

# Newborn

This article has been translated from WikiSkripta; ready for the **editor's review**.

**Newborn** means a child from the time of birth until the end of the 28th day of life. During the neonatal period, the adaptation of the various body systems to extrauterine conditions takes place and mortality is the highest of all childhood. It is a very specific period, which is why the medical specialty of *neonatology* was gradually established.<sup>[1]</sup>

## Newborn classification

### By gestational length

- **preterm, premature (immature)** (birth before completion of 37th gestational week according to WHO<sup>[2]</sup>);
- **birth at term** (births between 38 and 42 weeks of gestation);
- **transfer** (births after the 42nd week of gestation).

### Birth weight to gestational age

- **hypotrophic** (below the 5th percentile for a given gestational age);
- **eutrophic** (between the 5th and 95th percentile for a given gestational age);
- **hypertrophic** (above the 95th percentile for a given gestational age).

Combining these divisions, we can divide the newborns into 9 groups.

Regardless of these criteria, we label:

- **low birthweight newborns** (NNPH, low birthweight, LBW), weight below 2500 g;
- **very low birthweight newborns** (NVNPH, very low birthweight, VLBW), weight below 1500 g;
- **extremely low birthweight** (NENPH, extremely low birthweight, ELBW), weight below 1000 g.

## Newborn characteristics

At birth, the head makes up a quarter of the body's length. **Energy** is obtained primarily by **breaking down glycogen** in the first 24 hours, followed by fat breakdown (premature infants have small glycogen stores). Daily requirement of sugar: 5-15 mg/kg/min, fat: 3 g/kg/day, protein: 3 g/kg/day. Total energy requirement is usually around: 80-100 kcal/kg/day.

Normal daily fluid intake is 60-70 ml/kg on the first day. Then increase by 10 ml/kg/day to **150 ml/kg/day**. Insensible losses tend to be 25 ml/kg/day in neonates and up to 70 ml/kg/day in preterm infants.

### Signs of life

The respiratory rate of a newborn should be in the range of **40-60 breaths** per minute. Heart rate should be **150-180/min.** at first, then **120-140/min.**<sup>[3]</sup> The newborn should have active muscle movement.

Another of the important signs of life is the presence of **neonatal (unconditioned) reflexes** (the searching and sucking reflexes that enable food intake, the expulsion reflex, the defence reflex, the orientation reflex, the grasping reflex, the position reflex, etc;<sup>[4]</sup>)

The acousto-facial reflex should be present **from day 10**. Search and gait reflex **by month 3'**. Sucking reflex, Moro reaction, upper limb reflex grip **by month 4** and lower limb reflex grip **by month 12.**<sup>[5]</sup>

### Developing sensory functions

**Hearing'** should be well developed in a newborn. It prefers the sounds of speech, preferring the female voice of higher frequencies. A freshly born child is likely to recognize and prefer **his mother's voice** to that of a strange woman, and only recognizes his father's voice a little later.

**Smell'** allows the baby to **orient itself in its environment**. It turns away from unpleasant smells and responds positively to pleasant scents. At one week of age, a breastfed baby can distinguish the smell of its mother's nipple.

In the case of *taste*, the baby prefers *sweet*. It avoids bitter or otherwise unpleasant tastes. It has more taste buds than an adult.



Postpartum baby

The **visual system** is well developed in the retina but **lens mobility and visual acuity are restricted**. Visual acuity is low at birth (about 20/400). It does not reach adult visual acuity until around *1 year* of age. Fixation and tracking in the visual field appear by 2 months of age. The optimal distance for accommodation of the eye is 20-25 cm. Prefers the human face (and all figures that resemble it) to geometric figures. Prefers moving objects, bright colours and colour contrasts. Newborns often have strabismus, which usually **disappears by 3 months** of age (ophthalmological examination is recommended if persistent).

