th>
<th>Duration of Increment Phase</th>
<th>Duration of Yielding Phase</th>
<th>Total Duration of Stretcher Action</th>
<th>Interval Between Contractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st.</td>
<td>4 Cont.</td>
<td>17½ mm.</td>
<td>1 min.</td>
<td>1 min 30 sec.</td>
<td>2 min 30 sec.</td>
<td>1 min 20 sec.</td>
<td>1 min 20 sec.</td>
</tr>
<tr>
<td>2nd.</td>
<td>4 &quot;</td>
<td>15½ mm.</td>
<td>50 secs.</td>
<td>2 &quot; 10 &quot;</td>
<td>1 &quot; 50 &quot;</td>
<td>2 min.</td>
<td>1 &quot; 50 &quot;</td>
</tr>
<tr>
<td>3rd.</td>
<td>4 &quot;</td>
<td>10½ mm.</td>
<td>1 min.</td>
<td>1 &quot; 30 &quot;</td>
<td>2 &quot; 30 &quot;</td>
<td>2 min.</td>
<td>2 min.</td>
</tr>
<tr>
<td>4th.</td>
<td>4 &quot; (1 hour)</td>
<td>15 mm.</td>
<td>1 min 20 sec.</td>
<td>1 &quot; 20 &quot;</td>
<td>2 &quot; 40 &quot;</td>
<td>1 &quot; 50 &quot;</td>
<td>2 min.</td>
</tr>
<tr>
<td>5th.</td>
<td>2 &quot;</td>
<td>13 mm.</td>
<td>1 &quot; 20 &quot;</td>
<td>1 &quot; 40 &quot;</td>
<td>3 min.</td>
<td>3 &quot; 20 &quot;</td>
<td>3 min.</td>
</tr>
<tr>
<td>6th.</td>
<td>3 &quot;</td>
<td>12½ mm.</td>
<td>1 &quot; 30 &quot;</td>
<td>1 &quot; 30 &quot;</td>
<td>3 min.</td>
<td>3 min.</td>
<td>3 min.</td>
</tr>
<tr>
<td>7th.</td>
<td>2 &quot;</td>
<td>11 mm.</td>
<td>1 &quot; 40 &quot;</td>
<td>50 secs.</td>
<td>2 &quot; 30 &quot;</td>
<td>3 &quot; 40 &quot;</td>
<td>3 min.</td>
</tr>
<tr>
<td>8th.</td>
<td>4 &quot; (2 hours)</td>
<td>11½ mm.</td>
<td>1 &quot; 30 &quot;</td>
<td>1 min.</td>
<td>2 &quot; 30 &quot;</td>
<td>2 &quot; 40 &quot;</td>
<td>2 min.</td>
</tr>
<tr>
<td>9th.</td>
<td>2 &quot;</td>
<td>10 mm.</td>
<td>1 &quot; 30 &quot;</td>
<td>50 secs.</td>
<td>2 &quot; 20 &quot;</td>
<td>2 &quot; 40 &quot;</td>
<td>2 min.</td>
</tr>
</tbody>
</table>

Analysis of Tracing No. 9., endeavouring to represent the method adopted in studying individual tracings.
RECORDS and DETAIL of CLINICAL FINDINGS in INDIVIDUAL CASES.

Prior to illustrating the sixty tracings there are a few points of interest to be referred to, namely:

(1) Torphin's records of painful sensation of labour contractions being first experienced at a pressure of from 25 - 35 mms. of mercury were found to be true only in 10% of the labour cases in this study. The remainder were on an average below this level.

(2) On account of the variability and difficulty in obtaining any accurate readings of the uterine tone by means of the external hysterographic technique it was deemed advisable not to record it in this series.

Of the sixty tracings two are of special interest worthy of being mentioned here. They are:

(1) Hysterogram in Fig. 7 records graphically a transitional phase from first to second stage contractions. The latter possesses typical sharp superimposed lines on the peak of each wave, which lines /
lines are the result of the increased intra-abdominal pressure due to the expulsive efforts of the secondary powers.

Fig. 7. Tracing illustrating transitional change from first to second stage contractions.

(2) Hysterogram in Fig. 8. gives a complete record of the second stage. A single sustained contraction lasting just under five minutes marks the point at which the baby was expelled. The points at which the head, shoulders, and breech emerged through the vulva have been marked on the tracing respectively. It is interesting to note in the same hysterogram, the sudden fall in the intra-abdominal pressure following on the birth of the child.
Fig. 8. Tracing illustrating complete record of the second stage.

