

## **Assessment of neonatal viability - the Apgar score**

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### **Summary**

In dogs, perinatal mortality is relatively high, and deaths peak around birth and during the first week of age. Among the several causes, the long process of whelping plays an important role in canine perinatal mortality. Therefore, also in dogs the early neonatal assistance to puppies is mandatory. However, in comparison to humans, knowledge and technological ability in dog neonatology are tremendously scarce. The Apgar score for the newborn viability assessment at birth represent a feasible method for the prompt recognition of newborns that needs special assistance immediately after birth. The five parameters Apgar score, adapted to the canine specie by different studies, advantages and limits, as well as clinical application are presented and discussed.

### **Text**

In mammals, the reproductive process is considered successful when a pregnant female gives birth to a live and viable offspring, at the end of a normal-course pregnancy. The majority of offspring losses can be addressed to the mortality occurring during the perinatal period. In dogs, perinatal mortality is considered as the sum of deaths related to stillborn, plus the puppies dead within the neonatal period. Canine perinatal mortality is relatively high, reaching values up to 40%, and deaths peak around birth and during the first week of age. Among the several causes responsible for a such high perinatal deaths percentage, the birth process plays an important role. In dogs, indeed, the process of parturition is relatively long, even under physiological conditions, and it could become even longer in case of dystocia. Thus, fetal asphyxia is thought to be one of the most common cause of perinatal puppies death. As in other mammals, the process of birth is challenging, and the first minutes after birth are the most life-threatening, and the quality of the first few minutes after birth has pivotal and long-term consequences on newborn's life. Therefore, the assistance and care to each single newborn is mandatory, also in veterinary medicine, similarly to human medicine.

In comparison to humans, knowledge and technological ability in dog neonatology are tremendously scarce. This can be due to the difficult to obtain biological samples for analysis, easily performed in human neonates, such as blood sampling, but also to adapt to the different general practices of veterinary assistance in comparison to humans hospitals. Moreover, the paucity of knowledge about dogs and cats neonatal physiologic features makes difficult to recognized newborns who need assistance.

The transition from the fetal to the neonatal life involves an efficient multi-systemic adaptation process of the organism. The most critical change is related to the beginning of respiration that influences the early survival of the neonate. Breathing is the key function for the immediate neonatal survival. When the fetus is mature and ready for birth, the passage through the birth canal, the blood oxygen to nitric oxide ratio, and the umbilical cord detachment, are the first stimuli to start the first breath. Consequently to the first breath, the lung inflate, and a number of changes concerning the respiratory and circulatory systems occur. As a consequence, a cascade of

physiological changes leading to the first hours neonatal adaptation, is necessary for fetal-to-neonatal viability and survival.

The neonatal viability, that is the potential of the neonate to survive outside the uterus after birth, depends largely on fetal organ maturity, but also on environmental conditions and neonatal care. In addition, in comparison to human neonates or foals, calves or piglets, puppies and kitten are largely immature at birth, making them extremely vulnerable. Moreover, differently to humans, in most instances dogs and cats give birth under field conditions and only rarely in veterinary facilities, so that the techniques for neonatal evaluation and assistance should be adapted to every kind of environmental condition.

The veterinarian assistance to the parturient bitch is recently highly requested from both pet-owners and especially from breeders, because of the high economic values of dams and litters. The survival of a number as much higher as possible of newborns is therefore wanted not only from an ethical perspective, but also from an economic point of view.

The prerequisite for a prompt recognition of newborns that needs special assistance immediately after birth, is the availability of a simple method for newborn viability assessment.

Since the 50s, the Apgar score proposed by Virginia Apgar for the quick assessment of neonatal viability in humans, was widely used all over the world, and still remains the most suitable method for the viability assessment and short-term survival prognosis in babies.

In humans the Apgar score encompasses five parameters, easy to assess, for the clinical evaluation of the infant soon after birth, usually within 1 minute after birth and again at 5 minutes after birth, and may be repeated later for newborns with low scores. These five parameters are resumed in an acronym built on the surname of its creator, so that APGAR recall easily the initials of the five parameters to be assessed: A, as appearance, P as pulse, G as grimace, A as attitude, R as respiration. To each one of these parameters a score ranging from zero to two is assigned, for a total sum ranging between zero and ten. On the base of the final sum, three classes of neonatal viability were defined: when the score is less than 3 the neonatal condition is considered as critical and the newborn need medical assistance; when the score is between 4 and 6 the condition of the neonate is considered as low, and the newborn should be supervised or submitted to medical assistance; when the score is 7 to 10 the newborn clinical condition is normal, and the neonate need only routine care.

Because of its feasibility, the Apgar score was thereafter introduced also in veterinary medicine, and after adaptation according to the specific physiologic features, used for the neonatal evaluation of foals, calves and piglets, whereas in the dog, the Apgar score was not widely used until recently. However, thanks to its feasibility of execution and the limited use of instruments (only a stethoscope), this method appears to be useful for the neonatal evaluation under every clinical condition also in dogs.

