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Normal Growth and Development

- ◆ Typical kitten birth weight is 90 to 110g (range 80-140g)
- ◆ Influenced by many factors: breed, number of kittens in litter, queen's health
- ◆ Low birth weight associated with poor survival and congenital defects
- ◆ Weigh kittens at birth on gram scale, again 12 hrs later, and daily for first 2 wks of life
- ◆ First sign of illness may be failure to grow: a small amount of weight may be lost in the first 24 hours, but further weight loss or failure to gain is abnormal
- ◆ Normal kittens gain 50-100g per week (10-15 g/day); should double birth weight by 2 weeks of age
- ◆ During first 2 weeks, neonates nurse (up to 8 hours/day) and sleep (up to 16 hours/day)
- ◆ Well-fed kittens have plump abdomens and appear content; hungry kittens cry excessively, appear restless, and have gaunt abdomens
- ◆ Sick kittens may be weak, nurse poorly, and isolated from the rest of the litter
- ◆ Senses:
 - ◆ Eyes open about 10 days of age (range 2-16 days); kittens recognize queen by sight by about 4 weeks; iris remains blue-gray until 4-6 weeks
 - ◆ Ear canal at birth is blocked by ridges of skin but widens and opens by about 9 days of age (range 6-17 days)
 - ◆ Newborn kittens have a good sense of smell
 - ◆ Pain perception is present at birth so analgesia should be provided for any painful procedures
- ◆ Crawling is well developed by 7-14 days; walking begins about 2 weeks of age; elimination of urine and stool is a reflex stimulated by the queen; voluntary urination and defecation appear at about 3 weeks

Immunity

- ◆ Kittens receive almost all their passive immunity during the first 18 hours of life (before gut closure) with the ingestion of colostrum; there is no trans-placental transfer of immunoglobulins in the cat
- ◆ Queen's milk contains lower amounts of immunoglobulins than colostrum and the composition of the milk changes over the course of lactation according to the needs of the growing and developing kittens
- ◆ Kitten serum IgG nadir (lowest level) is reached at 4-6 weeks of age and correlates with the period of greatest vulnerability to infection
- ◆ Failure of passive transfer can occur in orphaned kittens, and kittens prevented from nursing during the first 18 hours of life for any reason such as illness in the queen or risk of neonatal isoerythrolysis
- ◆ How to correct failure of passive transfer:

- ◆ Subcutaneous injection of adult cat serum from a cat with compatible blood type (15 ml/100g body weight, divided into three doses over 24 hours)
- ◆ Frozen stored colostrum: 2-6 ml per kitten
- ◆ Foster queen
- ◆ Kittens with uncorrected failure of passive transfer start to produce IgG at about 4 weeks of age; they are most vulnerable to infection from birth to 6 weeks of age

Veterinary Examination of the Neonatal Kitten

- ◆ Veterinarian should get complete medical history
 - ◆ For the kitten in question and the littermates
 - ◆ For the queen, including illness, nutrition, vaccinations, infectious diseases, genetic factors, etc.
 - ◆ Of the labour and delivery, especially for kittens under 2 weeks of age
 - ◆ For any previous litters
- ◆ Investigate the environment including temperature and humidity, sanitation, population density, parasitism, infectious diseases
- ◆ Examine kittens under 4 weeks of age with queen present and in home/cattery if possible
- ◆ Examine neonates gently, on a clean warm surface, wash your hands first, wear gloves
- ◆ Simple equipment needed: gram scale, pediatric rectal thermometer, otoscope with infant cones, penlight, stethoscope with an infant bell (2 cm) and diaphragm (3 cm)
- ◆ Observe kitten's response to environment, body condition, mentation, posture, locomotion, and breathing; healthy neonates will have a strong suckle reflex
- ◆ Temperature:
 - ◆ Normal body temperature for newborn kittens is 97-98°F (36-37°C)
 - ◆ Temperature then rises slowly, reaching 100°F (38°C) by about 4 weeks of age
 - ◆ For first few weeks of life, kittens are poikilothermic
 - ◆ Kittens lack a shiver reflex until about 6 days
 - ◆ Kittens gradually become homeothermic by about 4 weeks of age
- ◆ Inspect for gross abnormalities, for example:
 - ◆ Cleft palate or cleft lip
 - ◆ Umbilical hernia or infection (omphalophlebitis)
 - ◆ Umbilical cord should be dry and free of discharges; normally falls off by day 3
 - ◆ Open fontanelles
 - ◆ Limb deformities
 - ◆ Chest wall deformities (flat chest, pectus excavatum)
 - ◆ Nonpatent urogenital or rectal openings
- ◆ Elimination:
 - ◆ Check for normal micturition/defecation by stimulation of perineum with soft moist cloth or cotton ball and mineral oil
 - ◆ Check for constipation or diarrhea (present in about 60% of sick neonates), as well as hematuria or pigmenturia
- ◆ Eyes:
 - ◆ Inspect eyes for abnormalities of globe or eyelids and for neonatal conjunctivitis
 - ◆ Menace reflex does not appear until 21 days or later
 - ◆ Pupillary light responses are present soon after eyes open but can be as late as 21 days

