THE EFFECTS OF LABOUR ON THE FOETUS AND THE NEWBORN

[The number of foetal deaths and the mortality rate in the newborn have dropped greatly since the beginning of the century in developed and in many developing countries, but for the last ten years the figures have been almost stationary in developed countries. A recent investigation attributes almost one in three of all perinatal deaths to intrapartum anoxia, birth trauma, or both, and even if death does not occur, irreversible brain damage may be caused. A WHO Scientific Group on the Effects of Labour on the Foetus and the Newborn has examined the present situation with a view to its improvement.]

THE mortality of pregnant women and of babies has dropped steeply; the perinatal mortality in many countries, indeed, has fallen to around 30 per 1000 births. For the last ten years, however, it has remained more or less stationary. The most common cause of death in babies born at or around full term, according to a survey of perinatal mortality carried out in the United Kingdom,[1] is intrapartum anoxia, and the greatest opportunity for reducing perinatal mortality still further lies in tackling this problem along with that of cerebral and other trauma during birth. Not much is known about children who have suffered from intrapartum anoxia or trauma and survived. Some are permanently crippled and become a charge on the community for the rest of their lives; but no one knows how many spastic or mentally subnormal children owe their condition to intrapartum anoxia or birth trauma. In May 1964, a WHO Scientific Group on the Effects of Labour on the Foetus and the Newborn[2] examined the conditions in which intrapartum anoxia and trauma occur. The report of this Group has now been published.[3]

The actual causes that initiate labour are still undetermined. Successful delivery depends on the health and well-being of the mother during and even before pregnancy; and so to some extent does the fitness of the baby to withstand the stress of labour and the transition to extra-uterine life. Its survival after birth depends on its size and development, its metabolic reserves, and its capacity for haemostatic regulation. But mere survival is not the sole desideratum in childbirth; the child's future is just as important. Its capacity for a full life can only too easily be impaired by inadequate care of the mother before, during, and after delivery, and of the child after birth.

The Placenta and the Intra-uterine Environment

The placenta is the link between foetus and mother, the organ across which gases and other substances vital for the growth and development of the foetus diffuse. The complex interaction of endocrine and immunological factors in the mother, placenta, and foetus is incompletely understood. Nor is it known whether the placenta can become adapted to the needs of the foetus or whether the foetus must just make do with the placenta it has. Observations at high altitudes suggest that both mother and placenta can become adapted, but the question needs further study.

From the point of view of labour, the diffusion of hormones, proteins, and other substances is less important than gaseous exchange across the placenta and the maintenance of an adequate supply of glucose. Contrary to a commonly held view, there is no direct evidence that the foetus in a normal pregnancy outgrows the capacity of the placenta to supply its basic needs. The partial pressure of arterial oxygen in the foetus, though low by adult standards, does not fall, nor does the oxygen-carrying capacity of the blood rise, until shortly before or during delivery. The foetus does not appear to suffer from lack of oxygen, probably because of adequate oxygen saturation of the blood and the high umbilical and foetal systemic blood flow.

The great advances of recent years in the basic knowledge of pulmonary physiology are not paralleled by similar advances in the knowledge of gaseous and other exchanges across the placenta. The blood supply to the uterus can be modified by the administration of catecholamines and oestrogens, but it is not known what proportion of the flow goes to the placenta as opposed to the myometrium, nor what barriers there are to the diffusion of oxygen and solutes, nor what the oxygen consumption of the placenta itself is. There is evidence that the diffusion capacity of urea increases during the last half of pregnancy in the lamb although the placenta has already

1. Butler, N.R. & Bonham, D.G. (1963) Perinatal mortality. The first report of the 1958 British Perinatal Mortality Survey, Edinburgh and London, Livingstone.