In 2009, Veronesi and co-authors proposed an Apgar score adapted for the neonatal viability assessment in dogs. Appearance was assessed by the evaluation of the mucous membranes color as follows: pink rated as 2, pale rated as 1 and cyanotic rated as zero. Pulse, referring to heart rate, was rated as 2 when it was > 220 beats per minute (bpm), rated as 1 when it was between 180 and 220 bpm, and rated as zero when it was < 180 bpm. Grimace, indicating the reaction of the neonate to irritability, was assessed by the gentle compression of the tip of a paw, and evaluating the puppies

reaction: rated as 2 when the puppy reacted with crying and quick leg retraction, rated as 1 when the leg was weakly retracted in association to weak or none vocalization, and rated as zero when no leg retraction and no vocalization were stimulated. Attitude was evaluated by neonatal motion as follows: rated as 2 when strength spontaneous movements of the neonate were observed, rated as 1 when mild movement were detected and rated as zero for the absent attempt of neonatal movements. Respiration was assessed taking in consideration both respiratory rate (rr) and vocalizations: respiratory efforts were rated as 2 when clear crying was associated to >15 rr, rated as 1 when mild crying was associated to 6-15 rr, rated as zero when no crying was associated to <6 rr. Similarly to the classification used for humans, on the base of the final sum, also for the newborn puppies, three neonatal classes of viability were identified: 0 to 3, newborns with severe distress; 4 to 6, newborns with moderate distress; 7 to 10, normal newborns with no distress. The Apgar score was highly positively correlated to puppies survival at 2 and at 24 hours after birth. The viability assessment allowed the recognition of puppies with Apgar score less than 7, requiring different degree of assistance. Three out of seven (43%) of severely depressed puppies recovered and 88% of moderately depressed puppies recovered after neonatal care. Apgar score was also positively associated to mammary gland searching and suckling/swallowing reflexes, other parameters indicative of newborn dogs vigour. In the same year, other two studies (Silva et al, 2009; Lucio et al, 2009) reported the use of an Apgar score in the evaluation of canine neonatal viability at birth, and 5 and 60 minutes after delivery, but no details about the method of evaluation or reference were reported. Silva et al (2009) found lower Apgar score at birth and at 5 minutes after birth in puppies born from cesarean section compared to vaginal delivery. Lucio et al (2009) evaluated the Apgar score associated to acid-base parameters in newborn puppies born at normal parturition, after obstetrical assistance or cesarean section, and born following oxytocin administration. The authors reported a low Apgar score in all the pups at birth, associated to a mixed acidosis; the Apgar score improved in all newborns after 5 minutes of birth, and carbon dioxide tension, base excess and venous blood pH improved at 60 minutes after birth, although a metabolic acidosis persisted.

Subsequently, other authors focussed on the clinical application of the Apgar score for neonatal viability assessment, even with some modifications.

The same protocol proposed by Veronesi et al (2009) was subsequently used to evaluate the effect of two different drugs for induction of anesthesia during emergency cesarean section in dogs by Doebeli et al (2013). The neonatal vitality, assessed by Apgar score at 5, 15 and 60 minutes after delivery was significantly higher when induction of anesthesia was obtained with alfaxalone as compared to anesthesia obtained with propofol, while the proportion of surviving puppies 60 minutes after delivery was not different between the two groups. The authors concluded that the Apgar score was very suitable for assessing neonatal vitality in puppies, and reported the usefulness of repeated evaluations during the first hour of life to assess individual improvement. Moreover, the impact of different drugs used for induction of anesthesia in dogs submitted to emergency cesarean section on neonatal viability, was reported.

Recently, Batista et al (2014) used the same Apgar score proposed by Veronesi et al (2009), with some modifications adapted to brachycephalic dog breeds (English and French Bulldog) for the clinical evaluation of puppies delivered by elective cesarean section at 5 and 60 minutes after birth. The slight variations included a lower heart rate considered as normal: >180 bpm rated as 2, between 120 and 180 bpm rated as 1, and < 120 bpm was rated as zero. Respiration was evaluated considering only the respiratory rate, and the mucous membrane color was rated as 2 when reddish,

rated as 1 when pink and rated as zero when cyanotic or pale. The authors reported a 24 hours survival rate close to 100% in puppies with Apgar score  $\geq 4$ , while neonatal mortality resulted concentrated in puppies with low Apgar score (0-3). The authors reported also the utility of the Apgar score to recognize neonates requiring immediate care and to choose the more appropriate resuscitation procedure intensity in relation to the degree of puppies viability. Moreover, the repetition of Apgar score at 60 minutes after delivery allowed to evaluate the improvement of the individual viability after intensive care

In another study (Groppetti et al, 2010) a different Apgar score was used, considering seven parameters and was associated to the umbilical blood lactate assessment for newborn puppies viability evaluation. The authors reported a close relationship between the Apgar score and umbilical blood lactate, but no relation was found between Apgar score and neonatal survival at 48 hours after birth.

None of the studies performed on dogs evaluated the relation between Apgar score at birth and long-term survival or neurologic outcome in survivors. However, several studies in humans demonstrated that the Apgar score is neither suitable for long-term neonatal survival prognosis nor for long-term neurological or mental impairment.

In conclusion, all the studies demonstrated the suitability of the Apgar score in the neonatal viability assessment immediately after birth and in the first hours of life. The value of the Apgar score to predict the short-term survival remains to be clarified, even if in two studies a close relationship between high Apgar score and survival at 24 hours after birth, was found. Although there is no guarantee that all puppies showing high Apgar score will surely survive, survival is more likely in pups with high Apgar score. The type of delivery has a significant impact on Apgar score, as well as the type of drug used for induction of anesthesia. However, for these last two parameters it is necessary to underline some considerations. Firstly, it is difficult to compare results according to the type of birth, because of the different protocols for anesthesia and for the surgical procedures used in case of elective cesarean section in the different studies. Secondly, in the studies performed on litters born by emergency cesarean section, many variables can had affected the neonatal viability, so that it is impossible to consider only the effect played by the type of parturition.

Further studies are required in order to define possible, if any, other breed-specific different parameters for Apgar score neonatal viability assessment in dogs and to better understand the effect of type of birth and possible influence of different anesthetic and surgical protocols used in case of elective cesarean section, while in litters delivered after emergency cesarean section, all the variables that could affect the neonatal viability should be taken in consideration.

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