- ◆ Divergent strabismus is normal until 8 weeks
- ◆ Cornea is mildly cloudy when eyes open
- ◆ Evaluation of the fundus may be difficult until about 6 weeks of age
- ◆ Teeth:
 - ◆ First deciduous teeth to appear are incisors and canines at 3-4 weeks of age
 - ◆ Premolars appear 5-6 weeks of age
 - ◆ Normal dental formula for deciduous teeth = 2(I3/3, C1/1, P3/2); there are no deciduous molars
- ◆ Ears/Skin/Mucous Membranes:
 - ◆ Inspect pinnae for evidence of trauma or skin disease
 - ◆ Ear canals are not easy to inspect with an otoscope until over 4 weeks
 - ◆ Hair coat should be clean and shiny
 - ◆ Healthy neonatal kittens may have hyperemic mucous membranes until 7 days old, whereas sick neonates often have pale, gray, or cyanotic membranes
- ◆ Cardiovascular/Respiratory:
 - ◆ Neonatal kittens have lower blood pressure than adults, as well as greater cardiac output, faster heart rate
 - ◆ Auscultation of the heart can be difficult in the very young
 - ◆ Functional murmurs may be present in neonates due to anemia, hypoproteinemia, fever or sepsis
 - ◆ Innocent murmurs not associated with disease are more common in puppies than kittens; murmurs present after 4 months of age should be investigated
 - ◆ Congenital heart disease usually produces murmurs that are loud and accompanied by a precordial thrill
 - ◆ Normal heart rate can be over 200 beats/minute (range 220-260)
 - ◆ Normal respiratory rate is 15-35 breaths/minute
- ◆ Abdomen:
 - ◆ Full abdomen is normal in well-fed kitten, but enlarged abdomen in an ill kitten may indicate aerophagia
 - ◆ Normal liver and spleen are not palpable
 - ◆ Kidneys are always palpable
 - ◆ Stomach may be palpable if it is full
 - ◆ Intestinal tract is palpable as fluid-filled bowel loops that should be freely moveable and nonpainful
 - ◆ Urinary bladder is also palpable, moveable, and nonpainful

Basic Therapeutics

Hypothermia:

- ◆ Occurs when rectal temperature 78-95°F (26-35°C); associated with depressed respiration, impaired immune system function, slow heart rate, GI paralysis, coma
- ◆ Rewarm slowly over 30 minutes to 2 hours; up to maximum of 101°F (36.3°C) to avoid dehydration
- ◆ Methods: incubator, O₂ cage, warm IV/IO fluids at 95-98°F (35-37°C), warm water enema, heat lamp, hot water bottle, hot water blanket

- ◆ Room temperature should be 85-95°F (29-35°C) with 55-65% humidity (use a hygrometer from hardware supply store or pet store)
- ◆ Turn kitten often and monitor rectal temperature
- ◆ Never attempt to feed hypothermic kittens until they are re-warmed (risk of aspiration)

Hypoglycemia:

- ◆ Common due to immature liver function and rapid depletion of glycogen stores
- ◆ Occurs in sepsis, hypothermia and inadequate nutritional intake
- ◆ Diagnosed when blood glucose is less than 50 mg/dL (<3 mmol/L)
- ◆ Prolonged hypoglycemia can cause brain damage and possibly heart muscle damage as neonatal heart uses glucose for energy instead of long chain fatty acids
- ◆ Clinical signs: lethargy, anorexia
- ◆ If not hypothermic or dehydrated, give 5-10% dextrose solution orally (1 ml/100g body weight) by stomach tube every hour until stronger and normoglycemic
- ◆ In an emergency, corn syrup can be rubbed on the gums (e.g., *Karo*® Corn Syrup)
- ◆ For more critical neonates, veterinary care is required:
 - ◆ IV/IO infusion of 10-20% dextrose (1 ml/100g)
 - ◆ Follow up with 2.5 to 5% dextrose in a balanced electrolyte solution, IO or IV
- ◆ Don't use hypertonic dextrose solutions subcutaneously or tissue sloughing will occur

