

A Proposal for a New Method of Evaluation of the Newborn Infant.*

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RESUSCITATION OF INFANTS at birth has been the subject of many articles. Seldom have there been such imaginative ideas, such enthusiasms, and dislikes, and such unscientific observations and study about one clinical picture. There are outstanding exceptions to these statements, but the poor quality and lack of precise data of the majority of papers concerned with infant resuscitation are interesting.

There are several excellent review articles^{1 2} but the main emphasis in the past has been on treatment of the asphyxiated or apneic newborn infant. The purpose of this paper is the reestablishment of simple, clear classification or "grading" of newborn infants which can be used as a basis for discussion and comparison of the results of obstetric practices, types of maternal pain relief and the effects of resuscitation.

The principle of giving a "score" to a patient as a sum total of several objective findings is not new and has been used recently in judging the treatment of drug addiction.³ The endpoints which have been used previously in the field of resuscitation are "breathing time" defined as the time from delivery of the head to the first respiration, and "crying time" the time until the establishment of a satisfactory cry.⁴ Other workers have used the terms mild, moderate and severe depression⁵ to signify the state of the infant. There are valid objections to these systems. When mothers receive an excessive amount of depressant drugs in the antepartum period, it is a common occurrence that the infants breathe once, then become apneic for many minutes. Evaluation of the breathing time is difficult. A satisfactory cry is sometimes not established even when the infant leaves the delivery room, and in some patients with cerebral injury, the baby dies without ever having uttered a satisfactory cry. Mild, moderate and severe depression of the infant leaves a fair margin for individual interpretation.

A list was made of all the objective signs which pertained in any way to the condition of the infant at birth. Of these, five signs which could be determined easily and without interfering with the care of the infant were considered useful. A rating of zero, one or two, was given to each sign depending on whether it was absent or present. A score of ten indicated a baby in the best possible condition. The time for judging the five objective signs was varied until the most practi-

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cable and useful time was found. This is sixty seconds after the complete birth of the baby. Insofar as possible, the rating was done by two observers only, but as the series progressed, the score as determined by the anesthesia resident present at the delivery was found to be sufficiently accurate. These ratings have been included in the present series.

The signs used are as follows:

(1) Heart Rate.—This was found to be the most important diagnostic and prognostic of the five signs. A heart rate of 100-140 was considered good and given a score of two, a rate of under 100 received a score of one, and if no heart beat could be seen, felt or heard the score was zero. If one attends the baby alone, it is easy to learn to look briefly at the epigastrium or precordium for visible heart beat, while palpation of the cord about two inches from the umbilicus is the most satisfactory method for determining the heart rate quickly, and avoids the area of clamping or tying of the cord. It is of great assistance to the person caring for the baby to have an assistant demonstrate by motion of a finger of one hand the heart rate as palpated by the other hand. In only three cases was a heart rate of over 140 detected, accompanied by arrhythmia in two of these infants. I was puzzled as to the proper way to rate this in these patients, but they were given a full score of two points. The tachycardia and arrhythmias were apparently related to an overdosage of a vasopressor drug during spinal anesthesia for cesarean section.

(2) Respiratory Effort.—An infant who was apneic at 60 seconds after birth received a score of zero, while one who breathed and cried lustily received a two rating. All other types of respiratory effort, such as irregular, shallow ventilation were scored one. An infant who had gasped once at thirty or forty-five seconds after birth, and who then became apneic, received a zero score, since he was apneic at the time decided upon for evaluation.

(3) Reflex Irritability.—This term refers to response to some form of stimulation. The usual testing method was suctioning the oropharynx and nares with a soft rubber catheter which called forth a response of facial grimaces, sneezing or coughing. Although spontaneous micturition and defecation are not a response to an applied stimulus, they were considered to be favorable signs if they occurred.

(4) Muscle Tone.—This was an easy sign to judge, for a completely flaccid infant received a zero score, and one with good tone, and spontaneously flexed arms and legs which resisted extension were rated two points. We are unable to agree with Flagg's description of spasticity⁶ as a sign of asphyxiation of the infant. The use of analeptics in the baby did not influence this score because of the standardized early time of observation and rating.