2. Members: Professor D.H. Barron U.S.A. (Chairman); Dr. K. Benirschke, U.S.A.; Professor R. Caldeyro-Barcia, Uruguay; Dr. G.S. Dawes, United Kingdom (Rapporteur); Dr. P. Ducas, France; Dr. L.S. James, USA; Professor P. Karlberg, Sweden; Professor M. A. Petrov-Maslakov, USSR (Vice-Chairman), Secretariat: Dr. F. Mortara (Secretary); Professor J. Walker (Consultant).

3. WHO Scientific Group on the Effects of Labour on the Foetus and the Newborn (1965) Report, Geneva (World Health Organisation Technical Report, Series No. 300).

reached its maximum weight, and histological studies show that the placenta continues to develop in this, as in other, species. In general, however, there are no adequate tests of placental sufficiency, and in their absence the criteria relied on are weight, morphological appearance, and survival of the foetus.

The Effect of Labour on the Infant

A normally developed healthy infant withstands without harm the stress of normal labour, the compression of the head and body, and the transient diminution of placental blood flow accompanying uterine contractions. There are even some indications that normal labour facilitates its adaptation to extra-uterine life. But the foetus may not withstand the stress of labour when this is greater than usual, and when its physiological reserves are reduced by disease or other abnormal circumstances. Labour may then cause intrapartum death or result in the delivery of a depressed infant which does not survive or is liable to subsequent complications. Irreversible brain damage may also result from intrapartum or neonatal asphyxia when the foetal reserves are insufficient.

The immediate effect of labour on the infant has been assessed by changes in the foetal heart rate and in movements. The usefulness of these methods of assessment has been much increased during the last few years, especially by the more extensive use of automatic recording methods. Observation of these changes often gives warning of impending disaster and is useful as a guide to therapeutic measures.

A brief rapid fall of heart rate, appearing within a few seconds of the peak of a uterine contraction, is usually caused by compression of the foetal head. Of more sinister significance is a longer-lasting fall in the heart rate, reaching its minimum about 45 seconds after the peak of a uterine contraction. This bradycardia of slow onset carries a particularly bad prognosis when superimposed on a heart rate already raised above the normal level (e.g., over 160 per minute) and when associated with rapid fluctuations in rate.

The position adopted by the mother in labour varies in different countries, and even in different communities within the same country. In the opinion of the Group, adoption of supine position during labour is unfavourable to the foetus, as it leads to partial obstruction of the inferior vena cava and predisposes to compression of the aorta during uterine contractions. It was remarked that the signs of foetal distress (as instanced by prolonged bradycardia of slow onset) are decreased or abolished in a number of women by changing them from a supine to a lateral position.

Raising the partial pressure of oxygen in the mother's blood by giving her 100 per cent. oxygen to breathe causes an increase in the foetal arterial partial pressure of oxygen in experimental animals, and can sometimes reduce the signs of foetal distress during human labour. The Group agreed that the use of apparatus for anaesthesia or analgesia that allows the mother to inhable less than 21 per cent. oxygen, even for short periods of time, is potentially dangerous and should be abandoned.

Abnormal Pregnancy and Labour

Disease in the mother or disorders of pregnancy may interfere with the growth and development of the foetus, which may die *in utero*, or be born prematurely, or arrive at term poorly equipped to face the stresses of labour or the adaptations needed in the neonatal period.

The etiology of many of the disorders of pregnancy, such as pre-eclampsia or premature separation of the placenta, is unknown. Although skilled care throughout pregnancy and labour can do much to mitigate their effects, a concerted effort is needed (the Scientific Group stressed) to study them afresh by engaging the interest and co-operation of obstetricians, physicians and other specialists in related disciplines.

A disease of particular interest to the Scientific Group from this point of view is diabetes mellitus, which offers an admirable opportunity for research. Diabetes is associated with a high incidence of pre-eclampsia and poly-hydramnios in the mother and unusual growth and development in the foetus. The Group felt that if large numbers of mothers suffering from various forms of diabetes were brought together and investigated by intensive multidisciplinary teams valuable results would rapidly be obtained.

