SECTION 1
KEY TOPICS IN FELINE MEDICINE

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1.1 HEALTH SCREENING

1.1.1 Introduction

• Performed to minimise anaesthetic risk and to maximise long-term health.
• Benefit of screening programmes is less clear.
• Clear planning and practice policy relating to which patients to screen, what to screen for and what to do with abnormal results.
• Understood and supported at all levels within the practice.
• Very little is published about health screening in cats and dogs.
• Current consensus opinion – some form of screening in some cats is appropriate so long as
  ○ The risk–benefit equation for the pet (of undertaking the test) and the owner (anxiety associated with the test and any abnormal parameters found) is taken into account.
  ○ The test results are available prior to anaesthesia.
  ○ The tests are selected individually.
  ○ An action plan is available should abnormal results be found.

Rationale

• Pre-anaesthetic screening determines whether the anaesthetic will be safe and/or whether modifications to the routine anaesthetic regime are required.
• Geriatric screening allows identification of sub-clinical disease and hence earlier management and improved outcome.

1.1.2 Which cats to screen and what screening tests to use

Options are as in Table 1.

Developing a screening plan

• All members of the practice need to be comfortable with the service that is offered.

Table 1 Patient and test selection for screening

<table>
<thead>
<tr>
<th>Which patients?</th>
<th>Which tests?</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Recommend to all patients over a specific age</td>
<td>All patients get the same screening</td>
</tr>
<tr>
<td>Only screen patients prior to anaesthesia</td>
<td>Screening becomes more in-depth as the patient ages</td>
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<tr>
<td>Only screen at owner’s request</td>
<td>*Screening targeted based on historical information</td>
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<tr>
<td>Actively discourage screening and manage clinically significant disease as it occurs</td>
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</table>

*approach recommended by author

• Clear written guidelines should be available for all staff to follow.
• Clients need to be informed of
  ○ The existence of the plan.
  ○ What the plan offers – the pros and cons.
• Clear pricing of the various plans offered.
• Everyone must appreciate that screening can create anxiety for the owner if there are ‘abnormal’ results.
• Clear ‘what if’ guidelines should be developed:
  ○ Clients need to have any abnormalities discovered explained to them as to the significance and put into perspective.
  ○ If you measure a parameter such as blood urea you need to have developed a policy within the practice of an appropriate response if the result is abnormal.
  ○ Waiting is an acceptable response coupled with further screening at a time in the future; however, if the response is always to wait and rescreen and to do nothing interventional until the patient becomes unwell then what is the point of screening?
  ○ Changes in anaesthetic protocol should be defined and the costs involved made clear.
What tests to do?
- In the absence of evidence the ‘best’
tests to do in an outwardly healthy
individual with no significant previous
history is unknown:
- Traditional – urea, ALT, TP, glucose
(creatinine, ALK-P).
- Less traditional but potentially valuable
for pre-anaesthetic screening – USG and
dipstick, PCV, electrolytes (with ALT,
TP, urea).
Less traditional but potentially valu-
able for geriatric screening – USG and dip-
stick, PCV, calcium, cholesterol, BP (with
ALT, TP, urea).

1.1.3 Interpreting the test results and
developing an action plan
- Tests should be as sensitive and specific
(Box 1) as possible to avoid false-positive
and false-negative results that could
initiate unnecessary, more invasive, risky
and expensive further investigation.

Box 1  Sensitivity and specificity

Sensitivity = proportion of positives which
are correctly identified, i.e. 258
abnormal livers of which 231 identified,
therefore SENSITIVITY 231/258 = 90%.
Specificity = proportion of negatives
which are correctly identified, i.e. 86
normal livers of which 54 identified,
therefore SPECIFICITY 54/86 = 63%.

What to do when …

…the protein is low
Action point
- Total protein is >5 g/l (albumin >3 g/l)
below the reference range.

NB – Accurate measurement of albumin
on in-house machines is difficult so a
low albumin in the face of a normal total
protein should be checked at an external
laboratory.

…With large falls in proteins, three main
causes are likely; urinary loss, GIT loss
and failure of liver production.
- Less common causes of hypoalbuminae-
ia – see Section 3.15
- Elevated albumin levels are due to dehy-
dration.
- Elevated globulin due to dehydration,
immune or inflammatory response or
neoplasia.

Response
- Pre-anaesthetic – elective procedures
should be delayed and investigation
undertaken.
- Geriatric screen – monitor or inves-
tigate potential cause depending on
general health and other abnormalities
documented.

…the urea (± creatinine) is high
See Section 3.7.
- Consider whether cause is likely to be
pre-, intra- or post-renal in origin.
- Most cases are likely to be pre- or
intra-renal.
- Urea/creatinine will not rise until 75%
of renal mass is lost.
- All cases should have urinalysis per-
formed.

Response
- Pre-anaesthetic – fluid therapy and main-
tenance of renal blood flow during anaes-
thesia are important.
- Geriatric screen – assign to an IRIS stage
if intrinsic renal disease with appropri-
ate adjunctive tests.

…the ALT/ALP is high
- Increased liver enzymes are more likely to
be pathologic in cats (see Section 3.12).


1.1.4 Screening for neoplasia

- Cancer is a major cause of death or euthanasia in older cats.
- If the tumour is advanced before clinical signs are apparent options for treatment, particularly curative therapy, are unlikely.
- Computed tomography and MRI are sensitive ways of looking for mass lesions associated with any type of tumour; however, in man, 90% of lumps identified on CT screening are non-neoplastic. The availability and cost of CT/MRI and the need for general anaesthesia make this method of screening inappropriate for the majority of cats.
- Radiography is significantly less sensitive and abdominal ultrasound time consuming and very operator dependent.
- Few blood or urine tests for early diagnosis are available (Table 2) and often sensitivity and specificity are poor with false-positive results creating anxiety in clients and necessitating further more invasive diagnostics or false negatives giving the client and clinician a false sense of security that may mean subsequent warning signs are missed or misinterpreted.

Table 2  Blood and urine screening tests for cancer in cats

<table>
<thead>
<tr>
<th>Test</th>
<th>Target</th>
<th>Accuracy</th>
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<tbody>
<tr>
<td>Veterinary bladder tumour antigen</td>
<td>Transitional cell carcinoma</td>
<td>Not reported</td>
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<tr>
<td>Plasma/urine metadrenalines</td>
<td>Phaeochromocytoma</td>
<td>Not reported</td>
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<tr>
<td>Serum thymidine kinase</td>
<td>Haematopoietic neoplasms</td>
<td>Not reported</td>
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<tr>
<td>Serum biomarkers</td>
<td>Lymphoma</td>
<td>Sensitivity and specificity 85%</td>
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</tbody>
</table>
1.2 PREVENTATIVE MEDICINE

1.2.1 Vaccination

Initial vaccination
- Most manufacturers recommend an initial vaccination at 6–9 weeks of age and a second injection at 12–14 weeks. This schedule is designed to begin vaccination as soon as a significant number of individuals have lost their maternally derived immunity and to give a second injection when almost all individuals will respond.
- Despite this a percentage of individuals will not seroconvert to vaccination, making the first booster at 15 months of age important to ensure protection.
- Vaccination can be performed earlier than 6 weeks in high-risk groups, but should be as an additional immunisation and is outwith the manufacturer’s recommendations. Killed, genetically engineered or subunit vaccines should be used.