Tube Feeding Technique:

- All equipment should be meticulously clean and sterilized between uses
 - Feeding tubes: 5 Fr for kittens <300g, 8 Fr for kittens > 300g
 - Syringes (3- and 10-ml)
 - Commercial kitten milk replacer or emergency home-made formula
- Warm tube and syringe in warm water before use
- Measure from tip of nose to just before the last rib and mark tube (tube will have to be re-measured and re-marked weekly as the kitten grows)
- Fill the tube with milk replacer warmed to 95-100°F (35-38°C) and position the kitten in sternal recumbency with the head raised
- Pass the tube down the left side of the mouth into the esophagus, advance to the mark
- Tube should pass easily with no obstruction and only slight resistance from the kitten
- Slowly infuse the required amount of milk replacer
- Before withdrawing the tube, kink it to prevent entry of air and then withdraw quickly
- Normal stomach volume is approximately 40-50 ml/kg (4-5ml/100g)
- Manufacturer's recommendations should be followed for quantity to feed; feedings should be every 2-4 hours during the first week of life
- Diarrhea is the most common problem seen in kittens fed milk replacer: reduce volume fed, dilute 50% with water or a balanced electrolyte solution for a few feedings, try a different brand
- Energy requirement for kittens in first few weeks of life is 22-38 kcal/100g/day

Hypovolemia/Dehydration:

- ◆ Occurs easily due to diarrhea, vomiting or decreased intake; neonates have poor compensatory mechanisms and immature kidney function

- ◆ Difficult to assess hydration status; skin turgor is not reliable under 6 weeks of age due to increased fat content and decreased water content
- ◆ Mucous membranes should be moist and either hyperemic or pink but may remain moist even in the face of severe dehydration
- ◆ Pale mucous membranes and slow CRT may indicate 10% dehydration or more
- ◆ Normal neonatal urine is clear and colorless; in dehydration, urine is dark with specific gravity over 1.017
- ◆ Warmed oral fluids or subcutaneous fluids can be used when kitten normothermic, no GI dysfunction, not seriously dehydrated
- ◆ IV fluid therapy: best for serious dehydration and illness
- ◆ IP route should not be used in neonates due to risk of peritonitis
- ◆ IO access used when IV not possible, can administer blood, fluids, medications

Causes of Kitten Mortality

- ◆ Rates vary from 4% (in disease-free research colonies) to over 30% (in some pedigreed catteries); typically pedigreed catteries experience 10-20% mortality at 4 weeks
- ◆ Pre-weaning losses of over 20% should be vigorously investigated
- ◆ Typical risk periods for losses: During pregnancy (absorptions, abortions), at birth (stillborns), in the first 2 weeks of life, and the period immediately after weaning
- ◆ Investigation requires examination/treatment of individual kittens, diagnostic testing
- ◆ Necropsy: not performed often enough; results can provide information to save rest of a litter or future litters
 - For the best results, the whole body should be submitted (refrigerated, not frozen) to a qualified pathologist
 - If necessary, freezing is preferable to avoid tissue deterioration and some information can still be obtained
 - Gross anatomic necropsy, histopathology and cultures should be performed
- ◆ Most common factors: Low birth weight, congenital defects, trauma, inadequate nutrition, maternal neglect, environmental factors, infectious diseases and parasitism, neonatal isoerythrolysis (NI)

Low Birth Weight

- ◆ Multiple causes, may be hard to determine: Prematurity, inherited diseases (i.e. inborn errors of metabolism), congenital defects, *in utero* infections, and others
- ◆ Kittens under 75 grams at birth often have a poor survival rate
- ◆ Become familiar with average birth weights for each breed
- ◆ Kittens losing more than 10% of their body weight after birth have a poor prognosis

Congenital defects

- ◆ Defects present at birth, may be due to multiple causes (e.g., genetics, drugs, infections, spontaneous abnormalities, etc.)
- ◆ Up to 20% of live-born and stillborn kitten deaths involve major anatomical abnormalities
- ◆ Defects include: Cleft palate, craniofacial defects (e.g., Burmese, American Shorthair head defects), heart defects, gastroschisis, skeletal abnormalities, incomplete twinning