The dangers of abnormal labour are well known. Inadequate uterine contractions lead to mechanical difficulties in delivery, prolong labour, so increasing the risk of intrapartum infection, and are an indication for the use of oxytoxic drugs, which have their own dangers. Excessive uterine contractions may produce hypoxaemia in the foetus. The foetus may also suffer from hypoxaemia because of some abnormality of pregnancy resulting in an insufficient uterine blood flow at the moment of labour, or because the mother has been given spinal or epidural analgesia or drugs such as chlorpromazine.

The Normal Infant at Birth

When labour and delivery are uneventful and no sedatives or analgesic drugs have been given to the mother, the healthy newborn infant begins to breathe promptly and within a few seconds is crying lustily. How can the infant's condition be assessed other than by clinical impression, so as to facilitate comparison between infants in different countries and under different conditions ? The Scientific Group favoured the use of some such system as the Apgar scoring system,[4] which is applied one minute after birth and is based on five signs : the heart rate, the respiratory effort, muscle tone, reflex irritability, and colour. A score of zero each is given for no heart beat, no respiratory effort, no muscle tone, no response to a glancing slap on the soles of the feet, and blue or pale colour. A score of one is given for a slow heart beat and two for a heart rate over 100 ; one for a slow or irregular respiratory effort and two for a good effort accompained by crying etc. This method of evaluation might prove useful in comparing the condition of infants in different institutions and different countries in the first few

4. See : Apgar, V. & James, L.S. (1962) Amer. J. Dis. Child., 104, 419.

minutes of life, and the score at five minutes might give a better correlation with the long term prognosis.

With the Apgar scoring system most healthy infants have a score of 7 to 10 and cough or cry within seconds of delivery. Mildly or moderately depressed infants score 4, 5 or 6; their heart rate and reflex irritability are good, but sustained respiration has not been established. Severely depressed infants score 0, 1, or 2 and need immediate resuscitation. Asphyxia and maternal medication can both depress the newborn infant, and precipitous or traumatic delivery, prenatal infection, and prematurity may all play parts that are difficult to distinguish. Because of the possibility that one factor interacts with or potentiates another, additional methods of differential diagnosis are needed.

Oxygen levels in the umbilical arterial blood of vigorous infants range from zero to nearly 70 per cent. saturation, and this varying degree of hypoxia is accompanied by hypercapnia and acidosis. Birth is followed immediately by an increase in acidosis, which continues for several minutes even when lung expansion is good. This situation lends support to the view that the healthy infant become mildly asphyxiated during delivery (in the sense that it suffers from hypoxaemia plus hypercapnia and acidosis) and that oxygen supplies are low or exhausted immediately after birth. Animal experiments indicate that in asphyxia the oxygen content of the arterial blood falls to nearly zero in 2½ minutes, the carbon dioxide rising by approximately 10 Torr per minute and the pH falling by some 0·1 units per minute. The rapidity of these changes indicates that in the healthy newborn infant the period of asphyxia is probably brief; it may act as a major stimulus to respiration.

While the return of the blood gases to normal is rapid, up to 3-4 hours are needed to achieve a relatively normal acid-base balance (primarily by loss of carbon dioxide through the lungs). Within 24 hours the baby's acid-base balance is the same as the mother's before labour. The ability to make these adjustments may be impaired in premature or depressed infants.

Circulatory and Respiratory Adjustments in the Newborn

The initiation of breathing is due to a combination of asphyxia and sensory stimuli. Its maintenance, at an arterial blood oxygen pressure substantially above that of foetal life, is attributed to continued sensory stimuli to the respiratory centres, but the exact mechanism needs further investigation, especially the interaction of the oxygen and carbon dioxide pressures, the pH, and the temperature. The lungs of the normal healthy infant at term are capable of ample exchange of gases within a few minutes of birth.