Two full detailed examples are given (one each for morphine and pethidine) in the three separate periods investigated. Tables are also provided in order to supply the findings collectively.
LABOUR RECORDING.
(Morphine Sulphate ½ gr.)

Tracing No. 1  Fig. 9.

MRS. CATHERINE HAYES,  Age: 24.

Presentation and Position:  - Vertex. L.O.L.
Last Menstrual Period:  - 4th June, 1946.
Date of Recording:  - 23rd. March, 1947.
Length of Control Period of Recording: - 30 minutes
Total time of recording:  - 2 hours 15 minutes.

Findings in Labour: -

(1) At time of commencement of tracing: -

Labour Contractions:  - Fairly strong, well established. Coming at 1½ to 2 minutes interval.
Cervix:  - Taken up. Three fingers dilated (per rectum).
Level of Head:  - High mid-cavity.
Foetal Heart:  - Good - 125 per minute.

(2) Findings at time of administration of drug: -
No obvious change from findings in No. (1).

(3) Findings at completion of Experiment: -

Labour Contractions:  - Strong. Coming at 2 to 3 minutes interval
Cervix:  - Well taken up. Three quarters dilated (per rectum).
Level of Head:  - Mid-cavity.
Foetal Heart:  - Good - 132 per minute.

(4) State of membranes:  - Intact.

Changes noted after administration of the drug on: -

(a) The Mother.

Sleep:  - 11 minutes after administration for 1 hour 5 minutes. Wakening with each pain.
Relief of pain:  - Rise in pain threshold of 3 mm. of mercury during sleep.
MRS. CATHERINE HAYES (Contd.)

Side Effects:
- Pallor: Nil.
- Nausea: Slight. Prior to sleep.
- Vomiting: Nil.
- Other points: Pupillary constriction persisted to end of experiment.

Before | After | After | After
--- | --- | --- | ---
15 min. | 30 min. | 1 hour.

B.P. | 125/75 | 125/75 | 123/75 | 120/75
Pulse. | 80 | 84 | 60 | 85

(6) The Foetus.

No alteration or deterioration was noted in the foetal state during the entire recording.

Subsequent Progress:
- Total time in labour: 15 hours 15 minutes.
- Length of time from completion of experiment till delivery: 3 hours 30 minutes.
- Mode of Delivery: Spontaneous.
- State of child at Delivery: Cried at birth.
- Third Stage: Placenta delivered spontaneously - 45 minutes after birth of child.
- Blood loss slightly above average.

Summary of Tracing:

Following the administration of Morphine, contraction rate slowed down. There was a gradual but progressive change from first to second stage type of contractions. Diminution in amplitude for about fifteen minutes, occurring a quarter of an hour after administration of the drug. Later amplitude increased in size. No appreciable change in the total duration of individual uterine contractions. Interval between uterine contractions progressively lengthened.
LABOUR RECORDING.

(Pethidine Hydrochloride 100 mgm.)

Tracing No.11. Fig. 11.

MRS. ADRIENE GILMARTIN, Age: 21.

Presentation and Position: - Vertex. R.O.L.
Last Menstrual Period: - 18th April, 1946.
Expected Date of Delivery: - 25th January, 1947.
Date of Recording: - 5th February, 1947.
Length of Control Period of Recording: - 1 hour.
Total time of recording: - 2 hours 30 minutes.

Findings in Labour:-

(1) At time of commencement of tracing:-

Labour Contractions: - Well established.
Fair. Coming at 3 minutes interval.
Cervix: - Taken up. Two to three fingers dilated, (per rectum).
Level of Head: - High-mid-cavity.
Foetal Heart: - Good - 133 per minute.

(2) Findings at time of administration of drug:-

Same as above except that the head was at a somewhat lower level, and the cervix was three fingers dilated.

(3) Findings at completion of Experiment:-

Labour Contractions: - Strong. Coming at an average of 2 minutes interval.
Cervix: - Half dilated, (per rectum).
Level of Head: - Mid-cavity.
Foetal Heart: - Good - 135 per minute.

(4) State of membranes: - Intact.

Changes noted after administration of the drug on:-

(a) The Mother.

Sleep: - 20 minutes after administration and lasting for 1 hour 30 minutes.
Relief of pain: - Rise in pain threshold of 4 mm. of mercury during sleep.
Side /
MRS. ADRIENE GILMARTIN (Contd.)

