A NURSING PROCEDURE FOR FETAL HEART RATE AUSCULTATION DURING LABOR

by

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ABSTRACT

For many years attempts have been made to define clinically the indicators of fetal distress during labor. But the criteria for fetal distress have not been clearly defined and frequently paradoxical clinical situations have existed. Increased comprehension of the intrauterine state of the fetus has been the object of much perinatal research. Significant advances in fetal electrocardiography, biochemical studies and clinical assessment of the newborn have been made. Certain changes in fetal heart rate have been observed in association with uterine contractions and have been correlated with biochemical and clinical evidence of fetal and neonatal distress.

Caldeyro-Barcia, one investigator of fetal heart rate changes during labor, identified two changes which indicate fetal distress; tachycardia, and a fall in rate which starts at or following the peak of the uterine contraction, reaches minimum values 30 to 50 seconds later, and recovers to initial values in about the same length of time as the fall. This pattern he calls a Type II dip. He states that these two indicators can be recognized by clinical auscultation if it is performed in a serial manner which he describes.

A modification of this suggested serial auscultation procedure was carried out during the labors of 15 women to test in a beginning way the feasibility of the clinical application of this medical research finding to nursing

practice. The results indicated the auscultation procedure to be feasible if care is taken to maintain mother and nurse comfort, distractions are kept to a minimum and time is allowed for the procedure. Fetal heart rate patterns were identified and some recognized as resembling Type II dips. In addition, relationships were demonstrated between the two indicators (tachycardia and fetal heart rate patterns resembling Type II dips) and Apgar rating one minute after birth. The association of tachycardia and appearance of patterns resembling Type II dips with low Apgar rating of the newborn supports the findings of Caldeyro-Barcia.

INTRODUCTION

The rate of perinatal deaths has dropped greatly since the beginning of the century. However, for the last ten years the figures have remained almost stationary in developed countries (World Health Organization, 1965, p. 184). The position of the United States in regard to perinatal mortality number is falling among the nations of the world (United Nations, 1966). The problem of preventable perinatal wastage needs to receive more attention.

A normally developed, healthy infant appears to experience without harm the stress of normal labor. But the fetus may not withstand the stress of labor when this is greater than usual or when the infant's physiological reserves are reduced by disease or other abnormal circumstances such as umbilical cord occlusion or utero-placental insufficiency. Labor may end with the delivery of a depressed or stillborn infant (World Health Organization, 1966; Romney, 1966; Caldeyro-Barcia, 1966).

For many years attempts have been made to define clinically the indicators of fetal distress during labor. But the criteria for fetal distress have not been clearly defined, and frequently paradoxical clinical situations have existed. If the practitioner were able to define fetal situations that reflected distress he would be obligated to initiate therapeutic measures to improve the intrauterine environment or to deliver the fetus from the environment.

Increased comprehension of the intrauterine state of the fetus is the object of much perinatal research. Such fetal homeostasis is dependent upon oxygen transfer from mother to fetus and upon effective umbilical and fetal circulation, studies have focused on the related maternal, placental and fetal variables contributing to fetal hypoxic stress.

Biochemical Substrata for Fetal Hypoxic Stress

Recent investigations (Saling, 1966; Mishrahy, 1962) of fetal and maternal pH, Pco_2, Po_2, fixed acids and buffer base levels have provided wide ranges of normal values and have shown that deviation from those ranges is the biochemical substratum for fetal hypoxic stress. Rooth (1964; 1965) and James (1960) have demonstrated that the initial biochemical disturbance in hypoxic stress is one of progressive maternal or fetal acidosis. James, Weisbrot, Prince, Holaday, & Apgar (1958) and Méndez-Bauer, Arnt, Gulia, Escarcena, & Caldeyro-Barcia (1967) obtained positive correlations between Apgar score of the newborn and pH of fetal blood. Two investigators offer a definition of fetal distress during labor (fetal hypoxic stress); a disturbance of fetal homeostasis characterized by a decreased oxygen supply to the fetus, a low pH, and a high Pco_2, (Caldeyro-Barcia, 1966, p. 7; Romney, 1966, p. 60).

Mechanisms of Fetal Hypoxic Stress during labor

The mechanisms by which labor impairs transport of oxygen and carbon dioxide are not well understood. A current hypothesis that is supported by some researchers (Borell, Fernström, Ohlson & Wiquist, 1964; Caldeyro-Barcia 1966; Wright, Morris, Osborn, & Hart, 1964) is that each uterine contraction produces a transient episode of fetal hypoxia, caused by changes in maternal arterial inflow, venous outflow, and intramyometrial pressures which isolate the intervillous space. A more severe hypoxia would result if abnormal uterine contractility is encountered. The effects of a significant maternal acidosis, as from a long arduous labor, on an already compromised fetal-placental circulation, would further reduce oxygen transfer (Romney, 1966, p. 59).

Fetal Evidence of Hypoxic Stress

Alterations in fetal heart rate during labor have been the subject of much study. Recently these studies have used the fetal electrocardiograph as a trigger for the cardiotachometer and an electromanometer attached to an intrauterine catheter. This combination has afforded a simultaneous recording of fetal heart rate and uterine contractions throughout labor (Caldeyro-Barcia, 1966; Hon, 1962). Hon (1968, p. 38) and Caldeyro-Barcia (1966, p. 7) have identified fetal heart rate (FHR) patterns during labor that they hypothesize to be compensatory reactions of the distressed fetus and that provide useful tools for the early diagnosis of fetal distress.

A resumé follows of the description of FHR phenomena and assigned terminology from the study of 50 labors by Caldeyro-Barcia and his group (1966, pp. 7-13).

Fetal Heart Rate Phenomena as described by Caldeyro-Barcia

1. The basal fetal heart rate was measured during the interval between "dips" and ascents and falls of FHR. It was measured as the average value

between peaks and depressions. Basal rates with a mean value of 143 beats/minute were recorded in 35 normal labors delivering a vigorous newborn (Apgar 7-10). In 15 labors delivering a depressed newborn (Apgar 6 or lower) the mean basal rate was 165 beats/minute. This basal rate was significantly higher (p 0.001) than that of the control group of vigorous newborns. Therefore, persistent elevation of a basal FHR above 160 (tachycardia) was considered a sign of poor prognosis for the fetus.

2. Rapid fluctuations, transient ascents and spikes were described as rhythmical variations and sudden increases or decreases in FHR that showed no relationship to Apgar score of the newborn.

3. Dips. A dip was a transient fall of FHR caused by one uterine contraction. Between contraction and dip there was a consistent and characteristic time relationship. The dips were classified into two types, I and II.