Satisfactory adjustment of the circulation after birth depends primarily upon the establishment of an adequate pulmonary blood flow. The physiological regulation of the pulmonary flow in the newborn infant has not been fully elucidated and deserves study, since the passage of much blood through underventilated areas of lung results in hypoxaemia. Even less is known about the systemic circulation. The few studies made, on the blood flow to the foot and skin (which, like the brain, is proportionately a much larger organ than in the adult), show that the newborn infant can adjust these regional circulations with considerable efficiency. The Scientific Group observed that no direct measurements are yet available of the oxygen consumption of the brain, which even in the five-year-old child is half of the total oxygen consumption at rest.

Metabolic Reserves

During foetal life large metabolic reserves are normally accumulated: glycogen in the liver, skeletal muscle, and heart; and fat—the human infant, like the rabbit, having large reserves of brown fat. In the hours after birth the liver glycogen, which unlike the muscle glycogen can be mobilised for general use, falls to very low levels because the supply of glucose from the placenta has ceased. The liver glycogen is sufficient to tide the normal infant over the first 24 hours of birth, before feeding is established, but in many infants the blood glucose drops to dangerously low levels. Prolonged hypoglycaemia, especially if attended by neurological manifestations, may cause permanent brain damage. Carbohydrate metabolism at this critical period of life is therefore especially important and needs further study.

The fat stores are used to assist the infant in dealing with exposure to cold, when the oxygen consumption is raised and the temperature of the brown fat rises relatively to that elsewhere in the body. Removal of brown fat atmost wholly abolishes the ability of an animal to raise its oxygen consumption on exposure to cold and greatly impairs its thermal stability.

The metabolic reserves are relatively less in under weight infants and may be decreased by asphyxia. It is extremely important therefore that at birth the infant should be kept in a warm environment, so that its reserves are used to make the other extrauterine adjustments and not to combat cold. The metabolic situation needs further study, and in particular invites inquiry into whether the infant should be fed within the first few hours after birth and how it can be assured of adequate supplies of glucose, water, and salts.

Oxygen Consumption and the Thermal Environment in the Newborn Infant

Immediately after birth, the deep body and skin temperatures fall rapidly, the heat loss exceeding the maximum observed heat production threefold so that the body temperature always falls when the room temperature is low. This heat loss affects the infant's recovery from birth asphyxia. Vigorous infants achieve and maintain a relatively normal pH; but infants depressed for even a short period at birth fail to do so and in a cold environment develop an increasing acidosis. Since oxygen consumption is mainly regulated by the thermal gradient across the body surface, the best way of reducing the infant's metabolic rate to basal levels so that its reserves are husbanded to the maximum is to place it in an environment in which the temperature is equal to or greater than the skin temperature. At the

same time, allowance must be made for heat to be dissipated once the normal body temperature has been reached ; otherwise the temperature will raise and the infant become restless and show an increase in the metabolic rate.

The practical implications of these findings need no stressing, and indeed obstetricians are now-a-days well aware of the dangers of hypothermia in the infant. One important point is that it is not sufficient to place the infant in warm air, as in a standard incubator ; the radiating surfaces of the room must also be warm, else the conditions required for oxygen consumption at basal levels will not be obtained.

Resuscitation and Brain Damage

The object of resuscitation is to start the infant breathing as soon as possible, so restoring the uptake of oxygen and the elimination of carbon dioxide. The most effective method is to inflate the lungs with oxygen-enriched gas mixtures. If within half a minute, however, the heart-rate does not rapidly increase, the blood flow in the lungs will be inadequate and it will be necessary to carry out external cardiac massage until the heart rate increases, so as to avoid continuing asphyxia. If the infant is severely asphyxiated some minutes may pass before gasping begins, and even longer before rhythmic breathing is established.