(5) Color.—This is by far the most unsatisfactory sign and caused the most discussion among the observers. All infants are obviously cyanotic at birth because of their high capacity for carrying oxygen and their relatively low oxygen content and saturation.⁷ The disappearance of cyanosis depends directly on two signs previously

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considered—respiratory effort and heart rate. Comparatively few infants were given a full score of two for this sign, and many received zero in spite of their excellent score for other signs. The foreign material so often covering the skin of the infant at birth interfered with interpreting this sign, as did the inherited pigmentation of the skin of colored children, and an occasional congenital defect. Many children for reasons still mysterious to us, persist in having cyanotic hands and feet for several minutes in spite of excellent ventilation, and added oxygen. A score of two was given only when the entire child was pink. Several hundred children were rated at three or five minutes as well as at sixty seconds and in almost all cases a score of two could be given for color at these later times. This finding agrees well with the heel blood oxygen studies in 402 infants, conducted at Sloane Hospital during 1947-48.⁸ In an occasional instance the color was worse at five minutes than at sixty seconds, and these cases were therefore missed with our usual method of evaluation.

It has been most gratifying to note the enthusiastic interest and competitive spirit displayed by the obstetric house staff who took great pride in a baby with a high score. The same trend of interest has been noted in another hospital which has undertaken the ratings of babies in this manner.⁹

Material

DURING THE PERIOD of this report (seven and one-half months) 2096 infants were born in the Sloane Hospital for Women. Eighty four per cent of the anesthesia records of these births are on file. The missing 16 per cent are chiefly those with pudendal blocks or "natural childbirth" patients. The omission of these cases is regrettable for they form the best control group for any study on infant resuscitation. Little attempt will be made to analyze these figures statistically for the groups are still too small for such treatment.

Seventeen hundred and sixty charts were available for study. Twenty-seven infants were stillbirths, or a rate of 1.5 per cent. One thousand and twenty-one of the infants born alive were rated by the method just described and comprise the data for this report. Seven hundred and twelve infants were not rated.

Type of Delivery and Score

	No. Infants	Average Score
Low forceps or spontaneous	843	8.4
Cesarean section	141	6.8
Midforceps delivery	17	6.9
Breech delivery	16	6.7
Version and breech extraction	4	6.3

The infants in the best condition one minute after birth are those born vaginally with the occiput the presenting part. The incidence of the use of low forceps in this clinic is 34 per cent and after a two

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year daily observation of routine deliveries it did not seem to be of value to separate the spontaneous deliveries from those in which low forceps were used. Delivery by any other means produced no difference in the infants. The score for all these was slightly less favorable than those born spontaneously or with low forceps.

Cesarean Sections.—The cesarean section rate at Sloane Hospital is 10.5 per cent during this period. The anesthesia methods for the 141 rated infants born by cesarean section are listed:

	Infants	Average Score
Spinal anesthesia	83	8.0
General anesthesia	54	5.0
Epidural or caudal	4	6.3

The method used for spinal anesthesia was a single dose of nupercaine 0.25 per cent made hyperbaric with dextrose, in doses ranging from 6 to 7.5 mg., or pontocaine® 0.3 per cent, hyperbaric, from 7 to 9 mg. A 22 gauge needle was used. No supplementary anesthesia was given to these patients until after the birth of the infant. General anesthesia in all cases was accomplished with cyclopropane and oxygen. In 20 cases to be discussed later a relaxant was used with cyclopropane. Fractional epidural or caudal anesthesia (0.75 per cent xylocaine®) was continued in 4 cases for cesarean section after a trial of labor.

The indications for general anesthesia in cesarean section are thought to be a history of syphilis, septicemia, severe hemorrhage, or a history of traumatic experience with spinal anesthesia. Although this method does not take into account maternal risk or antepartum fetal problems, it is apparent that the mothers of the potentially poor risk infants received spinal anesthesia. In spite of this and the frequent maternal hypotension, the condition of the infants after spinal anesthesia was definitely better than after general anesthesia. The average time for delivery of the infant after induction of general anesthesia was fourteen minutes and twenty-four minutes after the administration of spinal anesthesia.

