Mini Review

CLINICAL SCALES FOR THE ASSESSMENT OF VITAL SIGNS IN NEWBORNS, INFANTS AND CHILDREN

G. Grigorov[1]*, B. Mladenov[2]

[1]Anaesthesiology and Intensive Care Clinic, UMPHATEM "N.I. Pirogov", Sofia, Bulgaria
[2]Children's Anaesthesiology and Intensive Care Clinic, UMPHATEM "N.I. Pirogov", Sofia, Bulgaria

ABSTRACT

Newborn assessment is an ongoing process that measures the development and adaptability to an extrauterine lifestyle. The newborn's Apgar score and behaviour form the basis for this assessment, and are related to the information described below: Maternal prenatal care history; Birth history; Maternal analgesia and anaesthesia; Complications during pregnancy or delivery; Treatment in the delivery room, together with determination of the clinical gestational age; Alignment with newborn classification by weight, gestational age, and risk of neonatal death; Physical examination of the newborn.

In the first 24 hours after birth, the evaluation of newborns is of great importance, because during this period the newborn is in a critical transition from intrauterine to extrauterine lifestyle. During this period, the risk of morbidity and mortality is statistically high. Assessment is important to ensure a successful transition. The assessment of the newborn includes the following stages:

- The first is done immediately after birth in the NICU to determine the need for resuscitation or other immediate interventions. If the newborn is stable, it stays with its parents after birth to establish early attachment. The newborn with complications is admitted to the IS for further evaluation and behavior.
- The second assessment is done 1 - 4 hours after birth, as part of the routine admission procedures. This evaluation includes a brief physical examination to assess the newborn's adaptation to the extrauterine lifestyle and to determine the g.v. All problems of the newborn at risk are thoroughly evaluated during this period.
- Before discharge, a doctor or healthcare professional performs a complete physical exam to determine new or potential problems. This is also the time to do the behavioral assessment.

Key words*: newborns, scales, vital signs, neonatology*

INTRODUCTION

In the first 24 hours after birth, the evaluation of newborns is of great importance, because during this period the newborn is in a critical transition from intrauterine to extrauterine lifestyle. During this period, the risk of morbidity and mortality is statistically high.

Clinical scales for the evaluation of the newborn are necessary for the timely monitoring of the vital functions of newborns with readiness for adequate behaviour if resuscitation is necessary. The APGAR assessment is a convenient method for quickly determining the

vital signs of newborns. The Silverman scheme assesses the presence of respiratory distress syndrome (RDS) and the severity of respiratory failure. The Ballard score determines the neuromuscular and physical maturity of newborns and their corresponding gestational age.
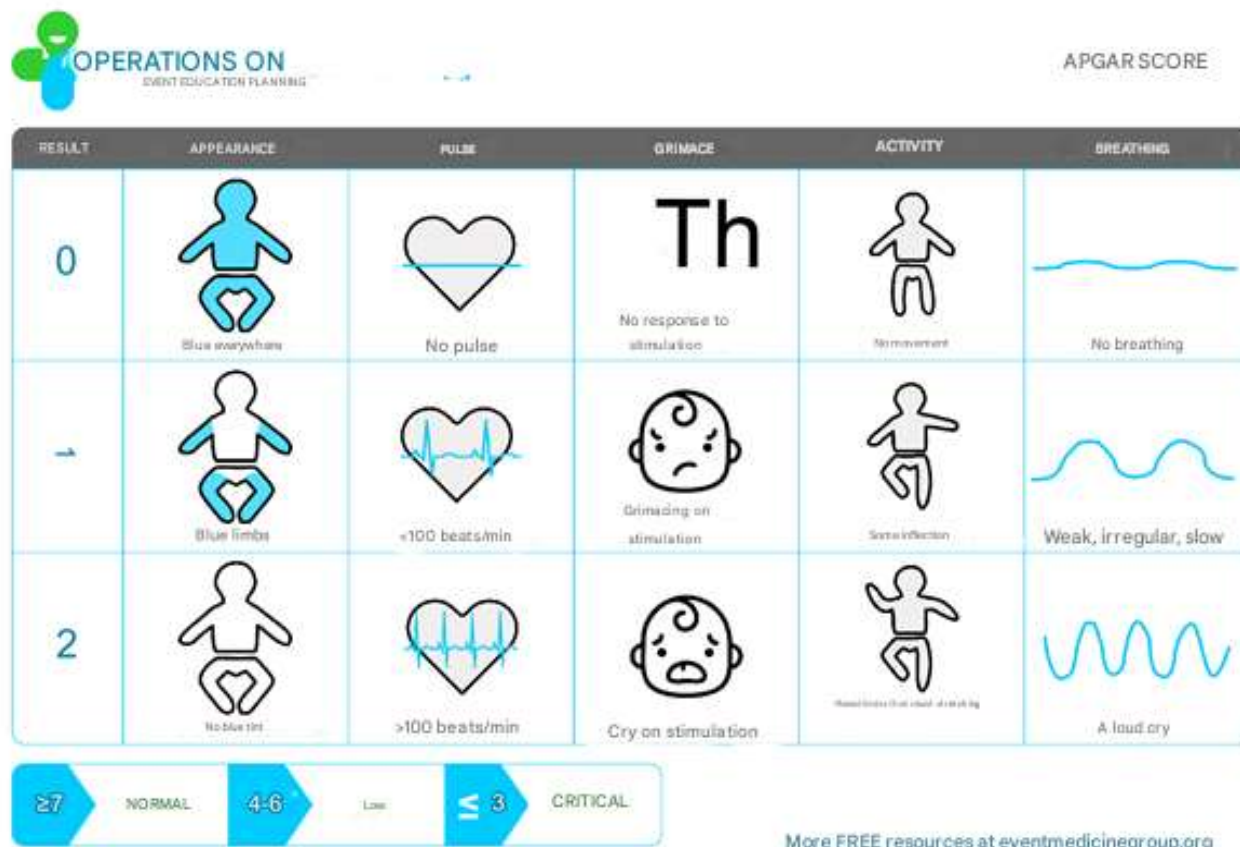
APGAR score