In the case of *touch*, the newborn responds positively to warmth and tactile reassurance. Finger sucking is observed as early as 24 weeks of gestation.<sup>[4][6]</sup>

## Behavioral states

According to Brazelton: deep sleep, light sleep (REM stage of sleep), slumber (transitional state between sleep and wakefulness), restless wakefulness, active wakefulness, crying. Sleep is not yet well consolidated (fragmented into multiple periods), lasting around 20 hours a day.<sup>[4]</sup>

## Neuromotor development

In the waking state, the limbs usually assume an asymmetrical position, conditioned by the **dominance of subcortical areas** over the immature cerebral cortex (tonic neck reflex or fencing reflex - the head is turned to the side and the limbs in the direction of gaze are in extension, while on the opposite side they are in semiflexion). His fists are usually clenched, unprepared for an active grip.<sup>[4]</sup>

## Psychosocial development

The newborn is able to learn. He is also capable of simple thought processes, but has a **brief and fleeting waking state** with the need for regular and frequent repetition of learning situations and social experiences. Analysis of the sound spectrum has shown differences between, for example, cries immediately after birth, cries of hunger and cries of pain. Able to imitate simple facial expressions (opening and closing of eyes and mouth, sticking out of tongue and simple vocalisation). Able to *recognise mother tongue from foreign language* (in contrast to adults, can distinguish subtle differences in the temporal relationships of consonants contained in human languages). A newborn (at 2 weeks of age) is distressed if spoken to in a language other than the one he or she has heard.<sup>[4]</sup>

## Body temperature

In the first week of life, a naked newborn requires an external temperature of 32-34 °C, a clothed one 24-27 °C. **Hypothermia** is a condition in which the body temperature of the newborn is less than **36.0°C p.r.**<sup>[7]</sup>. The most common reactions to cold are vasoconstriction, acrocyanosis, flexion posturing and non-shock thermogenesis. **Hyperthermia** is a condition in which the body temperature is higher than **37.5°C p.r.**<sup>[7]</sup>. The typical response to elevated temperature is vasodilation, sweating, hypoactivity and extensor posturing.

## Respiratory system

During labour, the compression of the chest as it passes through the birth canal expels amniotic fluid from the lungs into the upper airway, where it is swallowed. The rest of the liquid gets basally when the lungs are opened and is absorbed. Normal pO<sub>2</sub> ranges from 8-10 kPa in newborns, 6-9 kPa in premature infants. Normal pCO<sub>2</sub> is around 4.5-6.5 kPa<sup>[7]</sup>. Functional Residual Capacity (FRC) after birth corresponds to 30 ml/kg (i.e. the same FRC as in an adult).

## Digestive tract

Meconium leaves most often in the first 12 hours of life, physiologically **within 48 hours of life**<sup>[7]</sup>. The intestine is sterile, the intestinal flora develops in the first days of life. Breastfed babies have bifidogenic flora, babies on artificial nutrition have E. coli in their intestines. Lack of gut bacteria is the cause of vitamin K deficiency in the newborn<sup>[3]</sup>.

## Blood and the circulatory system

Mean BP should not fall below the value corresponding to gestational age in weeks. **Hypertension** occurs at BP values **greater than 90/60** in the newborn and **80/50** in the premature infant; Blood count:

- hemoglobin: 140-200 g/l (at birth, hemoglobin is 80% HbF)<sup>[3]</sup>;
- hematocrit: 0.43-0.63;
- erythrocyte count:  $5 \times 10^{12}/l$ , mean erythrocyte volume (MCV): 100-120 fl, [[Reticulocyte] ]y 3-7%;
- platelets  $100-450 \times 10^9/l$ <sup>[7]</sup>;
- leukocytes  $9-22 \times 10^9/l$ , after birth there are more polymorphonuclear cells than lymphocytes, at the end of the 1st week it is the opposite;
- I/T index = ratio of immature neutrophils (rods, metamyelocytes and myelocytes - I) to total neutrophils (T): < 20% or < 0.2<sup>[8]</sup>;
- hypoglycaemia: glycaemia < 2.5 mmol/l;
- hypocalcemia: calcemia < 2.25 mmol/l.

## Excretory system

Newborns often urinate for the first time after birth. It is normal if they urinate within 48 hours after birth. The volume of urine excreted is '*50-150 ml/kg/day*'<sup>[3]</sup>. The glomerular filtration rate increases with gestational week and age after delivery. Renal concentrating capacity is still limited (distal tubule not mature). Thus, there is a greater loss of sodium and thus a risk of hyponatremia. Fluid losses or inadequate fluid intake quickly lead to dehydration.