Booster vaccination
- Frequency of booster vaccination is controversial and there is disagreement between the recommendations of the data sheets provided by manufacturers and guidelines produced by other organisations such as the American Association of Feline Practitioners.
- Currently in the UK manufacturer recommendations for boosting of core vaccines are annual.
- AAFP recommends re-vaccination of cats every 3 years following the use of modified live FPV, and respiratory virus vaccines after the first booster vaccination at 15 months of age.
- Published literature is conflicting.
- Vaccination outside the manufacturers’ recommended schedule should be discussed with the client – if vaccine failure occur the veterinarian should be able to demonstrate informed consent from the cat’s owner.
- The frequency of booster vaccination is further complicated by the production of multivalent vaccines with different components potentially having different recommendations for frequency of re-vaccination.
- Booster frequency should also be based on local disease prevalence, susceptibility of the individual to infectious disease, previous history of vaccine reactions, intercurrent disease (such as FIV) and current treatments (such as use of immunosuppressive drugs).
- In areas of high disease prevalence, outdoor cats may well be receiving frequent challenge with field infection and therefore maintain high levels of immunity whereas in those areas cats that rarely go outside/meet other cats will be at higher risk of meeting the infectious agent if they do contact other cats and therefore need to have their vaccinal immunity maintained at a high level.
- Many owners feel that vaccination of older cats is unnecessary; however, as cats age immunity wanes and these individuals can be more susceptible to infectious disease and less able to mount an effective immune response should infection occur.
- Presence of antibodies predicts resistance to infection in FPV and FCV and in most (90%) of cats against FHV-1. Antibody levels are not predictive of resistance to FeLV infection.

Vaccine choice
- There are an increasing number of diseases for which vaccination is available.
- Attempts have been made to classify vaccination against some infectious diseases as essential (core vaccines) and others as optional (non-core) (see Table 3).
- Decisions should be based on regional disease incidence, household history and lifestyle of the kitten (indoor vs. outdoor).
Table 3  Core vs. non-core vaccines

<table>
<thead>
<tr>
<th>Core</th>
<th>Non-core</th>
<th>Value</th>
<th>controversial</th>
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<tbody>
<tr>
<td>FPV</td>
<td>FeLV</td>
<td>FIP</td>
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<tr>
<td>FHV-1</td>
<td>Chlamydophila</td>
<td>FIV</td>
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<tr>
<td>FCV</td>
<td>Bordetella</td>
<td>Giardia</td>
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<tr>
<td>Rabies&lt;sup&gt;a&lt;/sup&gt;</td>
<td>bronchiseptica</td>
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</table>

<sup>a</sup>Rabies endemic, travel to rabies-infected area likely, governmental policy.

Vaccine reactions
- Generally very rare and often associated with other vaccine components rather than the infectious agent itself.
  - Pedigree cats especially Burmese and semilong hair cats, e.g. Birman and Maine Coon, are overrepresented.
- Many cats and kittens will show mild signs following vaccination — this can be a good indicator of response to vaccination initiating an immune response.
- Significant illness that occurs post-vaccination should be reported to the manufacturer and investigated as far as possible to determine cause.

Injection site sarcomas
- Primarily associated with adjuvanted FeLV and rabies vaccination but have occurred following the use of other injectable preparations.
- Risk is approximately 1:10 000 cats.
- Locally invasive and moderate risk of metastasis.
- Vaccination on limbs/tail has been recommended as these sites are more amenable to radical surgery.
- Post-vaccination masses are common but should resolve within 4–6 weeks.
- Persistent masses should be investigated and should be removed if >20 mm with a wide surgical margin (including deep margin) with adjunctive radiation and chemotherapy considered.

Pre-vaccination testing for FeLV
- FeLV ELISA/RIM testing in healthy kittens where prevalence of FeLV is low has a high false-positive rate (>50% if prevalence <1%).
- Testing ‘at risk’ groups is of value.
- ‘At risk’ groups will depend on local knowledge of FeLV prevalence and distribution.
  - Feral and rescue cats are often considered ‘high risk’ but this is not supported by epidemiologic studies.
- Any positive result needs further confirmation.

1.2.2 Parasite control
- Regular endo and ectoparasite control is part of good husbandry as well as reducing public health risk.
- Frequency and type of parasite control will depend on
  - The life style of the cat.
  - Local disease prevalence and parasite resistance.
  - Individual sensitivity of the individual to parasitism, e.g. flea bite hypersensitivity.
  - Previous adverse reactions to specific compounds.
  - Specific disease issues that require treatment.
- Endoparasites can still be present in elderly indoor cats.

Available products
- A wide variety of products are available (see Table 4).
- Permethrin-based flea products for use in dogs are highly toxic to cats.
- Products for controlling larval stages of ectoparasites in the environment are also available.
- Some products also contain insect repellents, e.g. flumethrin, in combination with other parasiticides, e.g. imidacloprid.
- Over-the-counter products are also available as shampoos, tablets, spot-ons and collars:
  - Testing and efficacy of some of these products is limited.
## Table 4  Active ingredients of parasiticides for use in cats

<table>
<thead>
<tr>
<th>Active ingredient</th>
<th>Route</th>
<th>Taenia</th>
<th>Dipylidium</th>
<th>Echinococcus</th>
<th>Giardia</th>
<th>Angiostrongylus</th>
<th>Toxocara arrested larva</th>
<th>Uncinaria</th>
<th>Ankylostoma</th>
<th>Trichuris</th>
<th>Lungworm</th>
<th>Dirofilariosis</th>
<th>Fleas</th>
<th>Flies</th>
<th>Ticks</th>
<th>Demodex</th>
<th>Sarcoptes</th>
<th>Otodectes</th>
<th>Lice</th>
<th>Combined with</th>
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<td>1 Diclofenac</td>
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X = good efficacy; x = limited efficacy; C = collar; ED = ear drops; I = injectable; O = oral; T = topical.
1.3 PAEDIATRICS

1.3.1 Introduction
• Neonatal period covers the first 7–10 days of life.
• Characterised by poor neurological function, the progressive development of spinal reflexes and a total dependency on the dam.
• Followed by a transitional period (10–21 days of age) characterised by the development of a competent audio-visual system, further development of the neurological system and an increasing independence from the dam.
• Kittens enter a period of socialisation from 3 weeks of age lasting until around 3 months of age during which time feeding and sleeping occupy progressively less of the day, being replaced by social activity.
• There is maturation of the nervous system and hepatic and renal function.
• Kitten mortality is around 15–40% in the first 12 weeks of life with the majority of deaths occurring in the first week.

Definitions
• Paediatric – kitten hood covers the first 12 months of life but kittens have more or less adult physiology by 6 months of age.
• Congenital – defect present at birth, although it may not be clinically apparent on examination at this time. May or may not have a genetic basis.
• Inherited – defect has a genetic basis, may be no evidence at birth but will develop with age, e.g. PKD.

Is it inherited?
In general, inherited problems affect a proportion of the litter, unless the queen or stud cat is affected. The defect tends to be similar in all kittens. Congenital problems occurring due to an insult during pregnancy tend to affect all kittens but to varying degrees and sometimes different organs dependent on the exact stage of development at the time of the insult.

Major causes of kitten mortality
• Congenital anatomic or metabolic defect.
• Infectious disease.
• Inadequate/inappropriate nutrition.
• Trauma – dystocia, cannibalism, neglect.
• Neonatal isoerythrolysis.
• Low birth weight.

1.3.2 Evaluating the paediatric patient

Physiology
• Significant physiological changes occur during the first weeks of life that will directly affect the clinical signs shown, and the ability of the neonate to respond to disease.
• Separation of the placenta causes an increase in peripheral resistance and hypoxia develops rapidly inducing gasping respiration.
• Constriction of the umbilical vein squeezes significant quantities of blood from the placenta into the neonate and hence, where possible, should be left intact.
• In response to the increasing oxygen tension the ductus arteriosus narrows (complete closure in 1–2 days) and the pulmonary vessels dilate.
• Increased left-sided pressure results in the closure of the foramen ovale between the atria.
• Fetal pO_2 rises correcting the acidosis that develops in the newborn.
• Thermoregulation in the newborn is poor as the ability to shiver (develops by 6–8 days) and vasoconstrict in response to falling body temperature is limited.
Glucoregulation
- Newborn kittens have limited reserves of glycogen and poor hepatic gluconeogenic responses to low blood glucose.
- Able to maintain glucose levels for 24 hours if healthy.