Physical examination of newborns immediately after birth includes: auscultation of breathing and heart sounds, assessment of respiratory rate and rhythm, skin colour, reflex excitability and muscle tone. The APGAR score includes the five main indicators: *breathing, heart activity, muscle tone, reflexes and skin colour.* It is evaluated according to the ten-point system with points from 0 to 2 for each indicator and a maximum total score of 10. The clinical

_____
*Correspondence to: *G. Grigorov, AICC, UMPHATEM "N.I. Pirogov", Sofia, Bulgaria, e-mail: grigorov_grigor@yahoo.com, Phone number: +359 899 212 829*

condition of the newborn is assessed at the 1st, 5th and 10th min. after birth.

In 1952, Dr. Virginia Apgar recommended the APGAR score as a simple and convenient method for a quick assessment of the newborn's vital signs (1). Dr. Apgar was an

anaesthesiologist and followed the effect of anaesthetics administered to the pregnant woman prior to birth on the newborns, immediately after birth. APGAR assessment is widely used in neonatology practice today.

Figure 1. APGAR score score
(source: https://bookdown.org/nathalieyuen/understanding-the-whole-child/the-newborn.html)

The APGAR assessment consists of 5 indicators with a scale from 0 to 2 for each and their total summation*. **APGAR (APGAR)** is an* abbreviation:

A - **Appearance** - mainly skin colour: 0 - generalized cyanosis or pallor; 1- only the limbs are cyanotic-acrocyanosis; 2 - generic light of body and limbs;
P - **Pulse - Heart rate:** 0 - no heart activity; 1 - heart rate <100 bpm or >160 bpm. 2 - heart rate 100-160 bpm.
G - **Grimace - Reflexes -** twisting when touching the cheek - turning the head in the appropriate direction, grasping - grasps an extended finger, protected - after slightly lifting the body and releasing it, spreads arms with subsequent retracting to the body. 0 - no reflexes - no response to stimulation; 1- one of the reflexes is missing, reacts with a grimace or a weak cry; 2 - available reflexes-response upon stimulation. In some versions of the evaluation

scale, as an indicator G, reaction during aspiration is evaluated (2).: 0 - absent; 1 - sluggish reaction; 2 - active movements;
A - **Activity - Tone:** 0 - absent muscle tone and active movements; 1 - weakened muscle tone, light movements with partial flexion of the limbs; 2 - good muscle tone, moves actively, flexion of limbs with resistance when trying to extend;
R - **Respiration – Breathing:** 0 - no spontaneous breathing and crying; 1 - irrhythmic, weakened, shallow breathing, rinses with a weak voice; 2 - normal breathing, rinses with a loud voice;
The clinical condition of the newborn is assessed immediately after birth, at the 1st, 5th and 10th minute. **Rate: 7 to 10 tones per 1 minute.** Moderately severe depression: 4 to 6 hours and 1 minute, slowed heart rate and irregular breathing. Severe depressive state: 0 to 3 tones during the 1st min. with bradycardia and absent gasp-type breathing.

APGAR score score on the 5th min. correlates with higher perinatal mortality (3). Prolonged low APGAR score on the 10th and 15th min. correlates with neurological symptoms (hypoxic-ischemic encephalopathy) in the early neonatal period. (2, 4).