Side Effects:
- Pallor: Yes.
- Nausea: Yes.
- Vomiting: Yes. 12 minutes after drug given.

Other points: Complained of dizziness.

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After 15 min.</th>
<th>After 30 min.</th>
<th>After 1 hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.P.</td>
<td>132/80</td>
<td>125/76</td>
<td>122/75</td>
<td>129/79</td>
</tr>
<tr>
<td>Pulse</td>
<td>82</td>
<td>77</td>
<td>75</td>
<td>77</td>
</tr>
</tbody>
</table>

(b) The Foetus.

Condition of foetus was unaltered throughout the entire recording.

Subsequent Progress:

- Total time in labour: 18 hours.
- Length of time from completion of experiment till delivery: 4 hours.
- Mode of Delivery: Spontaneous.
- Third Stage: Placenta delivered 10 minutes after child birth. Normal blood loss.

Summary of Tracing:

- Slight acceleration. No change in type of contraction. Some increase in amplitude. Unaltered total duration of individual uterine contractions. Interval between contractions diminished progressively.
PUERPERIAL RECORDING.

(Morphine Sulphate \( \frac{1}{2} \) gr.)

Tracing No. 21. Fig. 13.

MRS. ELIZABETH CORSIE, Age: 36.

Labour Records:

Presentation: Vertex. R.O.A.
Mode of Delivery: Spontaneous.
Length of time in labour: 21 hours 15 minutes.

Progress after Delivery:

Uneventful. Involution satisfactory. Temperature, pulse and respiration were normal.

Recording:

Date: - 1st. March, 1947.
Recording commenced: - 70 hours after delivery.
Length of control period in tracing: 50 minutes.
Total time of recording: 2 hours 30 minutes.

Changes noted after administration of Drug:

(1) Side Effects:
- Pallor: Nil.
- Nausea: Nil.
- Vomiting: Nil.
- Other points: Pupillary constriction.

(2) Before. After. After. After.
- Pulse 72 69 65 70.
- B.P. 110/60 105/60 102/60 105/60

Patient was sleeping fifteen minutes from administration of drug till recording was stopped.

Summary of Tracing:

Doubling of the rate after administration of drug. Type of contractions unaltered. Prolongation in the total duration of individual contractions was very slight. Progressive increase in amplitude and shortening in the intervals between contractions.

This is the only case in which Morphine acted as a stimulant to uterine musculature. The remaining ones, as can be seen in the individual tracings, showed diminution both in the rate and amplitude of individual contractions.
PUERPERIUM RECORDING.

(Pethidine Hydrochloride 100 mgm.)

Tracing No. 31. Fig.15.

MRS. JOYCE WATT, Age: 25.

Labour Records:

Presentation and Position: Vertex. L.O.A.
Mode of Delivery: Spontaneous.
Length of time in labour: 10 hours 40 minutes

Progress after Delivery:

Uneventful. Involution satisfactory. Temperature, pulse and respiration were normal.

Recording:

Date: 27th February, 1947.
Recording commenced: 67 hours after delivery.
Length of control period in tracing: 45 minutes.
Total time of recording: 2 hours 30 minutes.

Changes noted after administration of Drug:

(1) Side Effects:
- Pallor: Yes.
- Nausea: Yes.
- Vomiting: Nil.
- Other points: After-pains were relieved 15 minutes after administration of drug. Dizziness and sweating noted.

(2) Before: After 15 min. After 30 min. After 1 hour.
- Pulse: 65 63 63 65.
- B.P.: 110/72 105/70 105/70 110/70.

Patient was sleeping seventeen minutes from administration of drug till recording was stopped.

Summary of Tracing:

Rate accelerated. No change in the type of contractions. No alteration in the total duration of individual uterine contraction. Interval between contractions diminished.
ANTENATAL RECORDING.
(Morphine Sulphate $\frac{1}{2}$ gr.)

Tracing No. 41. Fig. 17

MRS. JESSIE CAWTHORNE, Age: 28.

Last Menstrual Period: - 24th May, 1946
Expected Date of Delivery: - 1st. March, 1947.
Period of Gestation: - 40th week.
Presentation and Position: - Vertex. L.O.A.

Recordings:

Date: 28th February, 1947.
Length of control period on Tracing: 40 minutes.
Total time of recording: 2 hours 30 minutes.