The sequence of events in rhesus monkeys may cast some light on what happens in human infants. Asphyxia after delivery causes a brief period of respiratory efforts followed by primary apnoea, which, except when anaesthetics or analgesics have been administered to the mother, may last only a minute or two. It is followed by a succession of gasps, which may result in the establishment of breathing or be succeeded by secondary apnoea. Secondary apnoea causes permanent brain damage of rapidly increasing severity, some parts of the brain being especially susceptible. Intravenous alkali (e.g., trihydroxymethyl aminomethane) in glucose solution reduces the incidence and severity of the brain damage and restores breathing in secondary apnoea. The use of analeptics such as lobeline, however, has proved ineffective and even dangerous : and the application of cold, though it may act as a respiratory stimulant in primary apnoea, does not do so in secondary apnoea.

These findings indicate a number of subjects for further research : the reasons why certain parts of the brain are specially susceptible to damage from asphyxia, particularly in human infants ; the physiological and biochemical changes leading to the death of neurones subjected to asphyxial or other trauma ; the effects of brief periods of postnatal asphyxia on the infant (in view of the association of spastic diplegia with cyanotic attacks in premature infants) ; the relation between maturity and susceptibility to brain damage ; the study of drug antagonists for use when the mother has been given drugs during labour ; and the use of alkali to resuscitate asphyxiated infants.

Hyaline Membrane Disease

Hyaline membrane disease (or the idiopathic respiratory distress syndrome, IRDS, as it is also called) is a condition of newborn infants in which a hyaline membrane occludes the respiratory surface of the alveoli and may cause the death of the infant from asphyxia. Whether it has a single cause or a number of interacting causes is not known.

A condition similar to hyaline membrane disease has been produced in newborn lambs by rendering the mother hypotensive several hours before delivery, in newborn rabbits by giving the mother 10 per cent. oxygen to breathe before delivery, and in newborn monkeys and lambs by acute asphyxiation at birth. The etiology of the condition and the therapeutic measures to be applied might be explored in animals. But information could also be drawn from detailed observation of infants afflicted with the disease. It has, for example, been noted by experienced personnel that many of these infants are not normal at birth.

Perinatal Infection

Another hazard to the newborn infant is infection. The survey of perinatal mortality mentioned above found that in 13 per cent. of early neonatal deaths pulmonary infection was the chief cause of death. It is usually an ascending bacterial infection associated with a primary infection of the membranes, amniotic sac, and placenta, and its incidence is correlated with prolonged labour and delay between rupture of the membranes and delivery. Bacterial infections, such as those due to coagulase-positive staphylococci, *Pseudomonas aeruginosa*, or *Escherichia coli*, are to some extent preventable and can be treated with drugs during labour. Unfortunately, however, the organisms are often insensitive to the less toxic antibiotics, and the effective antibiotics (tetracycline, chloramphenicol) may endanger the infant. The Group stressed that the risk of bacterial infections is insufficiently appreciated in clinical practice.

Much remains to be elucidated in these infections. Do they, for example, precede the rupture of the membranes ? Are an increased maternal temperature and a raised foetal heart rate adequate and consistent indications of infection ? How can the organism concerned be identified ? How should the infections be treated ? Some 10 per cent.—15 per cent. of placentae show histological evidence of inflammation : can this be attributed in all instances to infection ?

Drugs in Pregnancy and Labour

The thalidomide disaster focussed attention on the effects of drugs in early pregnancy, but much less attention has been paid to those of drugs in late pregnancy and labour. And yet anaesthetics, analgesics, hypnotics, and sedatives are all given to the mother, as well perhaps as other drugs for the treatment of any disease she might have, with little or no knowledge of their possible effects on the newborn infant, whose enzyme systems and detoxication and excretion mechanisms may be very different from those of its parents.

The Group consequently recommended that new drugs used in late pregnancy and labour and in the newborn should be tested in animals in circumstances as close as practicable to those in which it is proposed to use them in humans, and that controlled clinical trials

(*Contd. on page 19*)

HOME NURSING

BY

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IT was strongly felt during the International Home Nursing Instructors' meeting held in Geneva in June 1965 organised by the Nursing Bureau, League of Red Cross Societies that in order to make an effective approach to Health Education of the Public, Home Nursing Instruction should be imparted in the community by trained nurses.