A neonatologist must be present at birth when newborns with impaired vital signs should be resuscitated. In APGAR assessment score from 4 to 6 points the neonate needs rewarming, airway aspiration, and tented oxygen delivery. With a rating from 0 to 3, immediate resuscitation measures, which include: endotracheal intubation, mechanical ventilation and monitoring of vital signs.

Respiratory distress syndrome (RDS) - a syndrome of respiratory failure of the newborn is expressed by signs of:

- Tachypnea-respiratory rate over 60 beats/min
- Circulation-epigastric, intercostal and jugular
- Expiratory moan
- Thoraco-abdominal asynchrony
- Nostril breathing
- Acrocyanosis - from impaired peripheral perfusion

In the Silverman - Anderson assessment score, if the total sum of the points on the five indicators from **Figure 1**. is 0, the newborn has no signs of respiratory failure, at a score of 1-4, has mild RD, at a score of 5-7, has a moderate RDS, at a score of 8-10, the newborn has severe RDS.
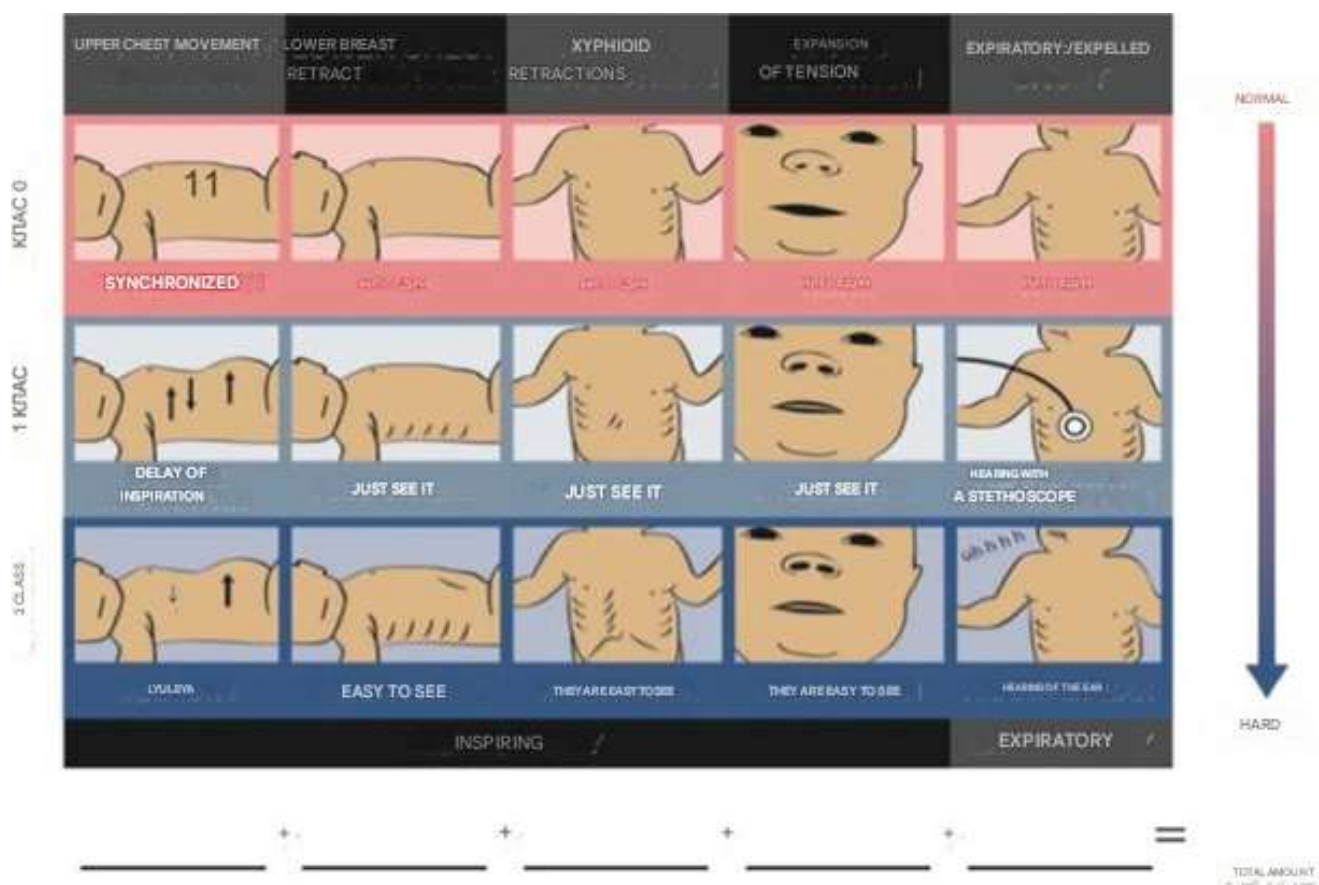
Figure 2. Evaluation of the newborn Silverman-Anderson score
(source: Hedstrom, AB, Gove, NE, Mayock, DE *et al.* Performance of the Silverman Andersen Respiratory Severity Score in predicting PCO $_2$ and respiratory support in newborns: a prospective cohort study. *J Perinatol* **38**, 505–511 (2018)

