A STUDY OF THE ONSET OF RESPIRATION IN THE NEWBORN

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In this study the different types of respiratory onset have been observed at the birth of 190 babies, and as a preliminary a brief review is made of the development of the mechanism for pulmonary respiration and the factors involved in the onset of such respiration.

Development of the Mechanism for Pulmonary Respiration

Barcroft (1946), in a series of experiments on sheep foetuses, observed the physiological development of the foetal nervous system. It starts at the lower part of the medulla, at the thirty-fourth day in the sheep, when the first reflex movements are obtainable. Stimulation of the trigeminal nerve at first causes localized movement of the head, then movements of the rest of the body, including the diaphragm. At the next stage the same stimulation causes a series of 10 to 20 rhythmic spasms involving the whole body. Each spasm resembles a gasp.

Barcroft was able to transect the brain in older foetuses without disturbing their growth *in utero* and by transecting at different levels he identified the parts of the brain involved in the different types of reflex movements.

The second stage of rhythmic spasms was found to involve the upper part of the medulla.

The third stage, one of segregation, develops about the forty-fifth day, when stimulation of the trigeminal nerve caused a movement of the whole body, followed, after a pause, by a respiratory rhythm. At this stage the pons Varolii is functioning.

The foetus becomes increasingly sensitive to stimuli and then, about the sixtieth day, becomes quiet. The stage of inhibition has developed and a sharp stimulus is necessary to produce any reflex movement. It involves the functional development of the inferior corpora quadrigemina.

The nervous mechanism for pulmonary respiration is now completed but, as the halfway period of gestation has not been reached, it will be seen that

the mechanism is ready long before it is required, and it is known that this mechanism even functions before birth, for Davis and Potter (1946) have shown that the foetus 'inspires' amniotic fluid.

Factors in the Onset of Respiration

The onset of respiration is believed to be caused by chemical rather than physical factors.

Immediately after birth the placental circulation is markedly impaired by the contracting and retracting uterus. This results in a diminution of the oxygen supply to the foetus and an increase in the carbon dioxide tension in the blood stimulating the respiratory centre to action. Schmidt (quoted by Smith, 1945) has shown that although the respiratory centre in the medulla is normally sensitive to changes in carbon dioxide tension in the blood, the chemoreceptors in the aortic and carotid bodies are particularly sensitive to oxygen lack and reflexly stimulate the respiratory centre.

Where anoxia is too great, the respiratory centre, together with the aortic and carotid bodies, becomes paralysed and the onset of respiration fails to take place. Heavy sedation also has a depressant action.

Types of Onset of Respiration

This study of the onset of respiration in the newborn was undertaken to determine the type of onset which occurred most commonly and four series of cases were observed.

(1) Spontaneous deliveries	125 cases
(2) Forceps deliveries	35 cases
(3) Caesarean section deliveries	20 cases
(4) Breech deliveries	10 cases

As will be seen from Table 1, the gasp, or short inspiratory respiration, was the most frequent type of onset in all modes of delivery. This included all cases where the gasp was distinct, although followed almost immediately in some cases by the onset of continuous respiration. Also included in this group were those cases where the onset was a cry, because,

although the predominant part of the breath was expiratory, there was a preliminary short inspiration.

According to Barcroft the gasp indicates that only the lower part of the medulla is functioning, the inference being that the centres higher up have been rendered functionless, probably by anoxaemia. These parts of the brain, having started functioning later than the medulla, are affected earlier.

TABLE 1
TYPE OF ONSET IN FOUR MODES OF DELIVERY

Type of Onset	Spontaneous Births	Forceps Births	Caesarean Sections	Breech Births	Total
Gasp	109	34	16	10	169
Rhythmic gasps with general body movements	4	0	1	0	5
Rhythmic gasps alone	12	1	3	0	16
Normal quiet respiration	0	0	0	0	0
Total in series	125	35	20	10	190

The second type of onset was seen in very few cases. Here a regular series of gasps occurred, associated with movements of other muscles, usually of the head and neck alone, but occasionally of the limbs also. According to Barcroft, the higher parts of the medulla were thus functioning.

In a slightly larger number of cases a series of gasps occurred without other muscular movement. This was the third type of onset and indicated that the eighth nerve nucleus was functioning.

No cases were seen where normal quiet respiration occurred from the onset. This meant that the centres above the pons were not functioning. It will therefore be seen that in all the cases studied, a degree of anoxaemia was present, extending to various levels in the brain.

Barcroft suggested two methods of inducing the onset of respiration. First, by the weakening of the inhibitory control originating above the pons, and, secondly, by increasing the bombardment of sensory impulses upon the lower centres so that they overcome the inhibition. In all cases studied, therefore, the onset of respiration occurred following the weakening of the inhibitory control due to anoxaemia.

Barcroft described one case where the onset of respiration was a single prolonged respiration, and suggested that this was an intermediate type. There was however, no case in this series where the inspiration was prolonged and could be termed anything more than a gasp.

Delay in Onset of Respiration

The periods of apnoea preceding the onset of the first respiration and the onset of continuous respiration were also observed and are noted in Tables 2 and 3.

TABLE 2
TIME BEFORE THE ONSET OF FIRST RESPIRATION

Onset of First Respiration	Spontaneous Births	Forceps Births	Caesarean Sections	Breech Births	Total
Within 5 seconds	94	2	3	0	99
Within 1 minute	27	14	13	8	62
Within 2 minutes	4	10	0	0	14
Within 5 minutes	0	8	2	2	12
Within 8½ minutes	0	1	2	0	3
Total in series	125	35	20	10	190

TABLE 3
TIME BEFORE THE ONSET OF CONTINUOUS RESPIRATION

Onset of Continuous Respiration	Spontaneous Births	Forceps Births	Caesarean Sections	Breech Births	Total
Within 5 seconds	53	0	0	0	53
Within 5 minutes	65	31	10	9	115
Within 10 minutes	7	4	10	1	22
Total in Series	125	35	20	10	190

As would be expected, the onset of the first respiration was delayed in the abnormal types of delivery. This was particularly the case in the forceps deliveries, where compression of the head by the forceps blades and cerebral oedema and haemorrhage cause further anoxaemia of the respiratory centres.

A certain degree of anoxaemia, however, is necessary to overcome the inhibitory control of respiration. This anoxaemia takes longer to develop in cases of Caesarean section where delivery is rapid and this explains the high proportion (50 %) of cases where the onset of continuous respiration was delayed for more than five minutes.

Summary

The onset of respiration was observed in 190 cases comprising four series, namely spontaneous, forceps, Caesarean and breech deliveries.

The gasp, or lower medullary type, most frequently initiated respiration in all groups.

In no case did the onset occur with normal respiration, indicating that some degree of anoxaemia was present in all cases.

The periods of apnoea before the onset of respiration were noted. The longer periods of apnoea occurred mainly following abnormal types of delivery, due probably to superadded cerebral oedema and haemorrhage.

I wish to thank Professor Kellar who suggested this study and in whose unit in the Simpson Memorial Maternity Pavilion the deliveries took place.

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