Nurses by nature of their training and capacity to impart nursing instruction including practice of nursing procedures, are well qualified to give this service for the enhancement of good health in our country. The Home Nursing course is one of sixteen hours given in 8 sessions of 2 hours each, (one hour theory and one hour practice) and includes taking care of the sick and injured at home, helping to prevent the spread of infectious diseases, and making good use of time, energy and money in caring for the sick. This course can be given to community people including housewives, social and village level workers, college students and secondary school children, who on successful completion of the course can obtain the St. John Ambulance Association Home Nursing Certificate which is valid throughout India.

In order that nurses may make an effective contribution to this important activity of the Indian Red Cross Society, I give below a few instructions in the methods underlying the conduct and examination of the St. John Ambulance Association courses.

A convenient class room with necessary equipment for a group of 16 to 25 persons should be arranged where eight classes can be held once or twice a week, the ninth session being used to hold the examination. Any trained nurse is qualified to teach this course and the examination is conducted by a trained nurse other than the teacher. Two copies each of the Examination Form A/3 and the class Attendance Sheet A/16 should be obtained from the Secretary of your St. John Ambulance Association State Centre. These forms must be *filled in duplicate*, as one set will be retained by your Centre and the other sent to Headquarters in New Delhi for issue of certificates.

On the front page of the Examination Form, "Explanation of Marking the Paper" is printed which should be noted carefully by the Examiner in order to mark accurately. It is important for the candidates to give their signatures on *both the examination forms*, prior to conducting the examination.

Five questions must be asked—bandaging being compulsory, and if no paper is set, one question in *viva voce* must be given in its place. Maximum number of marks for each question is 20. Total for 5 questions is 100 marks out of which 50 per cent. is pass marks.

On the back page of the Examination Form, the Instructor must mention her/his name, qualifications (i.e. R.N., R.M. or B.Sc. (Nursing) and full address. The Examiner, after making the necessary entries in the appropriate columns, must also sign clearly giving qualifications.

These forms in duplicate along with the Certificate fee of Re. 1 per successful candidate must be sent to the Secretary of your State St. John Ambulance Centre, who will forward one copy and the money to the Headquarters.

In the accompanying letter, it should be mentioned to whom you wish the certificates to be sent for distribution to the candidates after the Examiner has signed the Certificates.

A copy of the booklet "Regulations for Organisation, Instruction and Examination of classes etc."—price 30 paise, and the "Home Nursing Tutor's Guide"—price Rs. 3.35 per copy are available for sale with the Stores Officer, St. John Ambulance Association Stores Depot, 1 Red Cross Road, New Delhi—1, and may be obtained from him direct if desired.

I am grateful to the nurses who have been and are still giving this important service to the Red Cross and hope that other nurses will join us in helping to spread the teaching of Health in the Home to the general public.

The Effects of Labour on The Foetus and the Newborn—(*Continued from page 18*)

should be made before they are generally released. There is also a strong case, it felt, for doing the same with some drugs in current use.

Training and Research

Particularly in obstetrics, there is a grave shortage of clinical staff with a grounding in one or more of the basic or paramedical sciences. The Group therefore recommended that future specialists, early in their career, be enabled and encouraged to spend a year or more in a department of anatomy, physiology, pharmacology, biochemistry, or pathology.

The Group also included in its report a detailed list of recommended investigations, including some requiring both a clinical and a basic science approach.

* * *

The conclusion that seems to follow from the Scientific Group's report is that there is ample scope for further improvement in the care of mother and child throughout pregnancy and in labour. With increased knowledge of the complex processes involved in labour and in the adjustments made by the newborn infant to the extra-uterine environment, it would not be unduly optimistic to expect still further falls in perinatal mortality and morbidity and in the disturbances in later life that are most probably due to damage at this most critical period.

(*With acknowledgements to WHO Chronicle*)