Changes noted after administration of Drug:

(a) On Mother.

(1) Side Effects: -
Pallor: Nil.
Nausea: Yes.
Vomiting: Nil.
Other points: "Light-headedness".

(2) Before. After. After. After.
    Pulse 80. 76. 75. 75.
    B.P. 132/80 130/75 130/75 130/75

Patient slept for 1 hour 20 minutes following on the administration of the drug twenty minutes earlier.

(b) On Fœtus.

No change was noted other than an apparent slowing of the heart rate from 130 to 125 per minute.

Summary of Tracing:

The irregularity in the occurrence of Alpha Waves made it impossible to interpret the recording. However, it appears that Alpha Waves were markedly slowed-down while Beta Waves remained apparently unaltered.
ANTENATAL RECORDING.
(Pethidine Hydrochloride 100 mgm.)

MRS. ANN HARRIS,
Age: 24.

Last Menstrual Period: 12th April, 1946.
Expected Date of Delivery: 19th January, 1947.
Period of Gestation: 40th week.
Presentation and Position: Vertex. R.O.A.

Recordings:
Date: 18th January, 1947.
Length of control period on Tracing: 30 minutes.
Total time of recording: 2 hours 15 minutes.

Changes noted after administration of Drug:
(a) On Mother.

(1) Side Effects:
Pallor: Yes.
Nausea: Yes.
Vomiting: Nil.
Other points: Dizziness.

(2) Before. After. After. After.
Pulse 80 66 65 70.
B.P. 110/73 100/70 95/65 100/70.

Patient was asleep within 12 minutes from the administration of the drug and slept throughout the recording.

(b) On Foetus.
No alteration in the rate of foetal heart which was 130 per minute throughout.

Summary of Tracing:
Alpha Waves were irregular. No alteration in type of contractions, but there was progressive diminution in their size. Beta Waves poorly developed.
Fig. 9. Illustrations of five tracings in Labour before and after the administration of Morphine. (Time marking is at minute intervals in this and other tracings).

V. = Vomiting.
Fig. 10. Illustrations of five tracings in Labour before and after the administration of Morphine.
Fig. 11. Illustrations of five tracings in Labour before and after the administration of Pethidine.
Fig. 13. Illustrations of five tracings in the Puerperium before and after the administration of Morphine.
Fig. 14. Illustrations of five tracings in the Puerperium before and after the administration of Morphine.
Fig. 15. Illustrations of five tracings in the Puerperium before and after the administration of Pethidine.
Fig. 16. Illustrations of five tracings in the Puerperium before and after the administration of Pethidine.
Fig. 17. Illustrations of five tracings in the Antenatal period before and after administration of Morphine.
Fig. 18. Illustrations of five tracings in the Antenatal period before and after administration of Morphine.
Fig. 19. Illustrations of five tracings in the Antenatal period before and after administration of Pethidine.
Fig. 20. Illustrations of five tracings in the Antenatal period before and after administration of Pethidine.
<table>
<thead>
<tr>
<th>Tracing No.</th>
<th>Rate</th>
<th>Type</th>
<th>Amplitude</th>
<th>Duration of Increment Phase</th>
<th>Duration of Decline Phase</th>
<th>Total Duration of Habitual Action Between Contractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
<tr>
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<td>+</td>
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<td>+</td>
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<td>+</td>
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<td>20</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Total</td>
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<td>5 4 1 1 3 6</td>
<td>4 2 4 2 2 6 1 4 5</td>
<td>4 3 3 5 2 3 8 1 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Tabular representation summarising the analytical findings of individual tracings in Labour.