Assessment of gestational maturity of newborns
Assessment of the maturity of the newborn includes: assessment of gestational age by physical and neuromuscular indicators. The Ballard score score is based on certain physical and neuromuscular indicators. (5-7). Physical indicators include: skin, foot/plantar surface, ears/pinna, lanugo, male and female genitalia, mammary glands. Neuromuscular indicators include: body posture, "square window" (angle of contraction in the wrist), distance of the

hands to the body, "sign of the scarf" (position of the right upper extremity above the body, direction to the left), distance of the pecs to the ear during flexion in the hip joints.

Each indicator is evaluated by points: from 1 to 4 (up to 5 in terms of popliteal angle and skin).

The sum of the points for physical maturity is added to the sum of the points for neuromuscular maturity and the total number of points corresponds to a specific gestational age and weeks. **(Figure 3)**
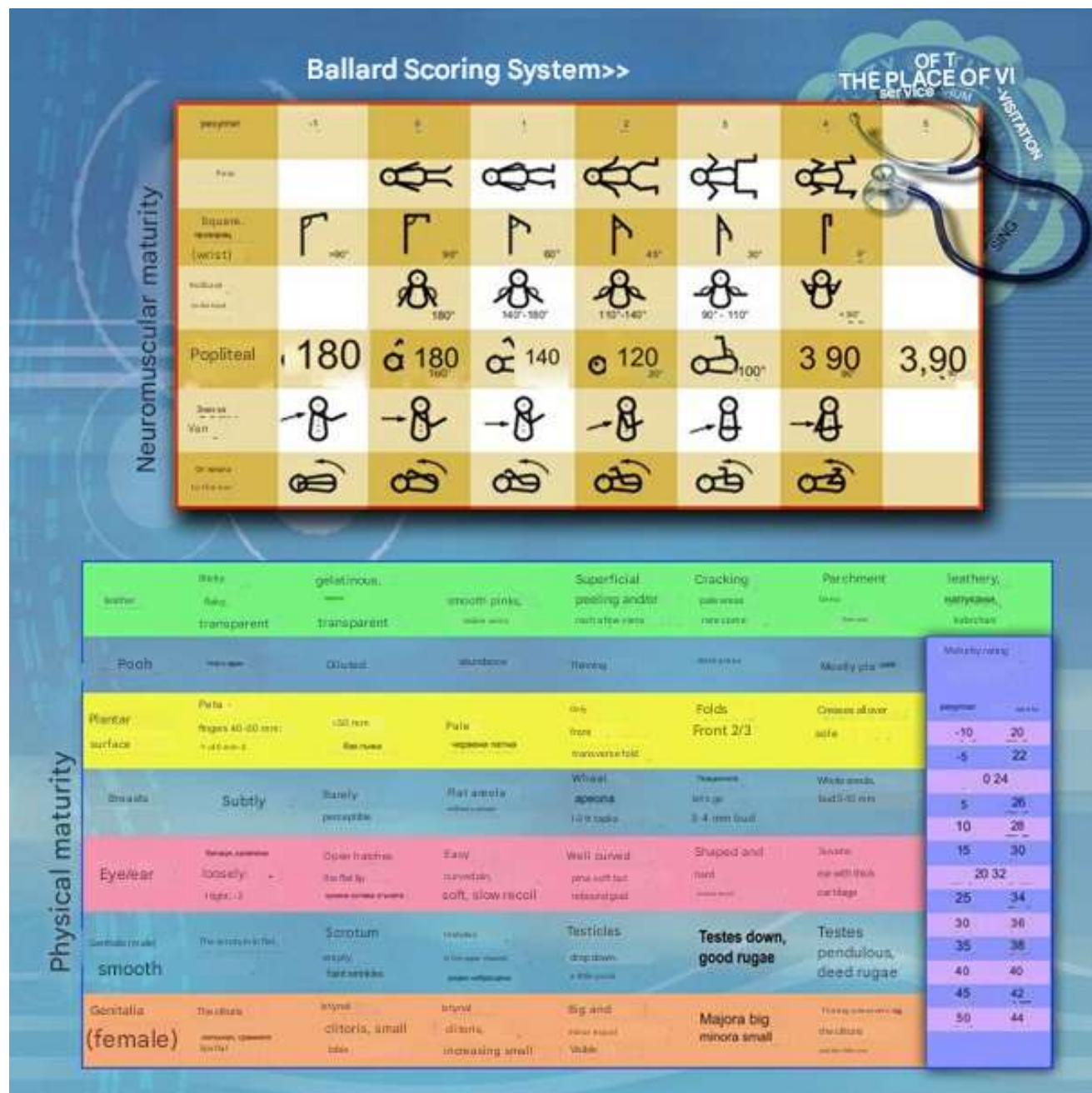
Figure 3. Ballard estimation of gestational age score
(source: Ballard JL, Khoury JC, Wedig K, et al: New Ballard score, expanded to include extremely premature infants. Pediatrics 119(3):417–423, 1991)