Acute renal failure

- diuresis < 0.5 ml/kg/hr;
- urea > 7 mmol/l;
- creatinine > 88 umol/l<sup>[7]</sup>.


## Signs of fetal maturity

The weight of the newborn is around **3500 g** and the length **50 cm**. It has a well-developed fat pad. The skin is pink, covered with a smear (*vernix caseosa* - secretion of sebaceous glands and exfoliated cells of the epidermis). On the nose it has milia (yellowish-white dots - retention cysts of the sebaceous glands). Teleangiectasias are visible on the root of the nose, eyelids and in the head. The hairs are fine, the nails extend beyond the ends of the fingers. The cartilage of the auricles should be developed. Genitalia mature (testes descended, scrotum grooved; labia majora covering labia minora). Entire foot striated.

 For more information see *Embryo growth, signs of fetal maturity*.

## Determination of gestational age

In neonatology, the most commonly used assessment of gestational age is **according to the Ballard scoring system** - it assesses a set of somatic features, the developmental functional responses of the newborn, and combining these to arrive at a gestational age with some probability.

The **eyelids** are erupted around the 26th gestational week (g.w.).The **skin** of a very immature newborn is dark red, thin and delicate, gradually thickening and beginning to peel at term. Subcutaneous blood vessels that are prominent at first gradually disappear. Similarly, the fine hairs (lanugo) covering the body *disappear*. Around 29 g. t. the **testes** in boys are **in the inguinal canal**, descending to the scrotum just before term. Girls first have a relatively large clitoris with small, widely spaced labia majora. At term, the clitoris and labia minora are *covered by the labia majora*. The nails reach the end of the fingers at 32 g. t., extending beyond them at term. Around 32 g. t., **striations appear on the plantar surfaces of the feet**, first in the part below the toes and gradually covering the entire plantar surface and crossing at various times (). Around 33 g. t., the ear cartilage **develops**, the ear becomes flexible, before 33 g. t. the ears are flat and maintain bizarre shapes when bent. The mammary glands of very immature children are absent, only the nipple is visible, the glands are palpable after 35 g. t.

*N.B.: By the physical examination given, the gestational age can be determined with a deviation of about 2 weeks.*<sup>[7]</sup>.

	Premature	Mature	Postmature <sup>[7]</sup>
vernix	not present or present in small amounts	covers the entire body	absent/reduced
lanugo	dense on body and extremities	discrete foci	not present
skin	thin, shiny, edematous, gelatinous in ELBW, subcutaneous blood vessels evident	pink, elastic, opaque	dry with ragades and desquamation
bones lbi	soft	firm	hard
nails		overlapping the fingertips	possibly yellow-green in colour
bolt	soft, flexible	rigid, springy	-
umbilical cord	tendon closer to the symphysis	tendon in the middle of the abdomen	-
subcutaneous fat	absent/simple	adequate	-
muscle tone	reduced	adequate	-
labia minora	prominent	overlapping labia majora	-

## Newborn nutrition

According to the WHO recommendations, the basis of nutrition for premature newborns is breastfeeding, which is recommended to start in the **first hours after birth**. Exclusive breastfeeding is recommended until 6 months of age and the only supplementation is vitamins D and K (vitamin K is only given if it was given orally instead of intramuscularly after birth). A fully breastfed baby does not need any formula or other fluids during the *first 6 months* of life. In the following period, non-dairy feeds are introduced with continued breastfeeding.<sup>[9][10]</sup>

# Links

## Related articles

- Newborn screening ■ Newborn nutrition ■ Newborn skull
- Low birth weight newborns

## External links

- JEŽOVÁ, Marta, Sylva HOTÁRKOVÁ a Katarína MŮČKOVÁ, et al. *Hypertextový atlas novorozenecké patologie : Multimediální podpora výuky klinických a zdravotnických oborů* [online]. Portál Lékařské fakulty Masarykovy univerzity [online], ©2010. Poslední revize 27.9.2011, [cit. 26.11.2011]. ISSN 1801-6103. <<http://portal.med.muni.cz/clanek-527-hypertextovy-atlas-novorozenecke-patologie.html>>.

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8. HAVRÁNEK, J.: *Hematologie*.
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