Hepatic and renal function
- Hepatic microsomal enzymes which are involved in many metabolic functions including drug metabolism may not be fully functional until 4–5 months postpartum, though near-normal liver function is probably present from around 8 weeks of age.
- Albumin levels in neonates are significantly lower than in adults, which can result in increased circulating drug levels.
- Glomerular filtration rate is approximately one-fifth of adult levels and tubular secretion mechanisms do not mature until approximately 8 weeks of age. This means that glycosuria is common and urine specific gravity is low (1.006–1.007).
- Kittens have a limited ability to conserve fluid; hence fluid requirements are high at around 120–180 ml/kg/day.
- Urine production begins in the first 24 hours.
- Protein excretion increases to 12 weeks then falls, fractional excretion of calcium falls and phosphate rises with maturity.

Immune function
- Neonates possess a degree of immune competence, but do not have a fully matured spectrum of responses.
- Reduced activity of cells involved in non-specific immune responses, such as neutrophils, is likely.
- With a poorly functioning immune system in terms of speed, magnitude and breadth of response, good passively acquired immunity is crucial.

Passive immunity
- Greater than 90% of passive immunity is provided from colostral intake; however, the protection afforded depends on the immune status and exposure of the dam.
- Gut permeability to immunoglobulins begins to decline within 8 hours of birth and no further absorption is possible after 48–72 hours.
- Passive immune protection of the intestinal tract continues during the whole period of suckling as IgA antibodies resist gastric degradation and can bind potentially harmful pathogens in the gut lumen.
- Colostrum also contains cellular components though their precise role is unclear.
- Kittens should be born into the same environment as the one in which the dam has been housed.
- Plasma transfusion to colostrum-deprived kittens has not been shown to be of value.

Cardiovascular function
- Heart rates in newborn kittens may respond to hypoxia by falling rather than rising (a protective mechanism).

Neurological development
- Over the first 11–12 weeks of life, kittens develop normal adult reflexes and response.
- Until that time they display primitive reflexes which gradually disappear.
- Behaviour patterns tend to be much simpler, being driven by hunger and the search for warmth.
- Newborn kittens will sleep for more than 80% of their time and will tend to lie quietly when replete and warm.
- When stressed (for whatever reason) they will cry and crawl around making side-to-side head movements.
Baseline data and physical examination
- Reference ranges for haematological and biochemical parameters are different from adults, therefore results need to be interpreted according to the age of the kitten (Table 5).
- Rectal temperature of dry, healthy day-old kittens is around 35.5°C (±0.8) [96°F (±1.5)] rising gradually over the first week of life to around 37.8°C (100°F). Adult temperature is achieved by approximately 4 weeks of age. Reference range for physiologic values in kittens are given in Table 6.
- Circulating blood volume of kittens is small (25–40 ml in a 4-week-old kitten), hence repeated blood sampling can cause severe anaemia and should, therefore, be kept to a minimum.

Table 5  Reference ranges for haematological and biochemical values in kittens

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Kittens (mean or range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (weeks)</td>
<td>0–3 days 2 weeks 4 weeks 6 weeks</td>
</tr>
<tr>
<td>PCV (%)</td>
<td>41.7 33.6–37.0 25.7–27.3 26.2–27.9</td>
</tr>
<tr>
<td>Hb (g/dl)</td>
<td>11.3 11.5–12.7 8.5–8.9 8.3–8.9</td>
</tr>
<tr>
<td>MCV (fl)</td>
<td>81.6 65.5–69.3 52.7–55.1 44.3–46.9</td>
</tr>
<tr>
<td>WBC (×10⁹/l)</td>
<td>7.55 9.1–10.2 14.1–16.5 16.1–18.8</td>
</tr>
<tr>
<td>Age (weeks)</td>
<td>2 (range) 4 (range)</td>
</tr>
<tr>
<td>Total protein (g/l)</td>
<td>40—52 46—52</td>
</tr>
<tr>
<td>Albumin (g/l)</td>
<td>20—24 22—24</td>
</tr>
<tr>
<td>Sodium (mmol/l)</td>
<td>ND 149—153</td>
</tr>
<tr>
<td>Potassium (mmol/l)</td>
<td>ND 4.0—4.8</td>
</tr>
<tr>
<td>Chloride (mmol/l)</td>
<td>ND 120—124</td>
</tr>
<tr>
<td>Inorganic phosphate (mmol/l)</td>
<td>ND 2.03—2.41</td>
</tr>
<tr>
<td>Calcium (mmol/l)</td>
<td>ND 2.35—3.24</td>
</tr>
<tr>
<td>Urea (mmol/l)</td>
<td>&lt;5 &lt;5</td>
</tr>
<tr>
<td>Creatinine (μmol/l)</td>
<td>ND 36—54</td>
</tr>
<tr>
<td>Cholesterol (mmol/l)</td>
<td>4.29—11.59 0.58—11.36</td>
</tr>
<tr>
<td>ALK-P (U/l)</td>
<td>68—269 90—135</td>
</tr>
<tr>
<td>ALT (U/l)</td>
<td>11—24 14—26</td>
</tr>
<tr>
<td>Creatinine kinase (U/l)</td>
<td>ND ND</td>
</tr>
<tr>
<td>Glucose (mmol/l)</td>
<td>6.08—10.32 7.92—8.96</td>
</tr>
<tr>
<td>Bilirubin (μmol/l)</td>
<td>1.7—16.9 1.7—3.4</td>
</tr>
<tr>
<td>Bile acids (μmol/l)</td>
<td>&lt;10 &lt;10</td>
</tr>
</tbody>
</table>
Clinical evaluation

Case history
- Basic information is essential to evaluate clinical and laboratory findings.
- Include a breeding history of the household, cattery management (hygiene, worming, vaccination, etc.), health of the queen during the pregnancy, the health of the remainder of the litter, age of the kitten and pattern of the illness to date.

Clinical examination
- Examination can be difficult.
- Neonates tend to show limited responses to disease, initially becoming agitated and crying, progressing to inactivity, hypothermia and loss of the sucking reflex.
- Changes can be very rapid; it is important that the owner is made aware of the potential significance of these signs to allow aggressive, early treatment.
- Weight gain can be a sensitive indicator of developing problems and can be easily measured by the owner. Failure to gain weight over any 24-hour period is worthy of further investigation.

External features
- Body weight; hair coat (amount, condition, parasites); state of hydration; signs of injury; appearance of umbilicus; discharge from nose; urine staining (patent urachus); diarrhoea/rectal patency; congenital malformation.

Eyes
- Swelling under lids indicates pus formation (often Staphylococcus spp., very rarely Chlamyphila felis); eyes open between 5 and 14 days, pupillary light response is usually present within 24 hours of the eyes opening, mild corneal cloudiness often present as eyes open.

Ears
- External auditory meatus closed at birth and opens between 6 and 14 days. Check for mites and middle ear infection (indicated by a bulging tympanum).

Mouth
- Mucous membrane colour; evidence of cleft palate.

Thorax
- Heart rate around 200–220 beats/minute; respiration 15–35 per minute; regular rhythm; heart murmurs may be functional (usually soft); lung sounds difficult to distinguish but should be present; check for symmetry and malformation of the thoracic cavity e.g. pectus.