Trauma

- ◆ Up to 10% of kitten losses attributed to trauma during birth or during the first three days of life
- ◆ May also be due to maternal neglect or cannibalism

Inadequate nutrition

- ◆ Kittens should nurse within two hours of birth, colostrum only absorbed within first 16-18 hours
- ◆ First born kitten may be subjected to a long wait before nursing if delivery is prolonged
- ◆ Difficult births may produce kittens that are too exhausted and traumatized to nurse effectively
- ◆ Inadequate milk production associated with: First time queens, aged queens, queens who are sick or malnourished, difficult labors, familial trait, mastitis, litters of small weak kittens

Environmental Factors

- ◆ Environmental stressors (overcrowding, noise, poor ventilation, etc.) may compromise maternal care
- ◆ Temperature fluctuations may be harmful to neonatal kittens; high room temperatures combined with high humidity promote some infectious diseases (pneumonia, mastitis); low temperatures can predispose to chilling

Infectious Diseases

- ◆ Highest death rates from infectious diseases are in the first 2 weeks of life and post-weaning period
- ◆ Pathogens include: *Strep*, *Mycoplasma*, herpesvirus, calicivirus, parvovirus, FeLV, FIV, FIP, *Toxoplasma*, *E. coli*, *Pasteurella*, Staphylococci, *Bordetella*, *Chlamydomphila*. Most important are *Strep. canis* (Group G, beta-hemolytic), coliform bacteria (i.e. *E. coli*), respiratory viruses especially herpesvirus
 - ◆ Bacterial infections such as *E. coli* and *Strep. canis* may be significant cause of kitten losses, especially between 5-10 days of age
 - ◆ Important route of bacterial infection is the umbilicus; dip cords in 2% iodine or chlorhexidine solution
 - ◆ Check umbilicus daily for swelling, redness, discharges

Neonatal Isoerythrolysis (NI)

- Responsible for up to 50% of neonatal deaths in some pedigreed catteries
- Blood typing can be performed using blood typing cards (RapidVet-H, DMS Laboratories, Flemington, NJ; <http://www.rapidvet.com/>) or by commercial laboratories
 - ◆ Two main blood types, A (dominant) and B (recessive); third blood type is rare (AB)
 - ◆ Most non-pedigreed cats are type A (95-98%), some breeds may be 40% type B
 - ◆ Antibodies are naturally occurring; no previous pregnancy or transfusion is necessary

- ◆ Type B cats have strong antibodies against type A cells with titers up to 1:2064; type A cats have weak anti-B antibody titers
- ◆ NI occurs in blood type A or AB kittens born to a type B queen
- ◆ Kittens are born healthy; some die peracutely; others stop nursing within first 3 days with suggestive symptoms: failure to thrive, red-brown urine, icterus, anemia
- ◆ Kittens with severe anemia from NI require transfusion with type B blood (preferably from the queen who will have no antibodies to her own red blood cells); mortality rate is high despite prompt intervention
- ◆ Prevention: remove kittens from queen for first 16-18 hours; foster nurse kittens with type A queen if available or hand feed milk replacer; plan breedings to avoid incompatible blood types when possible; ensure all breeding cats are blood typed and the type is recorded on pedigrees
- Ideally, pedigreed cats should be typed and cross-matched before blood transfusions, especially for breeds with a significant amount of type B cats
- Most non-pedigreed cats are blood type A, but cross-matching is still advisable before transfusions

Frequency of Blood Types in Pedigreed Cats (%)

(From surveys conducted by the University of Pennsylvania)

* indicates breeds with some type AB individuals

Breed	Type A %	Type B %
Abyssinian	86	14
American Shorthair	100	0
Birman *	82	18
British Shorthair *	64	36
Burmese	100	0
Cornish Rex	67	33
Devon Rex	59	41
Exotic Shorthair	73	27
Himalayan	94	6
Japanese Bobtail	84	16

Breed	Type A %	Type B %
Maine Coon	97	3
Norwegian Forest Cat	93	7
Oriental Shorthair	100	0
Persian	86	14
Russian Blue	100	0
Scottish Fold *	81	19
Siamese	100	0
Somali *	82	18
Sphynx *	83	17
Tonkinese	100	0

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