Black = Morphine.
Red = Pethidine.
A Tabular representation summarising the analytical findings of individual tracings in Puerperium.
<table>
<thead>
<tr>
<th>Tracing No.</th>
<th>Before and After Administration of Drug and Child Bath</th>
<th>Time of Third Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Three fingers / Three quarters</td>
<td>5½ hours. 40 minutes.</td>
</tr>
<tr>
<td>2</td>
<td>Four fingers / Half dilated</td>
<td>6 &quot; 20 &quot;</td>
</tr>
<tr>
<td>3</td>
<td>Three fingers / Four fingers</td>
<td>9 &quot; 20 min. 15 &quot;</td>
</tr>
<tr>
<td>4</td>
<td>Two/Three fingers / Four fingers</td>
<td>6 &quot; 20 &quot;</td>
</tr>
<tr>
<td>5</td>
<td>Three fingers / Four fingers</td>
<td>9 &quot; 15 min. 30 &quot;</td>
</tr>
<tr>
<td>6</td>
<td>Three fingers / Four fingers</td>
<td>6 &quot; 15 min. 1 hour</td>
</tr>
<tr>
<td>7</td>
<td>Three/Four fingers / Three quarters</td>
<td>4 &quot; 15 min. 25 min.</td>
</tr>
<tr>
<td>8</td>
<td>Three/Four fingers / Fully</td>
<td>3 &quot; 20 &quot;</td>
</tr>
<tr>
<td>9</td>
<td>Three fingers / Four fingers</td>
<td>4 &quot; 30 &quot;</td>
</tr>
<tr>
<td>10</td>
<td>Three fingers / Three/Four fingers</td>
<td>9 &quot; 10 min. 35 &quot;</td>
</tr>
</tbody>
</table>

A Tabular representation summarising the findings before and after the administration of Morphine in Labour.

\[ F = \text{Forceps Delivery} \quad (f) = \text{Foetal Distress} \quad v = \text{Vomiting} \quad H = \text{Free loss in Third Stage} \]
<table>
<thead>
<tr>
<th>Tracing No.</th>
<th>At Onset</th>
<th>Duration of Tracing</th>
<th>Time Interval Between Administration of Drug and Child Birth</th>
<th>Time Length of Third Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Two/Three fingers</td>
<td>Half</td>
<td>5 hours</td>
<td>14 minutes</td>
</tr>
<tr>
<td>12</td>
<td>Three quarters</td>
<td>Child delivered while recording was in progress.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Four fingers</td>
<td>Fully</td>
<td>2 hours</td>
<td>30 minutes</td>
</tr>
<tr>
<td>14</td>
<td>Three fingers</td>
<td>Half</td>
<td>7 &quot;</td>
<td>22 &quot;</td>
</tr>
<tr>
<td>15</td>
<td>Two/Three fingers</td>
<td>Four fingers</td>
<td>6 &quot;</td>
<td>5 &quot;</td>
</tr>
<tr>
<td>16</td>
<td>Three fingers</td>
<td>Three quarters</td>
<td>4 &quot;</td>
<td>5 &quot;</td>
</tr>
<tr>
<td>17</td>
<td>Three/Four fingers</td>
<td>Fully</td>
<td>2 &quot; 15 min.</td>
<td>10 &quot;</td>
</tr>
<tr>
<td>18</td>
<td>Four fingers</td>
<td>Three quarters</td>
<td>3 &quot;</td>
<td>12 &quot;</td>
</tr>
<tr>
<td>19</td>
<td>Three/Four fingers</td>
<td>Three quarters</td>
<td>4 &quot;</td>
<td>15 &quot;</td>
</tr>
<tr>
<td>20</td>
<td>Three fingers</td>
<td>Half</td>
<td>5 &quot;</td>
<td>20 &quot;</td>
</tr>
</tbody>
</table>

A Tabular representation summarising the findings before and after the administration of Pethidine in Labour.

\[ v = \text{Vomiting.} \]
DISCUSSION.

By the employment of external hysterography, sixty tracings were obtained, each being taken for a period of from 2 to 3 hours. As the number included in this series is small, it would be impracticable to formulate any definite conclusions. However, the findings may be summed-up as follows:-

Morphine in labour diminishes the rate of uterine contractions in 80% of well established cases in labour; in 10% of cases, increased frequency of contractions was noted, while in the remaining 10% the rate of contractions was unaltered. The amplitude and size of contractions showed progressive diminution for a period of 1 to 2 hours, yet no appreciable change in the total duration of individual contractions was to be detected. Early in the first stage before labour is completely established, morphine tends to retard the normal progress. This is not the case in late first stage or during the second stage, where contractions are diminished in amplitude and frequency, but the advancement of labour is not altered to any appreciable extent. During the third stage, however, the average time taken for the expulsion of the placenta in the ten cases, was approximately forty minutes, and the /
the blood loss was just above that which is expected normally. Pethidine, on the other hand, increased the rate and progressively magnified the amplitude of individual contractions in 70% of cases, for a period of 1 to 2 hours in a similarly treated group of cases, while in a further 30%, contractions remained unaltered. Labour is not suspended noticeably when pethidine is prematurely administered and any retardation that may occur is not so prolonged as in the case of morphine. During the latter part of the first stage and the whole of the second stage, however, labour seems to be most decidedly accelerated. Findings during the third stage were unquestionably in favour of pethidine, in-as-much-as, all the placentae of the cases receiving the drug, were expelled within fifteen minutes from the birth of the child. The minimal blood loss at this stage was also noticeable when pethidine was used.