<table>
<thead>
<tr>
<th>Age (days)</th>
<th>Rectal temperature (°F/°C)</th>
<th>Heart rate (bpm)</th>
<th>Respiratory rate (/minute)</th>
<th>Environmental temperature (°F/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–7</td>
<td>96 ± 1.5 [35.5 ± 0.8]</td>
<td>200–250</td>
<td>15–35</td>
<td>85–90 [29.5 – 32.5]</td>
</tr>
<tr>
<td>8–14</td>
<td>100 [37.8]</td>
<td>70–220</td>
<td>15–35</td>
<td>80 [26.5]</td>
</tr>
<tr>
<td>&gt;35</td>
<td>Adult</td>
<td>70–220</td>
<td>Adult</td>
<td>70 [21]</td>
</tr>
</tbody>
</table>
Abdomen
• Should feel full, but not swollen or tight; liver and spleen not palpable; intestines soft, mobile and non-painful; urinary bladder freely movable.

Neurological assessment
• Alertness, response to stimulation, suckle reflex; other reflexes appropriate to age; gait (walking from around 4 weeks old); posture.
• Flexor and extensor dominance appears more variable in kittens than puppies.

1.3.3 Investigation of neonatal disease
• Routine biochemistry and haematology can be performed from a very early age on blood obtained by jugular puncture.
• Many infectious diseases develop too rapidly to obtain results quickly enough (especially bacterial culture and sensitivity) to be of value to that individual.
• As infections are frequently a litter problem, laboratory data can improve management and treatment of any subsequent cases.
• Radiographs can be difficult to evaluate in kittens as mineralisation of the skeleton is poor and they are easily over-exposed, but can provide useful information. The kV should be reduced by up to half that used for an adult of similar body thickness.
• Faecal examinations can be easily performed and are of particular value where protozoan parasites are suspected.
• Many cases will, however, end up at post-mortem. Maximum information can be obtained if the carcass is fresh and, if not immediately available for post-mortem, the body should be stored in the fridge and not the freezer. Use a systematic approach and record details.

1.3.4 Treatment of the paediatric patient
• Special consideration needs to be given when giving drugs or fluids to paediatric patients.

Drugs
• Absorption, distribution, metabolism and excretion of drugs can be significantly different from adults.
• Few drugs have had dose rates calculated for use in the neonate.
• Generally an increase in initial dose is required with a lengthening of the interval between doses.
  ○ Kittens have a high body surface area but reduced metabolic capacity.
• Great care should be taken when administering some types of antimicrobials orally because of the potentially adverse effects on the developing gut microflora.
• Subcutaneous and intramuscular absorption of drugs is slower and less reliable than in adults.
• Antibacterials administered to the dam do not reach therapeutic concentrations in the milk.
• Nutritional support either by nasoesophageal or gastric intubation is important particularly in the face of sepsis.

Fluid therapy
• Fluid requirements are higher in neonates than adults, but total volumes can be low.
• Syringe driver can be of great value and can be significantly cheaper than fluid pumps; otherwise a burette with a paediatric giving set (60 drops/ml) will ensure that the kitten is not over-hydrated.
• Tend to be acidotic but reduced hepatic function can mean that they are less able to metabolise lactate into bicarbonate.
• Glucose can be replaced using a 5% dextrose solution mixed 50:50 with lactated Ringer’s or by giving 1–2 ml of 10–25% glucose IV to a profoundly depressed kitten.

Methods of drug and fluid administration

**Intravenous**
- 23 or 25 g catheter can be placed in the cephalic vein of many small kittens.
- Short legs can make the catheter very positional and flow difficult to maintain.
  - Splinting the leg can help but is uncomfortable for the kitten.

**Intraperitoneal**
- Not ideal as absorption can be relatively slow, especially in the face of hypovolaemia, and is poorly suited to long-term fluid therapy.
- Risks of puncturing viscera are low.
- Aseptic technique is mandatory.
- Fluid requirements should be calculated and the volume divided to be given 2–3 times daily.

**Intraosseous**
- Where venous access is not possible.
- Cortical bone is sufficiently soft such that a hypodermic needle (18–19 g) can be placed.
- Surgically prepare area and the needle is placed in either the proximal tibia or proximal femur.
- Only one attempt should be made at each site because if the bone is already punctured it will result in fluid leaking out.
- Fluids, drugs or whole blood can be given at the same rates as for IV therapy.

### 1.3.5 Common infectious diseases of kittens

**Ectoparasites**
- Fleas – can cause serious anaemia in young kittens with a heavy burden.

**Protozoan parasites**
- Coccidia – breeding establishments, acute diarrhoea may be haemorrhagic.
- Toxoplasma – anorexia, lethargy and hypothermia.
- Giardia – acute small intestinal diarrhoea.
- Tritrichomonas foetus – foul smelling watery diarrhoea.
- Protozoan parasites will be minimised by good husbandry, hygiene, daily disposal of faeces and avoiding overcrowding.
- Potentiated sulphonamides need to be used with care in neonates due to their reduced hepatic metabolism.

**Endoparasites**
- *Toxocara* spp. and *Toxascaris leonina* are almost ubiquitous parasites of kittens being transmitted in the dam’s milk.
- Heavy infestations are associated with unthriftiness, diarrhoea, poor coat condition and a ‘pot-bellied’ appearance.
- Rarely complete bowel obstruction is caused.
- Regular worming should be performed in all.
- Piperazine, though widely used, is potentially toxic particularly in kittens and overdose is common due to the size of the tablets.
- Benzimidazole group is more efficacious, safer and easily administered.
- Data sheets for other endoparasiticides should be checked to ensure they are suitable for the patient’s age.
Bacterial infections

- Variety associated with neonatal septicaemia in kittens:
  - Commonly *Staphylococcus*, *Escherichia*, *Klebsiella*, *Enterobacter*, *Streptococcus*, *Enterococcus*, *Pseudomonas*, *Clostridium*, *Bacteroides*, *Fusobacterium* and *Salmonella* spp.
  - *Bordetella bronchiseptica* – fatal respiratory infections.
  - Gram-negative bacilli are found most frequently.
  - *Haemoplasma* – *M. haemofelis* seems most pathogenic causing depression, lethargy, severe anaemia.
- Death can occur suddenly with few clinical signs, but more commonly frequent crying, restlessness, hypothermia, diarrhoea, dyspnoea, haematuria and cyanosis are seen.
- More chronic disease – kittens fail to gain weight as expected.
- Diagnosis is based on history and clinical examination.
- Treatment needs to be aggressive with antibacterials, fluids, glucose and oxygen.
- Potentiated amoxicillin represents a logical first-choice drug in the absence of culture and sensitivity results.

Diarrhoea

- Common in neonates but the role of bacteria is less clear.
- Majority of cases are self-limiting and can be treated using dietary manipulation and fluid therapy.
- Antibacterials should be avoided if possible as they can further disrupt the developing bowel microflora.

Viral infections

- Uncommon in kittens until maternally derived immunity begins to wane at around 5–6 weeks.
- FIV, FeLV, FIP and FPV can infect kittens transplacentally as well as perinatally via body fluids and milk.
- Transplacental spread of FPV can be associated with the use of modified live vaccines in pregnant queens.

1.3.6 Neonatal isoerythrolysis

- Blood group A kittens born to a B-group queen – naturally occurring anti-A antibodies passed in the colostrum resulting in immune-mediated destruction of the kitten’s red cells.
- Clinical signs – fading at a few days of age, haemoglobinuria, jaundice, tail tip necrosis.
- Mortality can be high even with aggressive treatment.
- Avoid mating an A-group tomcat to a B-group queen.
  - Where this occurs, kittens hand-reared for the first few days until gut closure has taken place.

1.3.7 Fading kitten syndrome

- Fading kittens is a syndrome that covers a multitude of infectious and non-infectious conditions of the neonate resulting in an animal that is born apparently healthy but gradually becomes inactive, loses the suckle reflex and dies in the first 2 weeks of life.
- Localising signs are usually absent.
- This condition represents a clinical description rather than a diagnosis and requires investigation as outlined above.