Implementation of resuscitation and medical procedures in premature infants against the background of the improvement of techniques and equipment in neonatology intensive care units improves survival of premature and at-risk newborn infants (5). For the timely resuscitation, adequate care and treatment of premature babies, the clinical scales of assessment according to APGAR, the assessment according to Silverman for RDS, as well as the determination of physical and

neuromuscular maturity according to the Ballard contribute score.

Continuous vital sign analysis for predicting and preventing neonatal diseases in the twenty-first century

It is increasingly evident that intermittent assessment of VS from review of standard bedside monitor data or medical record documentation fails to capture trends that portend impending pathophysiology, and that analysis of continuous VS data can improve outcomes of infants in the NICU. Display to clinicians of a score based on continuous analysis of HR characteristics has been shown in a large randomized clinical trial to decrease sepsis-associated mortality in preterm VLBW infants. While various analytics of continuous SpO2, RR, apnea, and BP **(Figure 4)** data either alone or in combination show promise for disease prevention or mitigation, they require more validation in randomized clinical trials. (13)
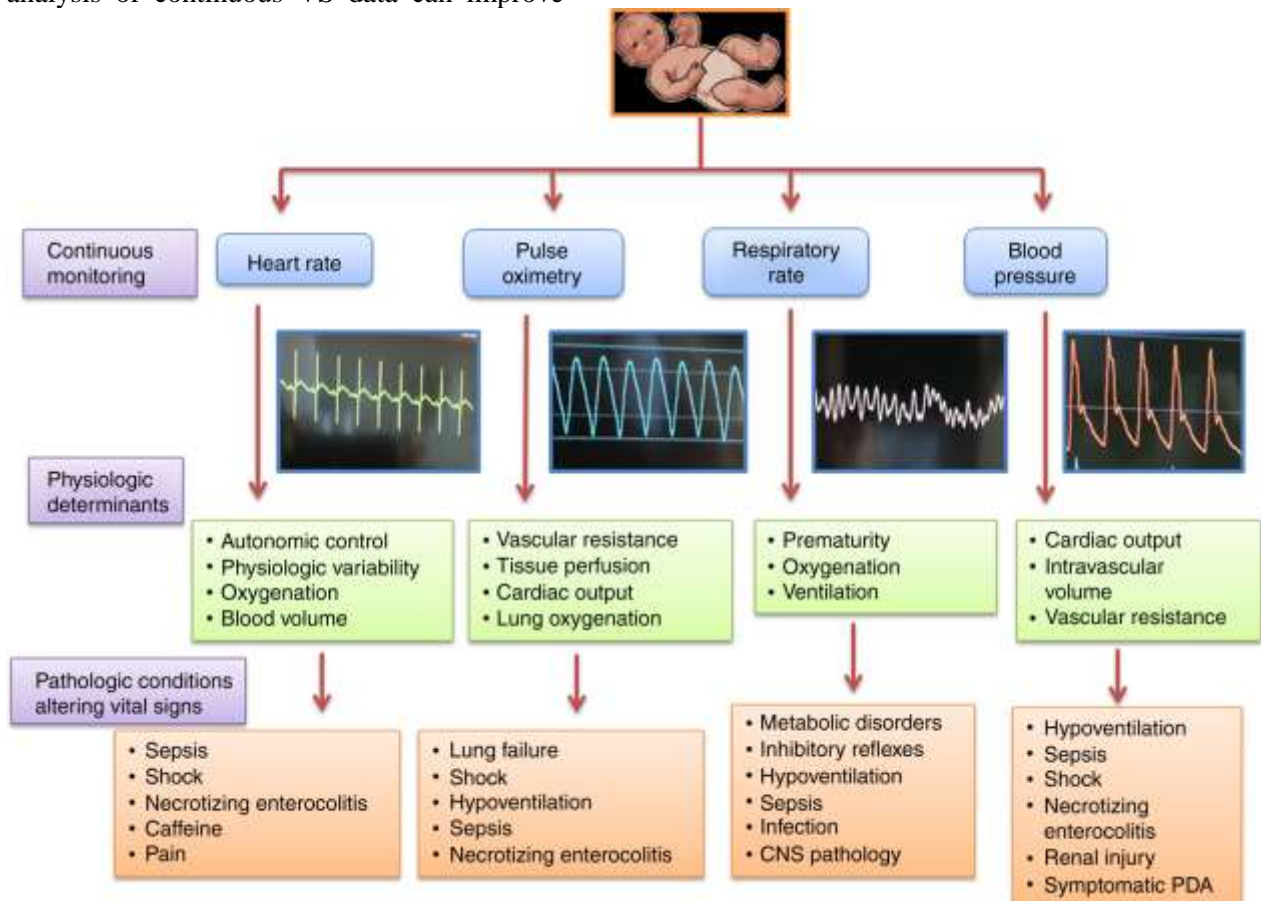
Figure 4. Continuous vital sign analysis and monitoring (Kumar, N., Akangire, G., Sullivan, B. et al. Continuous vital sign analysis for predicting and preventing neonatal diseases in the twenty-first century: big data to the forefront. Pediatr Res 87, 210–220 (2020).

