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The Apgar Score Has Survived the Test of Time

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IN 1953, Virginia Apgar, M.D., then Professor of Anesthesiology at Columbia University, College of Physicians and Surgeons, New York, New York, proposed a new method of evaluation of newborn infants.¹ Dr. Apgar, who had directed the Division of Anesthesiology in the Department of Surgery at Columbia University since 1938, was succeeded in 1949 by E. M. Papper, M.D. who became chairman of an independent Department of Anesthesiology. Both Dr. Apgar and Dr. Papper were appointed Professors of Anesthesiology. Dr. Apgar thus became the first woman to hold a full professorship at Columbia University, College of Physicians and Surgeons. No longer burdened by administrative duties, she devoted herself to obstetric anesthesia and resuscitation of the newborn.²

The origins of what soon became known as the Apgar score are uncertain (Dr. Apgar died in 1974). Legend has it that the idea for the score came to her in 1949, when a medical student casually mentioned the need for newborn evaluation during breakfast in the hospital cafeteria. Dr. Apgar allegedly picked up the nearest piece of paper imprinted with "Please bring your own trays" and quickly jotted down the five signs of the Apgar score. She then rushed off to the delivery suite to try it out.

A more credible account was provided by William A. Silverman, M.D. (deceased December 2004), who was a retired Professor of Pediatrics at Columbia University, who was a friend of Dr. Apgar since the mid 1940s. According to Silverman, after she moved to obstetric anesthesia, Dr. Apgar became appalled by the then prevalent neglect of apneic, small for age or malformed newborns. Listed as stillborn, they were placed out of sight and left to die. Dr. Apgar began to resuscitate these infants and to develop a scoring system that would ensure observation and documentation of the true condition of each newborn during the first minute of life. Further, it seems that the score was not conceived in a brief moment of inspiration. Dr. Apgar reported that between 1949 and 1952, several signs easily observed in the newborn were considered. Five were selected because they could be evaluated without special equipment and could be taught to the delivery room personnel without difficulty.³ These signs were heart rate, respiratory effort, reflex irritability, muscle tone, and color. A rating of 2, 1, or 0 was given to each sign at 60 s after delivery ([table 1](#)). This time interval was chosen because it commonly coincided with the maximum clinical depression.

Table 1. Apgar Score: Signs and Definitions

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Sign	Score		
	0	1	2
Heart rate	Absent	Slow (< 100 beats/min)	> 100 beats/min
Respirations	Absent	Weak cry, hypoventilation	Good, strong cry
Muscle tone	Limp	Some flexion	Active motion
Reflex irritability	No response	Grimace	Cry or active withdrawal
Color	Blue or pale	Body pink, extremities blue	Completely pink

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It is doubtful that Dr. Apgar was aware of a similar newborn evaluation system proposed 18 centuries earlier by Soranus of Ephesus, a Greek physician who practiced in Rome at the time of emperors Trajan and Hadrian (AD 98–138).⁴ Heart rate was the only sign not included in the “Soranus score” because the circulatory system was not discovered until 15 centuries later.

In 1962, two pediatricians created an acronym to facilitate teaching the five signs of the Apgar score. The acronym APGAR stands for appearance, pulse, grimace, activity, and respiration.⁵

In her original publication, Dr. Apgar envisioned that her scoring system would be useful in comparing the results of various obstetric practices, methods of maternal pain relief, and several neonatal resuscitation techniques used at the time.¹ These included such drastic measures as alternate immersion in cold and warm water, rectal dilatation, and oxygen insufflation into the stomach. Dr. Apgar’s first study (1952–1956) of more than 15,000 infants established that neonates scoring 8, 9, or 10 are vigorous and usually breathe within seconds after delivery. Mildly depressed infants score 5, 6, or 7, whereas severely depressed infants, scoring 4 or less, are blue and limp and have not established sustained respiration by 1 min.⁶ Not surprisingly, the Apgar score was found to provide valuable criteria for newborn resuscitation.⁷ It also became obvious that the five signs in the Apgar score are not of equal value, with heart rate and respiratory effort being the most important and color being the least important. This led Jeffrey S. Crawford, M.D., who was a British obstetric anesthetist at the University of Birmingham (Birmingham, UK), to propose the use of the A-C (Apgar minus color) score, allowing a maximum allocation of 8 points.⁸ The A-C score never became generally accepted, even though it was supposed to reflect drug effects in the neonate more accurately than the 10-point score.