Causes

- Congenital abnormality.
- Teratogenic effects.
- Inadequate nutrition.
- Inadequate colostrums.
- Low birth weight.
- Trauma.
• Neonatal isoerythrolysis.
• Infectious disease.

Key history
• Breeding history of household.
• Disease status of household.
• Individual breeding history of queen.
• Number of kittens born alive and dead.
• Health of queen now and during pregnancy.
• Status of other litter members.
• Status of other kittens in the household.
• Recent arrivals/showing/mating.
• Pattern of illness to date.
• Health parameters noted by breeder, e.g. weight gain.
• Hygiene, worming, vaccination and flea control regimes.
• Has the kitten ever appeared normal?
• Did the kitten ever suckle normally?
• Has supplementary feeding been provided (risk aspiration)?
• Blood group of queen and stud cat (if known)?

Clinical examination
• Examine the kitten, available litter mates and the queen (page 16–17).
• Weight gain can be a sensitive indicator of declining health in kittens and will often occur before other signs of illness.
• External features
• Mouth – mucosal colour, cleft palate.
• Thoracic auscultation and abdominal palpation.
• Neurological assessment:
  ○ Alertness.
  ○ Suckle reflex.
  ○ Response to noxious stimuli.
  ○ Reflexes (not fully developed until 12 weeks).

Decision making
• Level of problem – household, litter or individual.
• Congenital vs. hereditary.
• Infectious vs. anatomic.
• Likelihood of trauma.
• Possibility of neonatal isoerythrolysis.

Diagnostic investigation
• Routine haematology and biochemistry.
• Faecal and urinalysis.
• Bacterial culture.
• Serology.
• Imaging studies.
• Biopsy/post-mortem.

NB1 – Maximum information can be obtained at post-mortem if the carcass is fresh. If post-mortem is not immediately available the body should be stored in the fridge. NB2 – Serology for infectious disease in kittens under 5–6 weeks is of limited value due to the presence of maternally derived antibodies and/or the time required for a kitten to mount a detectable immune response.

1.3.8 Pain relief
• It is extremely difficult to assess pain in neonates/paediatric patients.
• Better to assume pain is present.
• Opiates can be used to effect.

1.4 GEROPTOLOGY

1.4.1 Introduction
Definition
• In people, there is no set age at which patients may be under the care of a geriatrician, the decision is determined by the individual patient’s needs and the availability of a specialist.

When is a cat old?
• Changes in nutritional, behavioural and metabolic function can be demonstrated
as early as 7–8 years (approximately equivalent to a 50-year-old person).

- Cats are generally considered to be old (senior equivalent to a 60–65-year-old person) when they reach 11–12 years and geriatric (equivalent to an 80-year-old person) when they are over 15.

- Cats mature more quickly and then age more slowly when compared to the dog especially medium and large breeds.

1.4.2 Effects of ageing

- Relatively little information about physiological changes with ageing in cats.

See Table 7.

**Table 7 Age-associated changes in major organ systems**

<table>
<thead>
<tr>
<th>System</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIT</td>
<td>Dental disease&lt;br&gt;Decreased salivation and taste sensation&lt;br&gt;Some evidence to suggest changes in gut function&lt;br&gt;Loss of oesophageal muscle tone&lt;br&gt;Atrophy and fibrosis of gastric mucosa&lt;br&gt;Reduced colonic motility&lt;br&gt;Reduced villous height and epithelial cell turnover</td>
</tr>
<tr>
<td>Kidneys and water balance</td>
<td>Decreased nephron numbers&lt;br&gt;Increased sensitivity to dehydration&lt;br&gt;Decreased sensitivity to thirst</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>Loss of lung elasticity&lt;br&gt;Increase in pulmonary fibrous tissue and decrease in alveolar numbers</td>
</tr>
<tr>
<td>Liver</td>
<td>Decreased numbers of hepatocytes</td>
</tr>
<tr>
<td>Endocrine and metabolism</td>
<td>Decreased growth hormone levels and adrenal function&lt;br&gt;Slow decline in metabolic rate&lt;br&gt;Loss of lean body mass&lt;br&gt;Reduction in energy requirements by 30–40%&lt;br&gt;Poor thermoregulation</td>
</tr>
<tr>
<td>Haematopoietic and immune system</td>
<td>Decreased haemoglobin concentration&lt;br&gt;Reduced immune competence&lt;br&gt;Bone marrow becomes pale and fatty&lt;br&gt;Less resistant to disease&lt;br&gt;Immune surveillance targeting potentially neoplastic cells declines</td>
</tr>
<tr>
<td>Skin</td>
<td>Thinning and loss of elasticity</td>
</tr>
<tr>
<td>Special senses</td>
<td>Reduced visual acuity and increased susceptibility to ocular damage&lt;br&gt;Decreased sense of smell</td>
</tr>
<tr>
<td>Activity and behaviour</td>
<td>Decreased activity&lt;br&gt;Increased time spent sleeping&lt;br&gt;Reduced ability to react to sudden environmental change&lt;br&gt;Loss of learned behaviour – grooming, excretory habit</td>
</tr>
</tbody>
</table>
1.4.3 Nutritional changes

- By changing diet in an older cat the aim is to maintain health, maximise longevity and reduce the risk of developing age-associated diseases.
- Limited evidence that feeding an older cat a senior diet will affect health, longevity or disease occurrence:
  - One study looking at addition of antioxidants and chicory root to the diet predicted modest increases in longevity of 11 months.

Nutritional needs

- Reduced activity and lean body mass, hence decreased basal metabolic rate.
- Reduced nutrient digestion and absorption.
- Decreased sensation from food – smell and taste.
- Decreased ability to adapt to change – older cats may not tolerate sudden changes in diet even if the new diet to be fed may have a beneficial effect in the long term.

Dietary changes

Energy

- Widely believed that older cats require less energy, associated with decreased resting metabolic rate and activity:
  - BUT caloric intake may need to be increased due to reduced gut function.

Protein

- Restriction in old cats is inappropriate, except in the face of other diseases such as chronic renal failure:
  - Higher protein diets also tend to be more palatable; this is important in older cats with reduced appetite secondary to sensory loss.

Fat

- Important for palatability and energy density.
- Sufficient fat must be given to provide essential fatty acids and fat-soluble vitamins.
- Increased levels of omega 3 polyunsaturated fatty acids (PUFAs) may be beneficial in the control of hypertension, maintenance of renal blood flow and reducing the level of deleterious cytokines which may be involved in weight loss in older cats.
- Excessive levels of PUFAs can lead to the accumulation of peroxidised fats increasing free radical damage.

Calcium and phosphorus

- Phosphate restriction on the basis of the likelihood of reduced renal function.

Potassium

- Increased requirement associated with CKD in which potassium wasting occurs secondary to polyuria and acidosis.
- Acidifying diets, such as those designed for management of urolithiasis, also cause potassium loss and are probably inappropriate in the majority of older cats as the risks of struvite urolithiasis are substantially reduced in older cats.

Magnesium

- Older cats may also require increases in dietary magnesium.

Texture

- Dental disease is the most common condition of old cats.
- Dry foods with softened texture or moist foods may improve palatability.

1.4.4 Common diseases of elderly cats

- Chronic kidney disease (16–30% of cats over 15 years old).
- Dental disease.
- Hyperthyroidism.
- Neoplasia.
- Weight loss.
1.4.5 Assessment of the elderly cat

• History and physical examination.
• ± Faecal and urinalysis.
• ± Haematology and biochemistry.
• Thyroid function.
• Blood pressure:
  ○ Hypertension relatively common associated with various diseases, e.g. CKD or hyperthyroidism.