Paediatric Vital Signs

The four basic vital signs are:

- **Body temperature.**
- **Blood pressure.**
- **Heart rate.**
- **Respiratory (breathing) rate.**

Healthcare providers check these during exams to get a snapshot of your child's overall health.

The normal range for paediatric vital signs can vary quite a lot depending on the child's age and other factors. For instance, the normal infant heart rate is much higher than the normal heart rate for a 12-year-old. (18)

How to take vital signs in children

While the process of taking vital signs consists of very similar steps to the same procedure in adults, there are additional considerations when caring for children. They are smaller and may be distressed/crying in a clinical environment. If children are scared, it can help to show the equipment, explain what you're going to do, or use distractions like a toy or video.

Temperature:
Rectal: most accurate
Axillary
Oral: for older children who can hold the thermometer under their tongue

Tympanic or temporal artery: quickly swipe across forehead or place in ear → reduced distress

Pulse:

For infants, use the brachial or apical pulse

For older children, the radial pulse is usually fine

Count the pulse for a full minute to ensure accuracy, especially as children's heart rates can be irregular

Respiration: Without letting the child know you're counting their breaths (as this can alter their breathing rate), count the number of breaths per minute. Watch for the rise and fall of the chest or abdomen.

Blood pressure: Use an appropriately-sized cuff (about 40% of the circumference of the arm). Check blood pressure last; if needed, leave cuff on and return to check later when child is calm.

Oxygen saturation (SpO2): Make sure the pulse oximeter is sized appropriately for the child.

Pain: Use an age-appropriate pain scale (like the "FACES" scale for younger children) to assess if the child is in pain. (18)

Figure 5. Normal Vital Signs in pediatrics by age (https://www.lecturio.com/nursing/free-cheat-sheet/normal-pediatric-vital-signs)

Paediatric Vital Signs Chart

It was created by Dr. Chris Novak, a paediatric resident at the University of Alberta, and Dr. Peter Gill, a staff paediatrician at The Hospital for Sick Children in Toronto, Canada.

Pain Scales

Pain scale is a tool of communication that can be used by a person in pain to communicate about her pain.

Scientists and medical professionals have so far developed   a variety of pain scales that can be used by the patients to communicate about their pain. Though simple pain scales are not enough to understand the complexity of various chronic pains, they are really useful for patients in conveying their condition to the medical practitioners.

Here, we are providing a list of the most common types of pain scales used regularly for pain assessment. (20)

PEDIATRIC VITAL SIGNS REFERENCE CHART

Heart Rate (beats/min)			Respiratory Rate (breaths/min)	
Age	**Awake**	**Asleep**	**Age**	**Normal**
Neonate (<28 d)	100-205	90-160	Infant (<1 y)	30-53
Infant (1-12 mos)	100-190			
Toddler (1-2 y)	98-140	80-120	Toddler (1-2 y)	22-37
Preschool (3-5 y)	80-120	65-100	Preschool (3-5 y)	20-28
School-age (6-11 y)	75-118	58-90	School-age (6-11 y)	18-25
Adolescent (12-15 y)	60-100	50-90	Adolescent (12-15 y)	12-20

Reference: PALS Guidelines, 2015

Blood Pressure (mmHg)				
Age		**Systolic**	**Diastolic**	**Systolic Hypotension**
Birth (12 h)	<1 kg	39-59	16-36	<40-50
	3 kg	60-76	31-45	<50
Neonate (96 h)		67-84	35-53	<60
Infant (1-12 mos)		72-104	37-56	<70
Toddler (1-2 y)		86-106	42-63	<70 + (age in years × 2)
Preschool (3-5 y)		89-112	46-72	
School-age (6-9 y)		97-115	57-76	
Preadolescent (10-11 y)		102-120	61-80	<90
Adolescent (12-15 y)		110-131	64-83	