The amplitude of the dip, measured in beats per minute, was the difference between the basal FHR preceding the dip and the minimal FHR recorded at the bottom of the dip. When amplitudes were totaled throughout a labor, the sum was an index of amplitude. The duration of the dip was the time during which the FHR remained below the level of the basal FHR preceding the dip. The lag time was the interval, measured in seconds, that elapsed from the peak of the contraction to the bottom of the corresponding dip. The lag time became the criterion for the recognition of the type of dip. The lag time of Type II dips was significantly greater than that of Type I dips. Figure 1 illustrates these variables and the chronological relationship between fetal heart

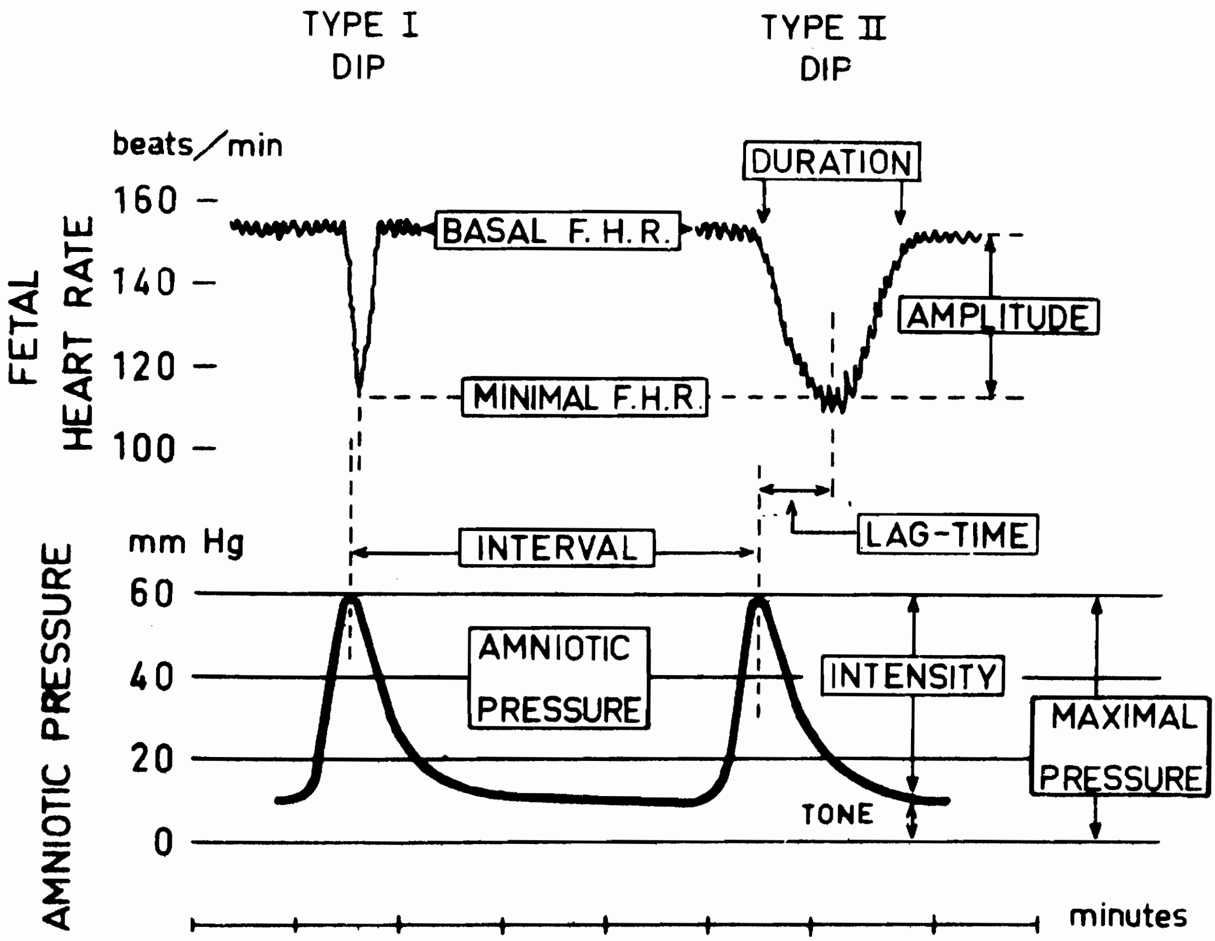

Fig. 1. Diagram illustrating the variables measured in FHR. tracings showing chronological relationship to uterine contractions (Caldeyro-Barcia, 1966, p. 9).

rate and uterine contraction.

The following differences between Type I and II dips were noted.

Type I dips:

(a) were recorded in increasing incidence as labor advanced, with cervical dilatation beyond 5 centimeters, and after rupture of the membranes.

(b) were recorded in 47 out of 50 labors.

(c) showed no significant difference between the group with vigorous newborns (Apgar 7-10) and the group with depressed newborns (Apgar 1-6).

(d) during labor did not seem to be a sign of fetal damage detectable in the newborn.

(e) had a mean lag time of 3.5 seconds.

Type II dips:

(a) when present in large number (i.e., when the index of amplitudes was greater than 600), were associated with the delivery of a depressed newborn (Apgar 6 or below).

(b) no significant difference was found in incidence between early and advanced labor or between periods before and after rupture of membranes.

(c) the production of Type II dips was facilitated by all the factors which reduce feto-maternal exchange (toxemia of pregnancy, maternal hypoxia, maternal arterial hypotension, nuchal cord, strong uterine contractions and bearing down efforts.)

(d) in a given labor, if all other conditions remained unchanged, the amplitude of Type II dips showed a positive linear relationship with the intensity of the corresponding contraction.

(e) had a mean lag time of 41 seconds.

Two signs in the FHR tracings were consistently associated with depression of the newborn:

(a) a persistent rise of basal FHR above 160 beats/minute;

(b) a great number of Type II dips of large amplitude, (total amplitude index greater than 600). These two signs (which usually appeared together) were considered as an indication of "fetal distress".

Caldeyro-Barcia (1966, p. 12) hypothesized that "one type II dip is produced by one uterine contraction when the latter causes a fall of fetal oxygen below a given critical level."

<u>Neural Mechanism of FHR Dips</u>

To postulate the neural mechanism by which Type I and Type II dips were produced, Caldeyro-Barcia (1966, pp. 13-18) assumed the heart rate of the fetus to be a function of the balance between the opposing effects of the vagal and sympathetic tones. A uterine contraction could cause a Type I dip by compression of the fetal head or compression of the umbilical cord. Either would cause a reflex stimulation of the vagus center producing a rapid, short lasting decrease in FHR. A uterine contraction would cause a Type II dip by compressing vessels supplying and draining the inter-villous space or by more severe umbilical cord compression. The produced fetal hypoxia would cause a hypoxia of the myocardium with a resultant decrease in FHR. That decrease would represent a transient augmentation of the vagal tone after the contraction.

The rise in basal rate was ascribed to a sustained elevation of the sympathetic tone of the fetus elicited by fetal hypoxia and acidosis.

Caldeyro-Barcia further postulated that the "typical" pattern of fetal distress serves two purposes: (a) the tachycardia to increase the exchanges between mother and fetus and (b) the Type II dip to prevent waste of the energy store of the fetal heart, by reducing FHR after each contraction when high cardiac output gives a low yield in feto-maternal exchanges.

In a small sample of 9 labors, Méndez-Bauer, et al. (1967) found an inverse linear relationship between pH of fetal blood and basal FHR and appearance of Type II dips. However, all investigators have not found correlations between fetal acidosis and specific changes in FHR. Saling (1966) feels that FHR changes have little value for the diagnosis of fetal distress. Some disagreement may be due to differences in the methods employed for recording and evaluating FHR changes.

Romney (1966, p. 60) states that "careful observations of fetal heart rate alone can provide valuable insight into the stability of intrauterine homeostasis. Significant changes in heart rate from established base line values in any fetus bear watching and may be indicative of fetal distress."

Few hospitals have more than the fetoscope as a tool for observation of the fetal heart rate. Caldeyro-Barcia describes a "correct method" of clinical auscultation that allows recognition of the "typical" syndrome of fetal distress, i.e., increase in basal rate and presence of a large number of Type II dips.