A ¼ gr. of morphine is slightly superior to 100 mgm. of pethidine, as far as the degree in raising the pain threshold goes. In the case of the former, it is raised by an average of from 3 to 10 mms. of mercury, while in the latter, the average is from 2 to 6 mms. of mercury.

Pethidine /
Pethidine seems to have shortened labour by an average of three hours when the two ten-group cases are compared. (Pages 92 and 93.)

Uterine contractions were apparently so affected in two of the cases in labour receiving morphine that the prolongation of the second stage made it necessary to terminate labour with forceps. In one of these two cases the head was arrested in the transverse position on the spines.

During the first five puerperal days, morphine acted as a powerful uterine sedative, the rate of contractions being diminished in 50% of cases, while the size and amplitude of individual contractions were simultaneously reduced. The diminution in the total duration of uterine action is due to a corresponding shortening of the declining phase of each contraction wave. Pethidine action, on the other hand, is well marked on the puerperal uterus, there being a progressive acceleration in the rate and corresponding increase in the size of each contraction for over one hour and thirty minutes. In over 50% of cases, there was an increase in the /
the total duration of uterine action due to a corresponding increase in the duration of both the increment and the decline phase of individual contractions.

It is interesting to mention that four cases, two in each group, had after-pains. The relief obtained after the administration of morphine and pethidine respectively was noticeable. Although the latter acted as a stimulant, its analgesic effect was just as pronounced as that of morphine.

It has already been mentioned that all recorded Antenatal cases were over 35 weeks of gestation. The basis employed in conducting and analysing each case during this period was exactly the same as in the other two periods. However, there was a major difficulty encountered in the Antenatal period, and this was the inconsistency and irregularity in the occurrence of Alpha Waves. In some, these contractions were absent for over two hours, while in others, their irregularity was so marked that to come to an accurate conclusion would have been practically impossible.
The side effects of both drugs seem to be more predominant in the Antenatal and Labouring cases. Vomiting occurred in 40% of the cases in labour, being equally distributed in the two groups of ten receiving morphine and pethidine. In the Antenatal group vomiting was more frequent in the cases receiving morphine, although pallor and dizziness were more noticeable in the pethidine cases.

The foetal heart is not evidently affected with pethidine when given in the Antenatal period and during the first and second stage of parturition. None of the babies delivered after pethidine administration showed any sign of respiratory depression. In the case of morphine, however, there was a suggestion of some deceleration in the foetal heart in about 60% of the Antenatal and Labouring cases, and in two of the latter group there was an associated cardiac arrhythmia in the foetus. At birth, both babies required resuscitation for marked asphyxia livida. One of the babies was a forceps delivery.

There was no foetal or maternal mortality amongst the cases investigated in this study.
In conclusion, one may add that recordings of uterine action with the method employed in this series is difficult, requiring time, skill, and patience. The apparatus is by no means an infallible instrument, yet records obtained in this way, are fairly accurate, revealing information of great value in aiding the clinical follow-up of the contractions in each case. The mainly sedative, though on certain occasions variable effect of morphine on uterine action, in labour and puerperium, has been demonstrated. Further the fact that morphine does not diminish uterine contractions in all cases was shown. On the other hand, pethidine, although it resembles morphine in diminishing the pain threshold, differed in that it acts mainly as a stimulant to both the labouring and puerperal uterus.
SUMMARY.

(1) Present knowledge on the mode of physiological action of the non-gravid, gravid, parturient and puerperal uterus is described.

(2) Types of uterine movements at different periods in the female life have been detailed.

(3) Our present knowledge on the methods of recording uterine activity in the non-gravid, as well as the pregnant and parturient uterus, has been analysed.

(4) The pharmacology of morphine and pethidine is described, with particular reference to their action on uterine movements.

(5) A comparison and an analysis of the tracings obtained by external hysterography regarding the affect of morphine and pethidine on uterine action in sixty cases in labour, puerperium and antenatal periods have been studied.

(6) Conclusions have been drawn as to the value and safety of these drugs as used in modern obstetric practice.
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