Reference: PALS Guidelines, 2015
For diagnosis of hypertension, refer to the 2017 AAP guidelines Table 4 & 5:
http://pediatrics.aappublications.org/content/early/2017/08/21/peds.2017-1904

Temperature (°C)		Oxygen Saturation (SpO$_2$)
Method	**Normal**	
Rectal	36.6-38.0	
Tympanic	35.8-38.0	
Oral	35.5-37.5	SpO$_2$ is lower in the immediate newborn period. Beyond this period, a SpO$_2$ of **<90-92%** may suggest a **respiratory condition** or **cyanotic heart disease**.
Axillary	36.5-37.5	

Ranges do not vary with age.
Screening: axillary, temporal, tympanic (↓ accuracy)
Definitive: rectal & oral (↑ reflection of core temp.)
Reference: CPS Position Statement on Temperature Measurement in Pediatrics (2015)

Dr. Chris Novak & Dr. Peter Gill for www.pedscases.com
(Edited March 2020 by Richard He)

Figure 6. Pediatric Vital Signs Chart(Reference: PALS Guidelines, 2015
http://pediatrics.aappublications.org/content/early/2017/08/21/peds.2017-1904

1. Numerical Rating Pain Scale

This is the most commonly used pain scale. The patient needs to rate the intensity of their pain on a scale of 0 to 10. Zero means no pain while 10 stands for severe pain. This scale is commonly used for persons above the age of 10 years. (20)

Numerical Rating Scale
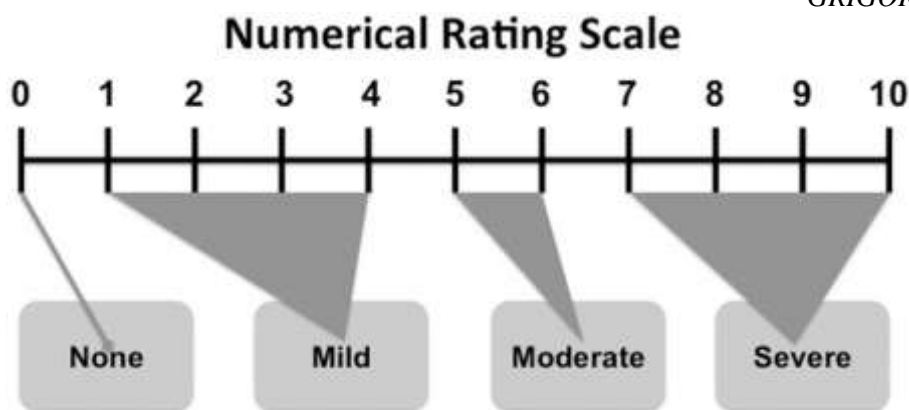
Figure 7. Numerical Rating Pain Scale (https://wecapable.com/pain-scale-definition-types-example-score/

2. Wong-Baker Faces Pain Scale

The rating in Wong-Baker pain scale is similar to the numerical rating but it combines pictures with the number for the rating of the pain. This scale can be used even for children as they can point to the face that depicts their intensity of pain. (20)

Figure 8. Wong-Baker Faces Pain Scale (https://wecapable.com/pain-scale-definition-types-example-score/)

3. FLACC Scale

FLACC stands for Face, Legs, Activity, Cry and Consolability. This scale is generally used by medical professionals to estimate the level of pain in infants or persons who cannot rate their pain themselves. Each of the five areas in FLACC is further assigned three points to make the observation more accurate. (20)

Figure 9. FLACC Scale https://wecapable.com/pain-scale-definition-types-example-score/

4.VAS Scale Visual Analog Scale

Technically speaking, Visual Analog for Pain consists of a horizontal (or vertical) line, usually 100mm in length. The left end of the line signifies no pain which is depicted by a smiling face while the right end signifies the worst possible pain with a frowning face. This visual depiction of pain levels helps the patient to communicate about the intensity of their pain. (21)