There is questionable support of the theory¹⁰ that infants who have been subjected to a trial of labor are in better condition than those in whom cesarean section was chosen electively, as indicated below.

	Infants	Average Score
Patients in labor	57	7.1
Patients not in labor	84	6.7

These small groups have been analyzed statistically¹¹ and are not statistically significant.

In obstetric circles there has been the subtle impression that the lower the cesarean section rate in a clinic, the better was the practice of obstetrics. There is a slight trend away from this idea, and that at times even cesarean section is a conservative form of therapy.¹²

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We have felt that with individual attention to selection of anesthetic agents and their administration by competent anesthesiologists, that infant survival after elective cesarean section might be made as successful as after an uncomplicated vaginal delivery. That we have not yet reached this point is illustrated in the next table. The group of cesarean section patients who had no antepartum problems and in whom labor was not present (secondary and tertiary sections) was compared with a similar group of vaginal deliveries in whom no problems of any kind were apparent. All received spinal anesthesia. The condition of the infants delivered vaginally was better than those delivered by cesarean section.

	Infants	Average Score
Normal, elective sections	38	7.7
Normal, low forceps or spont.	38	9.0

The most obvious difference between the two groups is the presence of labor in those delivered vaginally and the absence of labor in the section group. We do not know whether this implies some beneficial effect of labor on respiration, circulation and general well-being of the infant.

The experimental reports on the lack of placental transfer of d-tubocurarine, flaxedil,[®] decamethonium^{13 14 15 16} are intriguing. Several clinical reports seem to bear out this somewhat surprising finding. Other papers are in disagreement.¹⁷ In an effort to test this possibility clinically, 20 patients received a relaxant intravenously as a means of keeping the patient from moving, accompanied by as light a plane of cyclopropane as would produce unconsciousness. Seventeen received d-tubocurarine, and 1 patient each received flaxedil,[®] succinylcholine and decamethonium bromide. Thirteen infants were rated.

	Infants	Average Score
Sections: Cyclopropane without relaxant	41	5.0
Sections: Cyclopropane with relaxant	13	5.0

In addition to the fact that there was no difference in the infant's condition with or without the use as a relaxant, 70 per cent of the infants with relaxant needed oxygen administration in some form, while the number needing oxygen after cyclopropane anesthesia alone was likewise 70 per cent. The infants are not in better condition with relaxants and nothing is to be gained by the use of curare or similar drugs for cesarean section anesthesia. The occasional maternal respiratory depression necessitating assisted respiration is a distinct disadvantage to the technique.

Breech Deliveries.—There were 16 cases of breech deliveries excluding twins and version and breech extraction. All but one who precipitated without anesthesia were anesthetized with general anesthesia in a plane as light as compatible with the obstetric maneuvers. Nitrous oxide, ethylene or cyclopropane were used for this purpose. The average score was 6.7, essentially the same as for cesarean section infants. Regional methods were not used in this small group.

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Twins.—Nine pairs of twins were delivered by a variety of methods. The average score of the 18 babies was remarkably good, 8.6, and probably reflects the use of minimal medication during the first stage of labor. The use of regional anesthesia, however, again produced better results than general anesthesia in this small series.

	Infants	Average Score
Twins—general anesthesia	14	8.2
Twins—regional anesthesia	4	9.8

The condition of the first twin was somewhat better than the second.

	Infants	Average Score
Twin A	9	8.9
Twin B	9	8.2

Midforceps Delivery.—The condition of the infants following midforceps delivery was the same as by section or by breech delivery. There was no difference relating to the anesthetic method.

	Infants	Average Score
Midforceps, general anesthesia	11	6.8
Midforceps, regional anesthesia	6	7.0

Low Forceps and Spontaneous Deliveries.—This large group showed some improvement in the infant's condition following the use of regional anesthesia.