The 1952–1956 study also established that in all types of deliveries, approximately 6% of infants were severely depressed, 24% were moderately depressed, and 70% were vigorous.⁶ When analyzed by the type of delivery, the distribution of Apgar scores was quite different. Scores of 0–2 occurred in 20% of breach presentations, 12% of cesarean deliveries, and only 3% of vaginal vertex deliveries. Neonatal death occurred in 15% of infants scoring 2 or less, in contrast to 0.13% of infants scoring 8–10. The newly introduced umbilical artery blood sampling for biochemical analysis showed that, with a few exceptions, the more asphyxic the blood values were (high partial pressure of carbon dioxide, low pH and buffer base), the lower the score was 1 min after birth. Low Apgar scores and near-normal cord blood values tended to occur in infants exposed to heavy maternal medication, general anesthesia, or both.

Dr. Apgar’s findings were corroborated and expanded by the data collected in the Collaborative Study of Cerebral Palsy, Mental Retardation and Other Neurologic and Sensory Disorders of Infancy and Childhood sponsored by the National Institutes of Health, Bethesda, Maryland.^{9,10} More than 54,000 pregnant women participated in the study between 1959 and 1966. All received prenatal care and delivered at one of the 12 collaborating teaching hospitals. Apgar scores were recorded at 1 and 5 min after birth and at 10, 15, and 20 min for neonates who did not achieve a score of 8 or higher at 5 min. These children were followed up to the age of 7 yr.

After an early report from the study indicated that neonatal mortality correlates more strongly with the 5-min Apgar score,² most institutions added the 5-min score to their newborn evaluation. Most deaths occurred within 28 days after birth. Mortality was higher in low-birth-weight than in term-weight children of the same Apgar score. In the low-birth-weight group scoring 3 or less at 1 min, mortality was 48.2% and increased to 95.7% in those with very low Apgar scores at 20 min. For babies of term birth weight, the corresponding values were 5.6% and 59%, respectively. Among the survivors in the term-weight group scoring 0–3, cerebral palsy occurred in 1.5% of those with very low scores at 1 min, 4.7% with very low scores at

5 min, and 57.1% with very low scores at 20 min. Although low Apgar scores were risk factors for cerebral palsy, half of the children who later had cerebral palsy had Apgar scores of 7–10 at 1 min, and almost 75% of them scored 7–10 at 5 min. This was interpreted to indicate that a large proportion of cerebral palsy is not related to intrapartum asphyxia.¹⁰ Very low Apgar scores were assumed to indicate severe birth asphyxia, even though cord blood analyses were not performed. Subsequent studies showed poor correlation between Apgar scores at 1 and 5 min and the acid–base state of the infant at birth.^{11,12} Because of the litigious climate in the United States, the American Academy of Pediatrics, Elk Grove Village, Illinois, and the American College of Obstetricians and Gynecologists, Washington, D.C., jointly published a short article advocating proper interpretation of the Apgar score.¹³ It included a statement that “The Apgar score alone cannot establish hypoxia as the cause of cerebral palsy.” Additional criteria must be present at birth, namely an umbilical cord artery pH of less than 7; an Apgar score of 0–3 for longer than 5 min; neonatal seizures, coma, or hypotonia; and multiple organ dysfunction.

Almost 50 yr after the original publication by Dr. Apgar, after which her score became a standard throughout the world, a group in Texas reexamined the value of the score in the assessment of newborn infants.¹⁴ In an analysis of more than 150,000 deliveries between 1988 and 1998, they found a strong correlation between the Apgar score at 5 min of age and neonatal mortality. As was pointed out in the accompanying editorial, the Apgar score was not intended to be a measure of perinatal asphyxia, and in the 21st century, the 1-min score continues to fulfill Dr. Apgar’s goal of focusing attention on the condition of the infant immediately after delivery.¹⁵ The 5-min score remains an easy method for assessing the effectiveness of resuscitation and, to some degree, the vitality of the infant.

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