Weight

• Significant decline in the number of obese cats over 12–13 years of age.
• Significant increase in underweight cats over 15–16 years of age; the important goal is to try and maintain a stable, optimal weight.
• Both obesity and cachexia are associated with a significant increase in mortality in cats over 8 years.

Intercurrent disease

• Higher likelihood that an older cat has other disease processes besides the presenting complaint.
• Important considerations when deciding on what and how an investigation is to be performed.
• May influence prognosis.
• May affect therapeutic decisions.

1.4.6 Therapeutic considerations

• Effect on drug absorption is probably minimal.
• Subcutaneous absorption is likely to be reduced due to
  ○ Less interstitial fluid.
  ○ Reduced vascularity.
  ○ Increased incidence of dehydration.
• Decreased lean body mass affects drug distribution and effective body weight.
• Decreased fat may affect drug distribution and increases effective body weight.
• Plasma half-life will tend to be increased due to decreased renal/hepatic function.
• Older cats will cope less well with sudden changes in drug dose rates.
  ○ Increased sensitivity to hypotensive agents.

1.5 SUPPORTIVE CARE – FLUID THERAPY AND ANALGESIA

1.5.1 General principles

Many cats will need symptomatic and supportive care when they present prior to investigation or specific therapy. This section will focus on two major elements of supportive care: fluid therapy and pain relief. Nutritional support is covered in Section 4.13.5.

Hospitalised sick cats also benefit from TLC that would include grooming, provision of toys, boxes to hide in or scratch, playing and being given space to move around, e.g. an empty consulting room.

1.5.2 Fluid therapy

• Routine treatment of sick cats.
• Fluid overdose can occur easily with gravity-fed systems and can be fatal.
• Essential to ensure system flushed through before connecting to the cat.
• Unless continuous warming facilities or rapid delivery, heating the fluid bag is of little value due to speed of delivery.
• Choice of fluid important – volume, colloidal osmotic pressure, oxygen-carrying capacity.

Rate of administration

Crystalloids

• Choice (see Table 8).
• Should be calculated on body surface area and age.
For practical purposes 2 ml/kg/hour approximates to maintenance for adult cats.
- Maintenance rates for kittens:
  - <12 weeks – 5–6 ml/kg/hour.
  - 12–24 weeks – 3–4 ml/kg/hour.
- Standard surgical rate is 5 × maintenance.
- Shock rates 40–70 ml/kg/hour.
- More careful consideration of fluid rates when
  - Acute renal failure may be present.
  - Suspected or known cardiac dysfunction.
  - Bradycardia is present.
  - Severe anaemia (PCV <10–12%) especially if dehydrated.
  - Severe hypokalaemia (K⁺ <2.5 mmol/l).

Colloids
- Up to 10 ml/kg as a slow IV bolus.
- Maintenance 1 ml/kg/hour.

- Bovine haemoglobin glutamer (Oxyglobin) has both colloidal and oxygen carrying capacity. Maximum dose 7 ml/kg; potential to cause pulmonary oedema.

Blood transfusions
See section 4.11.6.

1.5.3 Analgesia
Choice of analgesic will depend on the likely underlying diagnosis, in the short term; if this is in doubt then opiates are much less likely to cause problems than NSAIDs. Where significant pain is present combination of pain relief, particularly NSAIDs and opiates given together, may be necessary.
- Assessing pain in cats can be difficult – if in doubt and it is safe give pain relief and observe cat for signs of improvement that indicate that pain was present.
• Signs suggestive of pain in cats:
  ◦ Inability to rest/sleep.
  ◦ Inappropriate activity level.
  ◦ Sitting in the back of the kennel.
  ◦ Mental attitude/demeanour (stupor or anxiety).
  ◦ Changes in attitude/personality.
  ◦ Poor hair coat.
  ◦ Lack of comfort when palpated.
  ◦ Facial expression, staring, fixed gaze, dilated pupils.
  ◦ Lack of appetite and thirst.
  ◦ Altered vocalisations.
  ◦ Posture.
  ◦ Tachycardia.
  ◦ Tachypnoea.
  ◦ Attempts to remove bandages are very focused on one area and may be due to pain.
  ◦ Body temperature and blood pressure may be increased or decreased.

Opiates
See Table 9.
• Different opiates are appropriate for managing different levels of pain:
  ◦ Only buprenorphine licensed for use in cats.
• Cats are more sensitive to opiate side effects than dogs.
• Appropriate for short- to medium-term pain relief.
• Suitable documentation essential according to the legal category of the opiate used.

CRI opiate-based pain relief
• CRI cocktails are intended to follow on from loading dose pain relief.
• Morphine, lidocaine and ketamine (MLK) – 60 mg M + 1000 mg L + 60 mg K/l (0.9% NaCl) @ 1–3 ml/kg/hour, protect bag from light.
• Fentanyl, lidocaine and ketamine (FLK) – fentanyl instead of morphine 1.2 mg/l (0.9% NaCl) @ 1–3 ml/kg/hour, protect bag from light.

NSAIDs
See Table 10.
• Very effective in managing pain and will provide further pain relief even when high-dose opiates have been given.
• Particularly suited for long-term pain relief.
• There is no current evidence that appropriate, long-term use of NSAIDs have negative consequences.
• Fewer NSAIDs are licensed and safe for use in cats due to reduced glucuronidation of some drugs within the liver:
  ◦ This does not apply to all NSAIDs and in fact half-life for some is shorter in cats than dogs.
• Use of NSAIDs is generally contraindicated when
  ◦ The cat is significantly dehydrated.
  ◦ Renal function is compromised.
  ◦ Gastrointestinal ulceration is suspected or likely to occur.
  ◦ There is moderate–severe cardiac disease.
• Glucocorticoids may be an essential part of therapy:
  ▪ Glucocorticoids can be given no sooner than 24 hours after NSAIDs with suitable gastric protection.
  ▪ Preferable wash-out period would be 4 days.
• Glucocorticoids have been given within the last 48 hours.
  ▪ Preferably not within last 4 days.

Misoprostol
• Where NSAID overdose is known or suspected to have occurred, misoprostol, a prostaglandin analogue, can be used to reduce likely side effects.
• Tablet size makes dosing cats problematic (200 μg tablets) – 5 μg/kg PO q8h.
• Misoprostol can cause diarrhoea, abdominal pain, vomiting and abortion.
### Table 9  Selection of opiates suitable for use in cats

<table>
<thead>
<tr>
<th>Generic name</th>
<th>Site of action</th>
<th>Route of administration</th>
<th>Dose rate (mg/kg)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buprenorphine</td>
<td>Partial agonist OP3 receptor</td>
<td>IV, IM, SC, PO (0.3 mg/ml)</td>
<td>0.01–0.02 q6h</td>
<td>1, S3</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>Primarily OP2 agonist, OP3 antagonist</td>
<td>IM, SC (10 mg/ml), PO (5 mg, 10 mg tablets)</td>
<td>0.2–0.5 q6–12h</td>
<td>POM-V</td>
</tr>
<tr>
<td>Codeine</td>
<td>Mechanism unclear, mu receptor?</td>
<td>PO (15, 30, 60 mg tablets; 5 mg/ml syrup)</td>
<td>0.5–2 q12h</td>
<td>2, POM-V</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>Pure OP3 agonist</td>
<td>IV (0.05 mg/ml); patch (12, 25, 50, 75 μg/hour)</td>
<td>See pg 25; 12μg/hour patch suitable for most cats</td>
<td>S2</td>
</tr>
<tr>
<td>Methadone</td>
<td>Pure OP3 agonist</td>
<td>IV, IM, SC (10 mg/ml)</td>
<td>0.1–0.3 IM q4–6h</td>
<td>S2</td>
</tr>
<tr>
<td>Morphine</td>
<td>Pure OP3 agonist</td>
<td>IV; IM (10 mg/ml)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.1–0.4 q3–6h</td>
<td>3, S2</td>
</tr>
<tr>
<td>Pethidine</td>
<td>Pure OP3 agonist</td>
<td>IM, SC (10–50 mg/ml)</td>
<td>5–10 q1–2h</td>
<td>S2</td>
</tr>
<tr>
<td>Tramadol</td>
<td>All opioid receptors, esp. OP3</td>
<td>PO (50, 100, 200, 300 mg capsules, 5 mg/ml)</td>
<td>2–4 q12h</td>
<td>4, POM</td>
</tr>
</tbody>
</table>

Legal category: POM-V – prescription only medicine – veterinary, S2 – schedule 2; S3 – schedule 3. Pethidine = meperidine.