> Correct Method. The recognition of the syndrome can be made by clinical auscultation provided that the fetal heart

> rate is counted during several consecutive periods of 15 seconds each. At least 20 such periods should be counted. The count should start before the onset of uterine contraction and must continue for at least 2 minutes after the uterus is fully relaxed. The average FHR corresponding to each period should be noted. For this purpose, it is useful to take 5 seconds of rest between every two counting periods. The chronological relations of each period with the uterine contractions should also be noted.
>
> This method permits to reconstruct an averaged curve of the variations of FHR and its relation with the peak of the uterine contraction. Type II dips are perceived as a slow fall in FHR which starts after the peak of the contraction and reaches minimum values between 30 and 50 seconds later--that is, when the uterus is fully relaxed. The recovery of the FHR to its initial value is also slow and takes about the same time as the fall. In Type II dips the changes in FHR are slow, and therefore may not be perceived without actually counting and noting the rate every 15 seconds.
>
> The more or less stable values of FHR counted between the dips correspond to the basal FHR; its value should be estimated as the average of all the counts made between the dips.
>
> Any drop of fetal heart rate having the chronological pattern described above should be considered as a Type II dip. ...There are at least two kinds of persistent fetal 'bradycardia' which have completely different mechanisms and prognostic significance. The first kind corresponds to an actual low basal FHR (110-120 beats/min.) recorded in the absence of Type II dips...; this kind of 'bradycardia' is compatible with a vigorous newborn. The second type is the 'bradycardic' pattern of FHR caused by the overlapping of Type II dips, usually corresponding to a severe fetal distress. Both types can be recognized by careful clinical auscultation performed by the method explained above (Caldeyro-Barcia, 1966, pp. 24-25).

Hosford (1967, p. 60) has described the labor nurse as one who must facilitate communication between the mother, the doctor, the resident, and anesthetist so all will be informed about the condition, feelings, attitudes of the mother. There is information about her other patient, the fetus, to relate to others also. This information should be as accurate as current understandings allow.

When a nurse is caring for a mother during labor she is assuming care for two patients--the mother and the fetus. Auscultation of fetal heart rate provides an objective measure of fetal well being. Auscultation of the fetal heart as a nursing function is established by tradition and practice. Variations of fetal heart sounds from the normal should be reported to the responsible physician immediately (American College of Obstetricians and Gynecologists, 1965, p. 40).

Traditionally, variation from normal, has meant a rate outside the range of 120-160 beats/minute or irregularity (Greenhill 1965; Eastman & Hellman, 1966; Oxorn & Foote, 1964). In the light of recent research this definition may need some revision.

Auscultation of the fetal heart in the traditional manner has not been a precise procedure. There is no established length of time for the auscultation period. The time often varies between 10-60 seconds. There is no established proper time to carry out the procedure in relation to uterine contraction. There is no specified procedure for recording the FHR. The rate may be reported or recorded immediately. The nurse may carry out other activities prior to recording the FHR.

Caldeyro-Barcia suggests that by listening for significant FHR patterns the status of the fetus can be more accurately assessed. Auscultation by his "correct" method, however, poses some serious questions of practicality. The length of auscultation time required is over five minutes. The counting must be done in a serial manner. While counting, the uterine contraction must be perceived and related to the serial counting. Recording must be done throughout the procedure in a limited time. An average FHR from several counting periods must be computed for the basal rate.

The purpose of the present study was to determine the feasibility of adapting Caldeyro-Barcia's "correct" method of fetal heart auscultation to the clinical situation.

The following research questions were posed to test the practical use of a method of FHR auscultation by a nurse.

1. Can a modification of Caldeyro-Barcia's "correct method" of FHR auscultation be performed by a nurse?

   a. Can the nurse maintain a count during a uterine contraction?

   b. Can she simultaneously perceive and record the time relation of the uterine contraction to the serial FHR count?

2. Will data received from auscultation by the "modified method" permit reconstruction of an averaged curve of FHR variation and show its relation to the perceived uterine contraction?

3. If FHR patterns showing a relation to the uterine contraction are identified, will any of these patterns resemble the Type II dips defined by Caldeyro-Barcia?

4. If patterns similar to Type II dips are identified, will their presence be associated with a low Apgar rating of the newborn?

METHOD

The "correct" method of clinical auscultation of the fetus as described by Caldeyro-Barcia requires the following six activities:

1. Counting of the FHR during several consecutive periods of 15 seconds each.

2. Counting of at least 20 such periods.

3. Starting the count before onset of uterine contraction.

4. Continuing for at least two minutes after the uterus is fully relaxed.

5. Taking five seconds rest between every two counting periods for recording purposes.

6. Noting the chronological relation of each period to the uterine contractions.

For the purposes of this study, the "correct" method was modified to exclude the second activity, i.e. counting of at least 20 such periods. The reason for this modification was to reduce the auscultation time from 5 1/2-6 minutes to 3-4 minutes. The number of counting periods from which to compute an average basal rate was thus limited. A discreet length of time was used for estimation of the basal rate instead of averaging all the counts made between dips. This count was called the pre-contraction rate. This modified method included the following steps:

1. Estimation of the pre-contraction rate by counting for 30 seconds during the period of uterine relaxation, starting at least 30 seconds after uterine contraction was perceived to be over, but further into the period of uterine relaxation when possible.

2. Counting of FHR during several consecutive periods of 15 seconds each.

3. Starting the count prior to onset of a uterine contraction.

4. Continuing the count for at least two minutes after the uterus was perceived to be fully relaxed.

5. Taking 5 seconds rest between every two counting periods for recording purposes.

6. Noting the chronological relation of each period to the uterine contraction cycle.

This series of steps, the modification of Caldeyro-Barcia's "correct" method, was termed the auscultation sequence. The main reasons for the modification were to reduce the auscultation time and to simplify the computation of the basal rate and the amplitude of patterns resembling Type II dips.

The auscultation sequence was carried out during the labors of 15 women. Subjects were selected in terms of convenience of time for the investigator. There was no selection for age, parity, antenatal complications or abnormalities of labor. Subjects were patients admitted to the University of Utah Medical Center during the month of February, 1968.

Fetal heart auscultation commenced when labor appeared well established, (e.g. uterine contractions every five minutes or less, cervix effacing and dilated 3 centimeters or more), and was continued at intervals, until delivery. Typical labor room nursing responsibilities were not assumed during time of data collection. A stop watch was used to count FHR.

Procedure

Each auscultation sequence was carried out in the following manner. An attempt was made to evaluate the approximate frequency of uterine contractions by palpation. Fetal position was estimated also, to assist in the placement of the fetoscope at the area of maximal fetal heart sound. A 30 second FHR was counted and recorded. This count was started at least 30 seconds following the end of the previous contraction, yet as near the time of the anticipated contraction as would allow a completion of the count. This 30 second count was the pre-contraction count used as an estimate of the basal rate for the ensuing auscultation sequence. If any adjustments were needed in positioning of the fetoscope, the patient, or the investigator, the needed adjustments were made at this time. The serial counting began at an arbitrary time but not more than 45 seconds following the pre-contraction count. If the anticipated contraction did not ensue within that time, that auscultation sequence was abandoned and another attempted prior to the next contraction. This insured a temporal propinquity between the pre-contraction count and the rest of the auscultation sequence. The FHR was then counted for 15 seconds. As the second hand on the stop watch marked the end of the 15 second period another period of counting was immediately begun. The total count from the first period was mentally retained through the second count. During the five second break the counts of the two previous periods were recorded. This pattern of serial counting and recording was continued through the uterine contraction and for at least eight periods following uterine relaxation. As the uterine contraction was perceived, the duration of its increment, peak and decrement was recorded during the appropriate five second breaks, demonstrating the time relationship to the FHR counting periods.