As the intensity of pain in VAS is majorly depicted with images of facial expression, it can be used on a wide range of patients including little children and elderly people who might not be accustomed to using other pain scales such as the Numerical Rating Pain Scale. It is much easier for any patient to express their perception of the intensity of their pain on VAS rather than converting it to a number as required in the Numerical Pain Scale. The patient can simply mark a spot on the scale that they feel represents their current state of pain. (21)
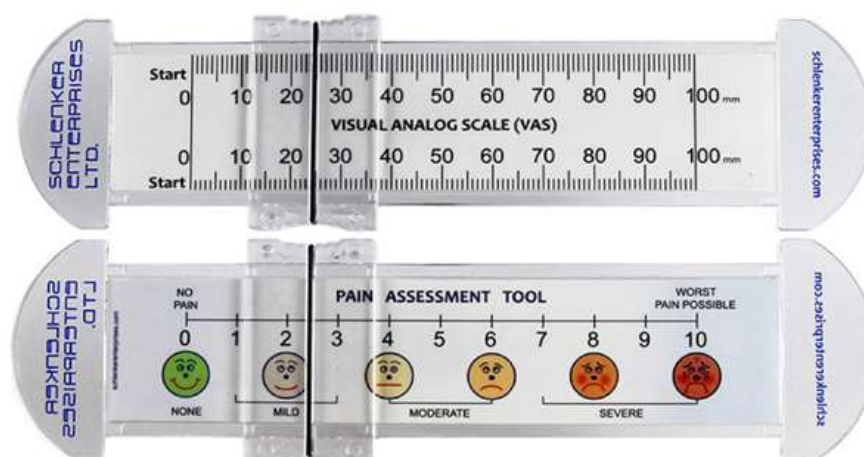

Figure 10. VAS Scale (https://wecapable.com/vas-pain-scale-100mm-line/)

The VAS is also more convenient when it comes to monitoring the pain progression in patients with chronic pain. The patient can easily indicate the level of increased or decreased pain on the scale which can be compared with the earlier level of pain. VAS is not only simple and time-saving but is also considered to be reasonably accurate. (21)

CONCLUSION

The history of the prenatal and birth process is essential for the postpartum sensory, motor and mental development of newborn children. The assessment of the newborn begins in the RN, continues in the Neonatal Unit, before discharge and after discharge from it at home. Assessment determines outcomes, behaviour, and prognosis of early and late neurologic impairment and outcome. There is also a wide range of scales in paediatrics to determine normal vital signs in children of various ages. Pain scales can be used to patients to communicate about their pain. Most common types of pain scales used regularly for pain assessment are: Visual Analog Scale for Pain (VAS): Scoring Pain, Numerical Rating Pain Scale, Wong-Baker Faces Pain Scale, FLACC Scale

REFERENCES

1. Finster M., Wood M. The APGAR score has survived the test of time. Anesthesiology. 2005 , 102(4):855-857
2. Hristova E., Petrova N., Newborns with perinatal asphyxia. Newborns at increased risk. Pediatrics. Bobev D., Genev E., (ed.) Arso, Sofia, 1998 130-132
3. Casey B. , McIntyre D., Lenovo K., The continuing value of the APGAR score for the assessment of newborn infants. New England Journal Of Medicine, 2001, 344 (7) :467-471
4. Hedstrom , AB, Gove, NE, Mayock , DE et al. Performance of the Silverman Andersen Respiratory Severity Score in predicting PCO2 and respiratory support in newborns: a prospective cohort study. J Perinatology 38, 505–511 (2018).
5. American Academy of Pediatrics: Committee on Fetus and Newborn. Hospital discharge of the high-risk neonate-proposed guideline s. pediatrics 1998: 102:411-417

6. Ballard JL, Navak K., Driver M., A simplified score for assessment of fatal malnutrition of newborn infants. Journal of Pediatrics. 95 :769-74

7. Ballard JL, Khoury JC, Wedig K, et al: New Ballard score, expanded to include extremely premature infants. Pediatrics 119(3):417–423, 1991.

8. La Hood A., Bryant C., Outpatient care of premature infants. American Family Physiology 2007; 76:8

9. Muntau A. The newborn child . Neonatology . Pediatria . Muntau A. and collaborators. Kalav I. (ed.) Sharov , Sofia, 1996, 15-16

10. www.en.wikipedia.org /wiki/Ballard Maturation Assessment

11. www.MedCalc : Ballard Maturation Assessment of Gestational Age.2010

12. www.Respiratory update.com/members/malnutrition assessment of gestational age. New Ballard Score.Cfm

13. Kumar, N., Akangire, G., Sullivan, B. et al. Continuous vital sign analysis for predicting and preventing neonatal diseases in the twenty-first century: big data to the forefront. Pediatr Res 87, 210–220 (2020).

14. https://bookdown.org/nathalieyuen/understanding-the-whole-child/the-newborn.html)

15. https://www.nature.com/articles/s41372-018-0049-3

16. https://www.pinterest.com/pin/643944446691990393/

17. https://www.nature.com/articles/s41390-019-0527-0

18. https://www.lecturio.com/nursing/free-cheat-sheet/normal-pediatric-vital-signs/

19. http://pediatrics.aappublications.org/content/early/2017/08/21/peds.2017-1904

20. https://wecapable.com/pain-scale-definition-types-example-score/

21. https://wecapable.com/vas-pain-scale-100mm-line/