1. Absorbed orally in cats (oral pH different to man/dogs), use injectable solution rather than sublingual tablets.
2. Also use as cough suppressant and anti-diarrhoeal; analgesic effect is mild, injectable preparation is available.
3. Oral tablets, suppositories and syrups are available; will often cause vomiting.
4. Also inhibits noradrenalin and 5HT pathways providing alternative pathways for pain relief.

<sup>a</sup>NB – injectable morphine preparations 10, 15, 20 and 30 mg/ml – check concentration being given especially where practice also uses morphine in horses.
<table>
<thead>
<tr>
<th>Generic name</th>
<th>Trade name</th>
<th>COX selectivity</th>
<th>Route</th>
<th>Available preparations</th>
<th>Dose rate (mg/kg)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin</td>
<td>Various</td>
<td>Non-selective</td>
<td>PO</td>
<td>75, 300 mg tablets</td>
<td>1–2 mg/kg q24h 10–25mg/cat q48–72hr</td>
<td>H, 1, 2</td>
</tr>
<tr>
<td>Ketoprofen</td>
<td>Ketofen</td>
<td>Non-selective</td>
<td>IV, IM,</td>
<td>1 mg/ml injectable 5 mg tablets</td>
<td>First dose 2 mg/kg then 5 d @ 1 mg/kg q24h</td>
<td>HR, 1, 2, 3</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>Metacam&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Preferentially inhibits COX-2</td>
<td>SC, PO</td>
<td>2, 5 mg/ml injectable 0.5, 1.5 oral suspension 1, 2, 5 mg tablets</td>
<td>0.3 mg/kg (single) or first dose 0.1 mg/kg with long term 0.05 mg/kg q24h</td>
<td>H, 1, 3</td>
</tr>
<tr>
<td>Robenacoxib</td>
<td>Onsior</td>
<td>Preferentially inhibits COX-2</td>
<td>SC, PO</td>
<td>20 mg/ml injectable 5, 6, 10 mg tablets</td>
<td>First dose 2 mg/kg, long term 1 mg/kg q24h</td>
<td>HR, 1, 3</td>
</tr>
<tr>
<td>Tolfenamic acid</td>
<td>Tolfedine</td>
<td>COX selectivity uncertain</td>
<td>SC, PO</td>
<td>40 mg/ml injectable 6, 20 mg tablets</td>
<td>4 mg/kg q24h for 3 days</td>
<td>HR, 1, 2, 3</td>
</tr>
</tbody>
</table>

H – hepatic metabolism with biliary excretion, HR – hepatic metabolism with renal excretion; COX – cyclooxygenase.
1. Standard GI and hypotension, lowest effective dose, almost exclusively used as an anticoagulant in cat.
2. Anticoagulant dose or has anti-platelet action.
<sup>a</sup>Available under other trade names as well.
Other drugs

**Medetomidine and dexmedetomidine**
- Can be given as single dose at 5–20 μg/kg.

**Gabapentin**
- Used for neuropathic pain, mechanism of action is unknown.
- Dose up to 5–10 mg/kg PO q8–12h.
- Can cause mild sedation and ataxia.

**Benzodiazepines**
- Used as muscle relaxants.

**Methocarbamol**
- Skeletal muscle relaxant. Dose 20–45 mg/kg PO q8h.
- Side effects – salivation, vomiting, lethargy weakness, ataxia and CNS depression.

**Amantadine**
- N-Methyl-d-aspartate (NMDA) antagonist analgesic.
- May potentiate effects of other analgesics.
- 1–4 mg/kg q24h PO – start at lowest dose and increase slowly.

**Amitriptyline**
- NMDA antagonist analgesic.
- Also used for behavioural therapy, FLUTD and management of ureteroliths.

**Non-drug modalities**
- Consider physiotherapy, acupuncture and other therapies.

**1.6 SEDATION AND ANAESTHESIA**

**1.6.1 Introduction**

It is outside the scope of this text to present a detailed discussion of sedation and anaesthesia in cats. The purpose of this section is to present a selection of protocols for sedation and anaesthesia that are appropriate for undertaking medical procedures in cats with various levels of sedative/anaesthetic risk. Before sedating or anaesthetising a patient it is worth considering:

- Whether the examination(s) can be undertaken without sedation/anaesthesia.
  - Does the risks of doing so outweigh the benefits of not sedating/anaesthetising.
- The effect the presenting signs and working diagnosis have on risk and choice of agent.
- All the procedures that would be appropriate to be undertaken to minimise the need for repeat sedation/anaesthesia.
  - What other procedures may be necessary should initial finding under sedation/anaesthesia redirect the investigation.
- Facilities that may be required to recover and monitor the cat following the sedation/anaesthetic.

**1.6.2 Pre-procedure assessment**

- All cases should have had a recent physical examination.
- (Dex)medetomidine should generally be avoided in hypotensive, hypovolaemic or senior (especially geriatric) cats but can be an effective in systemically well cats.
  - Lower-end premedication doses and minimum necessary induction agent should be given.
- Kittens under 12 weeks more susceptible to the sedative effects of opioids and benzodiazepines.
- Patient should be placed in one of the five American Society of Anaesthesiologists’ (ASA) stages.

**Stage**

1. Normal healthy cat.
2. Cat with mild systemic disease.
3. Cat with severe systemic disease that is not incapacitating.
4. Cat with severe systemic disease that is a constant threat to life.
5. Moribund cat not expected to survive 24 hours with or without operation.

1.6.3 Sedative protocols
• Choice of sedative will depend on
  ○ Procedure to be undertaken – how painful, how long, how still does the cat need to be.
  ○ Experience of the clinician and type of equipment available.
  ○ Status of the cat.
  ○ Demeanour of the cat.
  ○ Whether the sedation is to be given IV, IM or SC.
• Following sedation the cat should be kept in a quiet environment with subdued lighting and monitored.
• Following IM or SC administration sufficient time should be allowed for sedation to become effective.

• If sedation is ineffective decide whether it is appropriate to
  ○ Increase the dose.
  ○ Add in another agent.
  ○ Proceed to anaesthesia.
  ○ Abandon the procedure and reconsider the approach.

Sedative protocols
See Table 11.

Reversal with atipamezole
• 2.5× mg dose for medetomidine (half the volume).
• 5× mg dose for dexmedetomidine (half the volume).

1.6.4 Anaesthetic protocols
Premedication
• Reduces the dose of anaesthetic required and smoothes induction.
• Allows catheter placement in fractious cats.