The fetal heart was auscultated, when possible, every 30 minutes during the first stage of labor and every 15 minutes during the second stage. The auscultation sequence and a pre-contraction count were alternated throughout each labor. If the fetal heart rate was counted serially by the auscultation sequence at 2 o'clock, a pre-contraction count only was made at 2:30, auscultation sequence at 3:00 etc. Alternating in this manner limited the lengthy auscultation count to more practical intervals. Auscultation was carried out more frequently if unusual patterns were perceived.

Uterine contractions were observed by palpation during the auscultation sequence. If a second contraction intervened before the sequence was completed, no attempt was made to complete that sequence. When the sequence was halted for any reason, the cause was noted on the record.

Either a head fetoscope or a Leffscope was used for auscultation, depending on preference of the investigator. The tubing was checked to make sure there were no areas of cracking, slits or holes. The ear pieces were patent. The tubing on the head fetoscope was not longer than 9 inches. When the head fetoscope was used it was positioned on the listener's head, not held by hands.

Recording of FHR and perceived contractions was done in vertical columns on a record form devised by the investigator.

Following delivery, the infant was rated an Apgar score at both one minute and five minutes by the investigator. A check form guide of the five criteria was used. A stop watch was used for proper timing.

The auscultation record provided data to answer research questions 1, 2 and 3. Subjective data were necessary to answer questions relating to nurse comfort and mother reaction to the procedure. To determine if Type II dips were associated with low Apgar rating the mean total amplitude index of the vigorous newborns (Apgar 7-10) was compared to the mean total amplitude index for the depressed (Apgar 0-6) newborns.

RESULTS

The auscultation sequence was carried out during the labors of 15 women. The mother's ages ranged from 12-32, the mean age being 22.2. Their parity ranged from 0 to 5. There were seven primigravidas and eight multigravidas. Appendix A summarizes the information from the 15 auscultation records. A total of 69 auscultation sequences were attempted. According to the definition, 41 sequences were completed. During 14 samples fetal heart sounds could not be heard at the time of uterine contraction, but the sequences were completed. Ten sequences were not completed because of a second contraction intervening, two because of restlessness of the patient, two because of intervention of personnel to care for the patient, and one because an anticipated contraction did not materialize.

Appendix B, Pt. #7 shows the data from the auscultation record of one patient. Six auscultation sequences were carried out during her labor. The auscultation procedure began at 1800 and was carried out at 30 minute intervals (alternating the auscultation sequence with a pre-contraction count for 3 1/2 hours until 2130. Between 2200 and 2345 the patient became very restless, was bearing down with each contraction, had nurses and doctor at her bedside (paracervical block, adjustment of I.V., bed change, etc.) and was transported to the Radiology Department for pelvimetry. During this time auscultation sequences were not carried out. Pre-contraction counts were made for periods of 15 seconds only, but frequency of count was increased to every 5-15 minutes. At 2345, another auscultation sequence was carried out, though a count could not be maintained throughout the contraction when the patient was bearing down. After this sequence, counts of 30 seconds were achieved at 5-10 minute intervals until delivery at 0030.

The auscultation procedure met no objection from 13 of the mothers. There were two mothers who were so restless that even the pre-contraction count was difficult to carry out. Anxiety was expressed by several of the patients and family members about the condition of the baby. The length of the auscultation sequence apparently gave rise to this anxiety. The anxiety was expressed in the form of questions such as: "Is something wrong with my baby?" and "Why are you listening so long?" Though the purpose of the study and the length of the procedure was explained to each mother, assurance seemed necessary to allay fears concerning the baby.

Sustaining the count became difficult for the investigator unless a comfortable position was assumed at the beginning of the sequence. Hands and arms had to be kept free for palpation and recording. The Leffscope often allowed the investigator to sit during the procedure. Occasionally she could sit while using the head fetoscope. The bed could be raised to reduce stooping, or the knees braced against the side of the bed to maintain comfort.

The FHR could be heard and counted during the uterine contraction in 81% of the auscultation sequences. The uterine contraction was perceived and recorded in each completed auscultation sequence. No specific problems were noted in accomplishing this task.

The characteristics used for identifying FHR patterns as Type II dips were:

1. A decrease in FHR which starts at or after the peak of the uterine contraction.

2. The decrease reaches its minimum value 30-50 seconds later when the uterus is relaxed.

3. The recovery to the initial value takes about as long as the decrease (Caldeyro-Barcia, 1966, p. 25).

On the basis of these criteria, five patterns from three patients were identified as FHR patterns resembling Type II dips. These patterns are shown in Figure 2. Auscultation sequences in which FHR could not be heard during the time of uterine contraction, provided patterns that appeared appropriate to test against the criteria. Though data required to meet the first criterion were incomplete, five patterns still emerged which met criteria 2 and 3. These patterns are presented in Figure 3. There were five sequences in which the decrease appeared to start prior to the peak of the contraction (Figure 4.). The onset of the dip patterns may be confused by the presence of a concurrent Type I dip (Caldeyro Barcia, 1966, p. 10), or by the normal variation in basal rate. The patterns shown in Figures 3 and 4 were labeled as appearing similar to Type II dips though they did not precisely meet all of the criteria. It was felt that these deviations were minor. The 15 patterns plotted in Figures 2, 3