	Infants	Average Score
General anesthesia	692	8.2
Spinal anesthesia	25	8.9
Epidural, caudal anesthesia	102	9.1
Pudendal or no anesthesia	24	9.2

Prematurity

THERE WERE 70 infants in this series whose birth weights were between 500 and 2500 grams. The nonviable premature infants, under 500 grams, were excluded and considered to be abortions. The youngest child who has survived in the Premature Nursery of the Babies Hospital weighed 580 grams. Regional anesthesia again was associated with a better score for the child.

	Infants	Average Score
Premature, general anes.	44	8.0
Premature, regional anes.	24	9.2
Premature, no anes. ppt.	2	2.0

Resuscitation

OXYGEN, SUCTION, some method of positive pressure, endotracheal tubes and an infant laryngoscope are present in every delivery room. Oxygen was used freely if the infant's condition was not good. The three types of administration used are:

- (1) Face oxygen, in which method oxygen is added to inspired air, but without increase in pressure at the face.
- (2) Positive pressure mask, in which a small mask is held snugly on the infant's face, and some degree of positive pressure is applied

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to the pharynx.

(3) Endotracheal oxygen, in which direct laryngoscopy is performed, additional suction used if necessary, and intubation accomplished. Positive pressure usually with added oxygen is implied in this method.

The details of these methods and indications for their use as well as discussion of other resuscitative measures will be the subject of other communications.

Three hundred thirty six or 19.4 per cent of the 1733 living infants received oxygen by some method. Of this group

156 or 46 per cent received face oxygen.

111 or 33 per cent received positive pressure mask.

13 or 4 per cent received endotracheal oxygen.

56 or 17 per cent received an unspecified method.

The survival rate following the use of endotracheal oxygen in this clinic over a 3 year period is between 60 and 70 per cent of the cases in which it has been employed.

The incidence of the use of oxygen for the infant following the various routes of deliveries is as follows:

Cesarean section	54 per cent
Midforceps	8 per cent
Breech delivery	37 per cent
Low forceps and spont.	15 per cent

In 217 of 336 infants who received oxygen, ratings were obtained and the method of administration was recorded.

	Cases	Average Score
Face oxygen	117	6.7
Positive pressure mask	90	3.9
Endotracheal oxygen	10	2.1

In 14 of the group of 117 cases receiving face oxygen, a score of 9 or 10 was given, and these infants undoubtedly did not need the oxygen so administered.

Neonatal Deaths

THERE WERE 25 neonatal deaths in the entire group of 2096 deliveries, or a rate of 1.2 per cent. If the 38 stillbirths over 500 grams are included, the total fetal loss was 64 infants, or a rate of 3.0 per cent of total infants born. The distribution by type of delivery is as follows:

Type	Cases	Neonatal Deaths	Per Cent of type
Cesarean section	220	2	0.9 per cent
Breech deliveries	54	5	9.3 per cent
Low, midforceps and spont.	1822	18	1.0 per cent

Fourteen of the infants who died were under 2500 Gm. birth weight, representing a mortality of 7.8 per cent of the total number of

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premature infants born alive. Of the 11 mature infants who died, all had obstetric or medical reasons for their deaths. In this series anesthesia complications apparently did not contribute to the death of any case. Twelve of the infants who later died were rated at birth and averaged 2.3 points.

In order to check the approximate accuracy of the various scores, the fate of the infants in poor, fair and good condition was examined. After this initial experience, it seems to us that groups 8, 9, and 10 indicate infants in good condition, 0, 1, and 2, poor condition, and the remaining scores, fair condition.

Infants receiving 0, 1 or 2 scores	65
Deaths in this group 9 or 14 per cent	
Infants receiving 3, 4, 5, 6, 7 scores	182
Deaths in this group 2 or 1.1 per cent	
Infants receiving 8, 9, 10 scores	774
Deaths in this group 1 or 0.13 per cent	

Thus, the prognosis of an infant is excellent if he receives one of the upper three scores, and poor if one of the lowest 3 scores. From this we may also conclude that color as a sign is relatively unimportant when observed one minute after birth.

Summary

A PRACTICAL METHOD of evaluation of the condition of the newborn infant one minute after birth has been described. A rating of ten points described the best possible condition with two points each given for respiratory effort, reflex irritability, muscle tone, heart rate and color. Various applications of this method are presented.

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