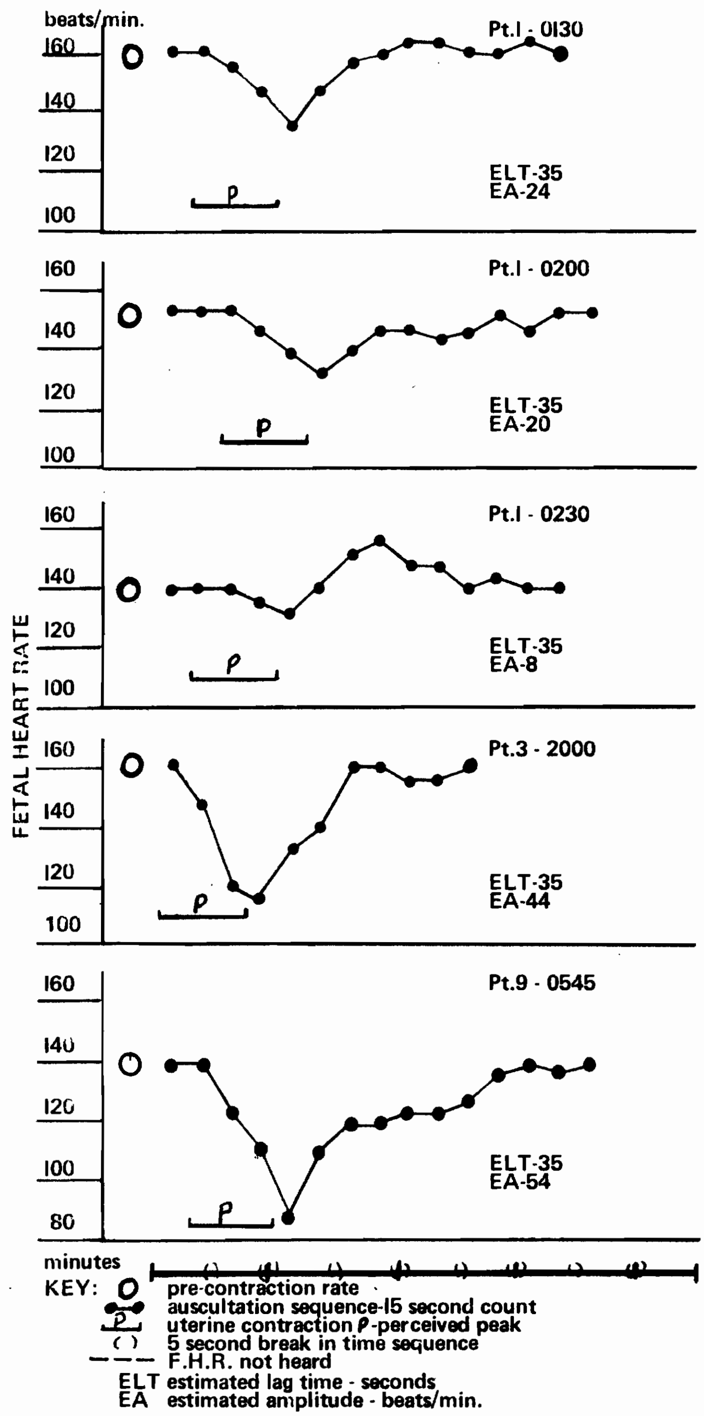

Fig. 2. FHR patterns that met the criteria for Type II dips

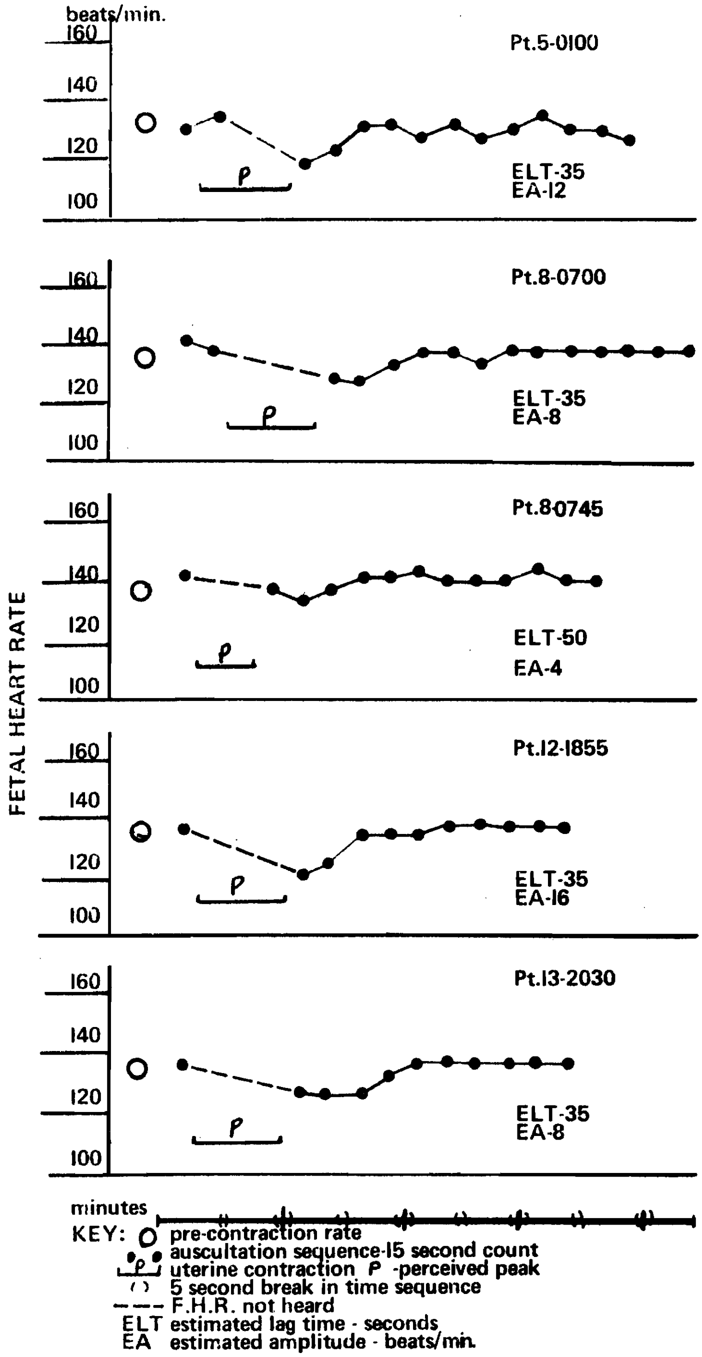

Fig. 3. FHR patterns that resemble Type II dips according to criteria 2 and 3, but data missing to meet criterian 1.

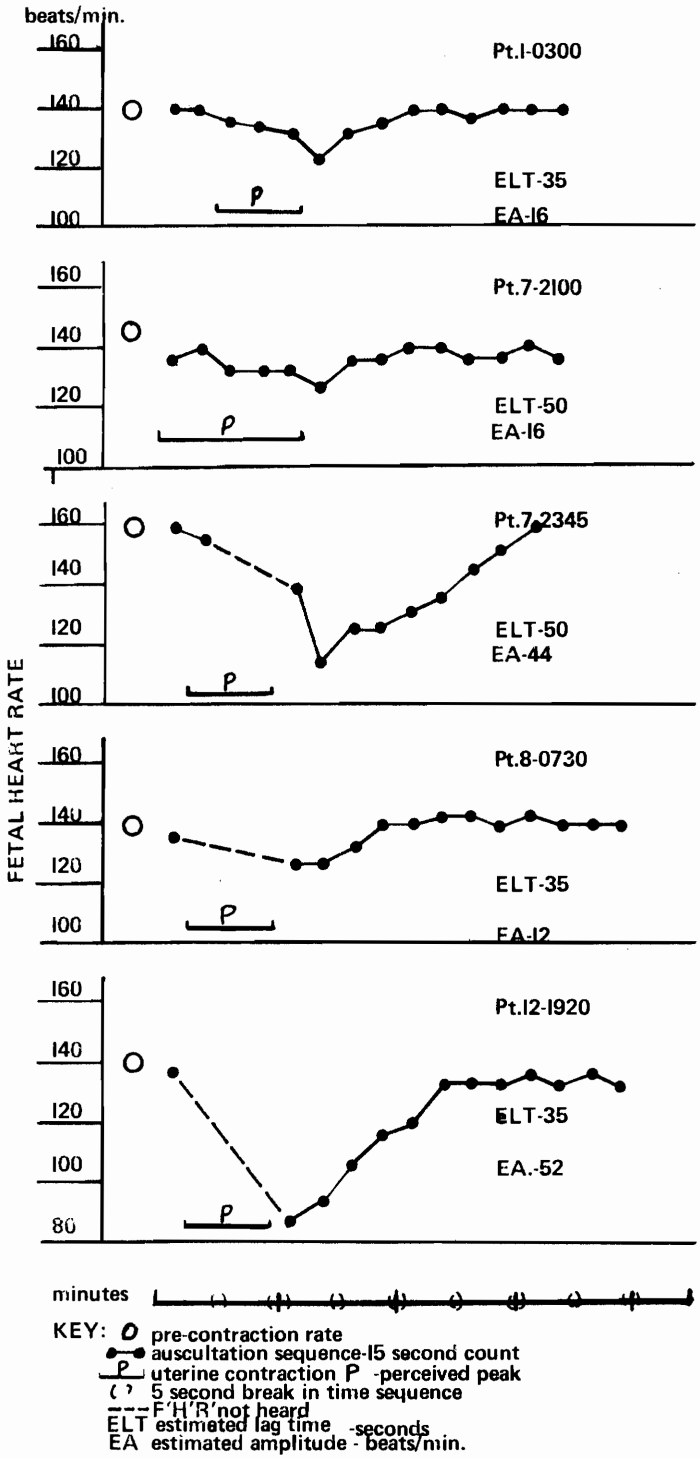

Fig. 4 FHR patterns that resemble Type II dips but in which decrease starts prior to the peak of the contraction.

and 4 appear to show a similar curve and time relationship to the contraction as the Type II dip diagramed in Figure 1.

The large total amplitude of Type II dips, not their presence during a labor was the criterion that was associated with low Apgar rating by Caldeyro-Barcia (1966, pp. 12-13). The auscultation sequence provided discontinuous data so that total amplitudes of FHR patterns resembling Type II dips could not be determined. The amplitude, measured in beats/15 seconds was the difference between the 15 second mean of the pre-contraction count and the count of the 15 second period in which the minimal rate was recorded. Thus, if the pre-contraction count was 70 (35 + 35) and the minimal rate 30, the amplitude was 5. However, by totaling the amplitudes of the discontinuous samples, an estimate of what the total might have been with complete data was obtained. To determine if depressed newborns (Apgar 0-6) had a different mean total amplitude of patterns resembling Type II dips from vigorous newborns (Apgar 7-10), a t test was applied. The mean total amplitudes of the patterns resembling Type II dips was significantly higher ($t = 3.26$ $p < 0.01$) in the group of 5 depressed newborns (M=12.0, S.D.=6.40) than in the group of 10 vigorous newborns (M=2.4, S.D.=4.05). This indicates that in this study a greater amplitude of patterns resembling Type II dips was associated with low Apgar in the newborns.

The amplitude of the dip pattern depends on the value of the basal rate. The pre-contraction count was used as the basal rate value in this study. To justify the use of this value as a basal rate, a comparison of means of the pre-contraction count (15 seconds value) and the averaged rate between dips in all auscultation sequences showing patterns resembling Type II dips was made. A _t_ of .75 ($p > .10$) indicated that there was no significant difference between the two means (pre-contraction means = 35.86, SD=2.33; averaged value mean = 35.72 SD=2.33). Therefore the pre-contraction count may be used as a basal rate. This conclusion must be considered tentative, since less than 20 counting periods were obtained during each auscultation sequences were used to determine the average FHR.

To further test the application of the modified auscultation procedure, a _t_ test was carried out to determine if there was a significant difference between mean basal rates in the two groups of infants (Apgar 0-6 and 7-10). The mean basal FHR per 30 seconds was significantly higher ($t=3.03$, $p < 0.01$) during the labor of the group of 5 depressed newborns (M=76.33, SD-4.04) than in the group of 10 vigorous newborns (M=66.86, SD-6.19). These findings are consistent with those of Caldeyro-Barcia (1966, p. 9).

DISCUSSION

The auscultation records and the subjective responses demonstrate the practicality of the auscultation sequence for the mother and the nurse with certain limitations. The nurse is obtaining information about one of her patients. She is, however, carrying out the procedure on her "other" patient. The nurse auscultating the fetal heart must have a dual purpose: To obtain information about fetal condition and also to help the mother cope with what is happening to her. Obstacles to the mother's ability to cope with the procedure may be fear that all is not well with the baby, lack of understanding of the purpose of the procedure, or an uncomfortable position. These and other difficulties need to be anticipated, identified, and minimized by the nurse.

This auscultation procedure requires sustained concentration on a repetitious activity. The stimuli the nurse wants to pick up during the auscultation sequence are auditory and tactile. She hears the heart sounds through the fetoscope and feels the uterine contraction by palpation. Distractions must be kept to a minimum. Occasionally a "syncopation effect" occurred between the FHR and the movement on the stop watch. Closing the eyes for a short time helped to minimize this and other visual distractions.

A possible modification of the "correct" method of Caldeyro-Barcia was made because the instruction to "take five seconds of rest between every two counting periods" was interpreted to mean the following counting pattern: 15/15/5/15/15/5 etc. It might have meant 15/5/15/5 etc. This method of counting introduced an element of possible error in that the listener retained the number from one counting period through a second period, then recorded both during the five second rest. It did, however, reduce each auscultation sequence time by 30-40 seconds.

The limitations of the auscultation sequence procedure in regard to the patient, nurse and method may be summarized as follows:

1. The mother's inabilities to cope with the procedure (anxiety, misunderstanding, discomfort) needed to be recognized and dealt with.

2. A comfortable stance was essential to allow the nurse to carry out the procedure without fatigue.

3. Distractions needed to be minimized so that auditory and visual perceptions remained uncluttered.

4. The auscultation sequence required 2-3 minutes longer than is customarily practiced.

5. It reduced the statistical sample from which the basal rate is calculated in the "correct" method of Caldeyro-Barcia.

The nurse received more information when using the auscultation sequence than with one single auscultation. As the reconstructed FHR curves demonstrate, <u>patterns</u> were identified and further distinguished by the time relat.onship they bore to the uterine contraction. The significant pattern resembling Type II dips was identified on the auscultation record by applying the criteria. The FHR pattern was a function of the average counts of periods in a serial sequence. Applying the criteria to these serial periods resulted in some ambiguous cases. There were two patterns that resembled Type II dips in appearance, but did not meet the lag time criteria. This occurred when the peak of the contraction fell within the limits of a second 15 second counting period, and the minimal point of the dip pattern was reached three counting periods later. This gave a lag time of 55 seconds - not meeting the criteria of 30 to 50 seconds.

Phenomena similar to those of the syndrome of fetal distress as described by Caldeyro-Barcia (i.e. Type II dips and tachycardia) were recognized by use of the auscultation sequence in this study. Further, the recognition of these components presented information about possible fetal insult. In Appendix B, Pt. 12 a Type II dip pattern was demonstrated at 1855. If a traditional auscultation had been carried out at that time, the rate would have been within normal limits (i.e. between 120-160 beats/minutes). Not until 1930, 35 minutes later, was a bradycardia evident.

In this study of 15 labors there were five babies with one minute Apgar ratings of 6 or below. It must be recognized that this represents a high incidence of prenatal depression for a group selected only for investigator convenience. The incidence of infants with one minute Apgar scores of 6 and below in a large study was 21.2 per cent (Drage, Kennedy, & Schwartz 1964).

It is possible that some bias was introduced by the investigator rating the infant on the Apgar scale. However, the investigator's rating were compared with the physician's ratings that appeared on the chart. Any discrepancies between the two ratings were not more than one or two points and never did the discrepancies affect the classification of depressed (Apgar 0-6), or vigorous (Apgar 7-10) infants. An independent rater would have been preferred and is recommended for any future studies of this type.

This study was conceived to test, in a beginning way, the feasibility of applying a medical research finding to nursing practices. A modification of Caldeyro-Barcia's auscultation procedure was applied to the clinical nursing situation. With the use of the modified procedure a relationship was shown between specific FHR changes and Apgar rating at one minute after birth. The relationship supported the findings of Caldeyro-Barcia.

Questions that need further investigation:

1. With many nurses carrying out the auscultation procedure, will results be similar?

2. How can this technique be taught to nurses?

3. Can a nurse auscultate by a serial method, while assuming typical labor area nursing responsibilities?

4. How do FHR patterns identified by serial auscultation relate to various maternal factors, e.g. blood pressure, temperature, position, type of contractions?

5. Will the use of a mechanical device (i.e. one utilizing the doppler effect) facilitate identification of FHR patterns along with palpation of uterine contractions?

Careful serial auscultation of the fetal heart rate, combined with manual palpation of uterine contractions during labor, will provide the nurse with more information about the fetus. The auscultation sequence is recommended as a tool for further clinical investigation.

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APPENDICES

SUMMARY INFORMATION
AUSCULTATION RECORDS

Patient	Aus. Seq. Attempted	Aus. Seq. completed	Aus. Seq. completed but rate not heard thru contr.	Aus. Seq. not completed	Patterns resembling Type II Dips	Tot. Amp. Type II dip patterns 15 sec.	Mean basal rates per 30 sec.	Apgar 1 min.	Meconium am. fluid	Nuchal cord
1.	9	7		2	4	17	79.76	1		
2.	4	2		2			55.30	8	X	XI
3.	10	4		6	1	11	75.85	6		
4.	2	2					66.25	7		XI
5.	5	5	1		1	3	67.77	7		
6.	3	3					65.44	7		
7.	6	6	1		2	15	80.69	3		XI
8.	5	5	3		3	6	69.50	9		
9.	4	3		1	1	13	68.80	8		
10.	3	3					68.00	9		XI
11.	5	3	3	2			69.37	7	X	

APPENDIX A

SUMMARY INFORMATION
AUSCULTATION RECORDS -- Continued

Patient	Aus. Seq. Attempted	Aus. Seq. completed	Aus. Seq. completed but rate not heard thru contr.	Aus. Seq. not completed	Patterns resembling Type II Dips	Tot. Amp. Type II dip patterns 15 sec.	Mean basal rates per 30 sec.	Apgar 1 min.	Meconium am. fluid	Nuchal cord
12.	3	3	3		2	17	69.37	5	X	
13.	5	5	3		1	2	70.00	8	X	
14.	3	1		2			76.00	6	X	
15.	2	2					78.25	9		
TOTAL	69	41	13	15	15					

COMPLETE AUSCULTATION SEQUENCE DATA AND APGAR RATINGS

PATIENT: #1

TIME	1940	2015	2045	2115	2145	2215	2245	2315	2345	0015	0045	0130	0145	0200
BASAL RATE	86	86	88	88	84	78	84	83	80	85	80	80	76	76
		43		44		40		43		45		40		38
		40X		40X		40X		43X		43X		40X		38
								XX						
		40XX		40XX		38XX		40X		43		39XX		38X
		41X		40X		40X		43		43		37X		37XX
		41		40		41		42		42X		34		35X
		41		40		40		43		41X		37		33
		40		44		39		42		41		39		35
		40		44		40		contr		40		40		37
		40		42		41				41		41		37
		41		43		40				41		41		36
		42		42		40				40		40		37
		41		41		40				40		40		38
		40		40		41						41		37
		40		40		40						40		38
				41		40								38
				42		40								
Est. lag time												35		35
Est. amplitude												6		5

APPENDIX. B

PATIENT #1 -- Continuation (Extension)

TIME	0215	0230	0245	0300	0315	0325	0330	0335	0340	0345	0350	0402
	72	70	70	70	70							
	--	35		35		35	35	40	40	40	40	DEL.
		35X										
		35XX		34X								
		34X		34XX								
		33		33X								
		35		31								
		38		33								
		39		34								
		37		35								
		37		35								
		35		34								
		36		35								
		35		35								
		35		35								
Estimated Lag Time - seconds		35		35								
Estimated Amplitude - Beats/15 seconds		2		4								

APGAR RATING-Minutes

	1	5
Investigator	1	4
M.D.	1	4

PATIENT: #2

TIME:	2115	2145	2215	2245	2255	2300	2305	2310	2315	2320	2323	2325	2326	2327	2328
BASAL RATE	60	60	63	60	60	60	50	40	60	60					
	33		30			29				28	28	30	23	23	DEL.
	29X		27X			30X				28X					
	XX		XX												
	30		32X			27				28XX					
	30		32			29				28X					
										to					
	30		30			29				D.R.					
	31		30			29									
	30		31			30									
	31		30			29									
	30		contr'			30									
	30					30									
	contr'														

APGAR RATING-Minutes

	1	5
Investigator	8	9
M.D.	7	8

PATIENT #3

TIME:	1630	1700	1715	1730	1745	1800	1830	1900	1915	1945	2000	2005	2010
BASAL RATE:	70	70	76	68	76	76	78	76	75	74	80	78	70
	35	35X		35		36	38		39X	XX	40X		35X
	33X	30XX		37X		36X	36		37X		37XX		25XX
	XX												
	30X	30X		36X		35X	36X		36		30X		30X
	33	33		36		35	37XX		36		29		35
	35	35		37		36	36X		36		33		35
	34	36		37		36	36		36		35		35
	35	36		36		36	37		36		40		contr'
	29X	36		36		36	37		37		40		
	30X	contr'		contr'		37	36		37		39		
	35					37	37		36		39		
	35					36	38		36		40		
	34						38						
	35												
	contr'												
Est. Lag time											35		
Est. amplitude											11		

PATIENT #3 -- continuation (Extension)

TIME:	2015	2017	2020	2022	2025	2028	2030	2032	2035	2040	2044
BASAL RATE:	70	70	80	80	80	90	90				
							45X	38	37	30	DEL.
							30XX				
							30X				
							30				
							40				
							45				
							contr'				

APGAR RATING - Minutes

	1	5
Investigator	6	8
Physician	6	8

PATIENT #4

TIME:	2200	2230	2245	2300	2302
BASAL RATE:	63	64	66	70	
	33		33		DEL.
	32		33X		
	33		30XX		
	33X		30X		
	33XX		33		
	33X		33		
	33		33		
	32		34		
	33		33		
	33		33		
	33		33		
	32		34		
	33				
	33				
	32				
	33				

APGAR RATING-Minutes

	1	5
Investigator	7	8
M. D.	7	9

PATIENT #5

TIME:	2245	2300	0015	0030	0100	0130	0200	0215	0220	0232
BASAL RATE:	79	70	55	60	67	64	70	70	68	
	37		28		33	33	35			DEL.
	36		30		34X	34	35X			
	40X		28		NHXX	35X	34XX			
	40XX		29		NHX	35XX	35X			
	40X		28X		30	34X	35			
	39		27XX		31	35	35			
	34		28		33	35	34			
	35		28		33	35	34			
	34		30		32	35	35			
	37		29		33	34	35			
	36		30		32	34	35			
	37		28		33	35	35			
	36		28		34	35	35			
	36		27		33	35				
	36		28		33	35				
	37		30		32					

Estimated lag time	35
Estimated amplitude	3

APGAR RATING-Minutes

	1	5
Investigator	7	9
M.D.	7	8

PATIENT #6

TIME:	1420	1450	1520	1550	1620	1650	1700	1715	1720	1722	1732
BASAL RATE:	67	66	63	68	62	60	63	70	70		
	32X		31		31					34	DEL.
	32XX		31X		31X						
			XX		XX						
	32X		30X		32X						
	33		31		32						
	33		30		32						
	32		30		31						
	33		31		31						
	32		30		31						
	32		30		32						
	32		30		32						
	33		31		31						
	33		31		31						
	33		30		31						

APGAR RATING-Minutes

	1	5
Investigator	7	9
M.D.	8	10

PATIENT #7

TIME:	1800	1830	1900	1930	2000	2030	2100	2130	2145	2200	2210	2215	2230	2240
BASAL RATE:	74	65	70	78	72	65	73	72	77	78				
	38X		35		32		34X		37X		37	36	40	36
	34XX		35X		33		35X		37XX					
									X					
	34X		34XX		32X		33XX		37					
	32		34X		33XX		33X		38					
					XX									
	32		35		33X		33X		37					
	33		35		32X		32		37					
	32		35		32		34		37					
	34		34		33		34		37					
	33		34		32		35		38					
	34		35		34		35		37					
	33		35		33		34		38					
	32		35		32		34							
	34		35		33		35							
			34		34		34							
			35		33									
Estimated lag time							50							
Estimated amplitude							4							

PATIENT #7 -- continuation (Extension)

TIME:	2250	2300	2315	2330	2345	2350	2400	0010	0020	0023	0030
					80	82	80	82	80	80	
	38	40	40	41	40						DEL.
					39X						
		To X Ray			NHXX						
					NHX						
					35						
					29						
					32						
					32						
					33						
					34						
					37						
					38						
					40						
Estimated lag time					50						
Estimated amplitude					11						

APGAR RATING-Minutes

	1	5
Investigator	3	8
M.D.	5	8

PATIENT #8

TIME:	0430	0500	0530	0600	0630	0700	0715	0730	0745	0750	0800	0810	0820	0828
BASAL RATE:	70	70	70	70	70	68	70	70	68	68	70	70	70	
		35		35		35		34	35					DEL.
		35X		35X		34		NHX	NHX					
									XX					
		35XX		34XX		NHX		NHXX	NHX					
		34X		34X		NHXX		NHX	34					
		35		35		NHX		32	33					
		36		34		32		32	34					
		35		35		33		33	35					
		34		35		34		35	35					
		35		34		34		35	36					
		35		35		33		36	35					
		36		35		34		36	35					
		35		35		34		35	36					
		35		34		34		36	35					
		35		35		34		35	35					
						34		35						
						34		35						
						34								
Estimated lag time						35		35	50					
Estimated amplitude						2		3	1					

APGAR RATING-Minutes

	1	5
Investigator	9	10
M. D.	8	9

PATIENT #9

TIME:	0545	0600	0615	0630	0645	0650
BASAL RATE:	70	64	70	70	70	
	35	32	35	35		DEL.
	35X	32X	35X	35X		
	31XX	32X	35XX	36XX		
	29X	32	34X	35X		
	22	34X	35	35		
	29	33XX	34	34		
	30	33X	34	35		
	30	32	35	35		
	31	32	34	35		
	31	33	34	35		
	32	33	34			
	34	35	34			
	35	34				
	34	35				
	35	35				

Est. lag time	35
Est. amplitude	13

APGAR RATING-Minutes

	1	5
Investigator	8	10
M. D.	7	9

PATIENT #10

TIME:	1245	1300	1315	1330	1345	1350
BASAL RATE:	70	66	66	70	68	
	35		33	35		DEL.
	35X		29X	33X		
	XX		XX			
	34X		32X	33XX		
	34		34	28X		
	34		34	31		
	35		35	35		
	35		35	35		
	35		35	35		
	34		34	35		
	34		35	34		
	35		34	34		
	35			35		

APGAR RATING-Minutes

	1	5
Investigator	9	10
M. D.	9	9

PATIENT #11

TIME:	1250	1315	1320	1325	1355	1410	1415	1420	1425	1445	1450	1500	1501	1505	1510	1512
BASAL RATE:	63	40	60	40	56	50	62	70	72	72	70	60	66	68	70	
	33			22	28	25	31	35				30				DEL.
	33			25	30	22	NHX	NHX				35				
					X											
	NHX			restless	NHXX	23	NHXX	NHXX								
	NHXX				32X	25	NHX	NHX								
	NHX				29X	27	32	33								
	NHX				28	35X	33	33								
	29X				31	33X	33	33								
	30				31	34X	33	33								
	31				32	35	34	35								
	33					33	35	36								
	33				restless	36	33	35								
	33					35	33	33								
	32					33		33								
	33															
	33															
	33															

APGAR RATING-Minutes

	1	5
Investigator	7	9
M.D.	7	9

PATIENT #12

TIME:	1820	1840	1855	1910	1920	1930	1940	1942	1945	1950	1957
	68	70	68	70	70						
	38		34		34	22	25	25	20	20	DEL.
	39X		NHX		NHX	23	25	26		25	
	39XX		NHXX		NHXX			30			
	39X		NHX								
	39		30		22			35			
	38		31		23						
	38		33		27						
	39		33		29						
	39		33		30						
	38		34		33						
	39		34		33						
	39		34		33						
	40		34		34						
	39		34		33						
					34						
					33						
Estimated lag time			35		35						
Estimated amplitude			4		13						

APGAR RATING-Minutes

	1	5
Investigator	5	9
M. D.	5	9

PATIENT #13

TIME:	2030	2100	2130	2200	2230	2300	2330	2400	0030	0100	0110
BASAL RATE:	68	70	70	69	68	70	67	68	76	74	
	34		34	to		35		34		37	DEL.
	NHX		34X	X -		35X		34X		36X	
				ray							
	NHXX		32XX			33XX		33XX		NHXX	
	NHX		33X			NHXX		34X		NHXX	
	32		33			33X		34			
	32		33			35		33		35X	
	32		34			37		34		35	
	33		34			34		34		35	
	34		34			34		34		34	
	34		34			35		34		35	
	34		34			34		34		35	
	34		34			34		34		35	
	34					35					
	34					38					

Estimated lag time	35
Estimated Amplitude	2

APGAR RATING-Minutes

	1	5
Investigator	8	9
M. D.	8	9

PATIENT #14

TIME:	2150	2200	2230	2300	2330	2351
BASAL RATE:	80	80	74	76	70	
		39		38X		DEL.
		38X		38XX		
		38XX		38X		
		38X		38		
		39		39		
		38		38		
		38		38		
		39		38		
		38		38		
		38		39		
		38X		38		
		38XX				
		37X				
		39X				
		39				
		40				

APGAR RATING-Minutes

	1	5
Investigator	6	9
M. D.	6	8

PATIENT #15

TIME:	0545	0615	0630	0645	0700	0705	0710	0715	0721
BASAL RATE:	70	76	80	80	80	80	80	80	
	35		37X						DEL.
	34X		38XX						
	35XX		39X						
	35X		38						
	36		39						
	35		39						
	34		40						
	34		39						
	35		40						
	35		40						
	34		40						
	35								
	36								
	34								
	34								
	34								

APGAR RATING-Minutes

	1	5
Investigator	9	10
M.D.	8	9

VITA

Name	Frances Trackwell Richart
Birthplace	Longview, Washington
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High School	Robert A. Long High School Longview, Washington 1943-1947
College	Seattle Pacific College Seattle, Washington 1947-1948
University	University of Washington Seattle, Washington 1948-1952
Degree	B. S. University of Washington Seattle, Washington 1952
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