Table 11  Selected sedative protocols for cats

<table>
<thead>
<tr>
<th>Agent</th>
<th>Dose rate</th>
<th>Route</th>
<th>Level of sedation and pain relief</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acepromazine + buprenorphine</td>
<td>0.02–0.03 mg/kg, 0.01–0.02 mg/kg</td>
<td>SC, IM or IV</td>
<td>Mild</td>
<td>ASA 1–3</td>
</tr>
<tr>
<td>Acepromazine + butorphanol</td>
<td>0.02–0.03 mg/kg, 0.2–0.3 mg/kg</td>
<td>SC, IM or IV</td>
<td>Mild</td>
<td>ASA 1–3</td>
</tr>
<tr>
<td>Acepromazine + methadone&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.02–0.03 mg/kg, 0.2–0.4 mg/kg</td>
<td>IM or IV</td>
<td>Mild–moderate</td>
<td>ASA 1–3</td>
</tr>
</tbody>
</table>
| Medetomidine<sup>b</sup> + ACP + opiate | 2.5–10 μg/kg | IM or IV | Moderate | ASA 1–2
| Midazolam + ketamine | 0.2–0.3 mg/kg, 5–10 mg/kg | IM or IV | Moderate to marked | ASA 2–4
| Methadone<sup>a</sup> | 0.2–0.3 mg/kg | IM | Variable | ASA 4–5 |

<sup>a</sup>Can substitute with morphine 0.2–0.4 mg/kg – must be given slowly IV, more likely to cause vomiting and transient excitement than methadone.

<sup>b</sup>Use half the dose rate for dexmedetomidine.
• ACP and an opiate are appropriate for most cases.
• NSAIDs should not form part of the routine premedicant; each patient should be assessed for potential contraindications to their use prior to inclusion.

Induction
See Table 12 for suggested intravenous induction protocols.
• Pre-oxygenate as appropriate.
• Induce in a calm quiet environment.
• Intramuscular protocols can be used, they are more difficult to titrate to effect and less applicable to cats undergoing medical investigation (as compared to routine procedures, e.g. neutering):
  ○ Medetomidine, morphine/buprenorphine/butorphanol and ketamine.
  ○ Xylazine and ketamine.

Intubation
• Generally required for most procedures.
• Cats can be difficult to intubate.
• Local anaesthetic sprayed onto the larynx is usually necessary.
• Aim to minimise attempts to intubate and associated laryngeal trauma.
• Using larger endotracheal tubes reduces dead space resistance:
  ○ A 4.5–5 mm uncuffed tube is suitable for most adult cats.
  ○ A small paediatric bronchoscope will fit down a 5 mm ET tube.
• The use of laryngeal masks is becoming more popular in cats as endotracheal intubation is not required. However, they do not protect the patient from aspiration.

Maintenance
• For most cases gaseous anaesthesia is appropriate using isoflurane or sevoflurane.

<table>
<thead>
<tr>
<th>Table 12 Intravenous induction agents</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drug</strong></td>
</tr>
<tr>
<td><strong>Use</strong></td>
</tr>
<tr>
<td><strong>Dose rate</strong></td>
</tr>
<tr>
<td>With premedication 2–5 mg/kg&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Formulation</strong></td>
</tr>
<tr>
<td><strong>Comments</strong></td>
</tr>
</tbody>
</table>

<sup>a</sup>Dose can be reduced by using midazolam/diazemuls at 0.5 mg/kg IV given a few minutes before induction.
Circuit
- Humphrey ADE circuit without soda lime with free gas flow rate of 70–100 ml/kg/minute.
- Ayre’s T-piece (± Jackson-Rees modification) with free gas flow rate of 250–300 ml/kg/minute.

Intravenous
- In some situations total intravenous anaesthesia is appropriate, e.g. bronchoscopy:
  o Propofol – 0.2 mg/kg/minute CRI or 2 mg/kg q5min to effect.
  o Propofol – 0.12–0.3 mg/kg/minute CRI + fentanyl – 0.1 mg/kg/minute CRI.
  o Alfaxan – 0.11–0.13 mg/kg/minute or 1.1–1.3 mg/kg q10 min to effect.

Monitoring
See Table 13.
- Appropriate for ASA stage and procedure being performed.

Recovery
- TPR should be monitored periodically.
- Monitoring should continue after extubation even if the cat is appearing alert:
  o Laryngeal oedema can occur obstructing the airway post extubation.
  o Post-anaesthetic deaths do occur after apparently and initial smooth recovery and extubation especially after nasal investigation.

Table 13 Monitoring of anaesthesia

<table>
<thead>
<tr>
<th>What does it tell you</th>
<th>Pulse oximetry (SpO₂)</th>
<th>ECG</th>
<th>Capnography (ETCO₂)</th>
<th>Blood pressure (BP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strengths</td>
<td>Oxygen saturation of haemoglobin in arterial blood and pulse rate</td>
<td>Heart rate and rhythm</td>
<td>Partial pressure of CO₂ in expired gas</td>
<td>Systolic BP – Doppler; Systolic, diastolic + mean BP – oscillometric</td>
</tr>
<tr>
<td>Limitations</td>
<td>Vasoconstriction and movement reduce reliability. Oxygen dissociation curve is sigmoid so SpO₂ slow to respond to a fall in arterial oxygenation. Hypoventilation can exist with high SpO₂</td>
<td>No information about the quality of circulation. If T waves are tall the machine will often double count</td>
<td>Limited value without capnographic curve. Experience required to interpret curve and decide upon appropriate action</td>
<td>Can be difficult to place particularly on sick patients that are vasoconstricted/hypotensive with poor pulse pressures</td>
</tr>
</tbody>
</table>
1.7 EMERGENCY AND CRITICAL CARE ALGORITHMS

1.7.1 Introduction
This section is intended to provide basic information primarily as algorithms for managing common feline emergencies that will present in general practice.

Triage
Regardless of the presumed cause, basic triage is vital to prioritise further investigation and emergency intervention. It might also alter decisions as to which emergency drugs to use. The following should be assessed and subsequently monitored:
- Level of consciousness.
- Airway and breathing.
- Heart rate and rhythm.
- Perfusion parameters – pulse, mucous membrane colour and capillary refill time.
- Temperature.

Emergency blood panel
Focus on parameters that can cause sudden deterioration in a patient’s status or affect drug use/therapy:
- PCV (and total solids).
- Glucose.
- Calcium.
- Electrolytes (potassium and sodium).
- Acid–base balance.
- Ammonia (bile acids) – if unavailable then ALT.
- Urea or creatinine.

Team organisation
- 3–4 people are required to manage a life-threatening emergency situation:
  - Clear role assignment improves efficiency and reduces the risk of something being left undone:
    1. Team leader – directs activity, makes decisions, primary case responsibility.

2. Drug/fluid administrator – placing IV lines, organising fluid and drug administration order by the team leader.
3. Monitor and recorder – placing of monitoring equipment, monitoring of vital parameters, recording changes, procedure performed and drugs administered.
4. Gopher – fetching and carrying, communication with owner.

1.7.2 Trauma/RTA
Basic approach
- Detailed history of the incident.
- How long ago?
- Is the patient improving, stable or deteriorating?
- Other medical problems/medication, e.g. NSAIDs?

Initial management
- Triage.
- Deal with life-threatening conditions:
  - AIRWAY → BREATHING → CIRCULATION.
- Place monitoring equipment and begin monitoring chart to evaluate trends:
  - Temperature, pulse, respiration.
  - Blood pressure and pulse oximetry.
  - Urine output.
  - PCV, TP, electrolytes, urea, blood gas.
- Establish IV access as soon as possible

Level of consciousness (LOC)
Declining
- Consider metabolic, hypoxia, hypotension, toxins, drugs, primary brain pathology.
- Hyperexcitability – manage as for seizures (section 1.7.6).
- Progression – alert → depressed → stupor → coma
  - Raise head and neck up to 20°.
  - Secure airway against aspiration.
  - Try and maintain end-tidal CO₂ @ 30–35 mmHg.
○ O₂ therapy – maintain saturation >99%; pO₂ >60%.
○ Avoid aggressive fluid therapy if possible – colloids preferred to crystalloids.
○ Glucocorticoids of no proven benefit.
○ Mannitol 0.25–1 g/kg as bolus over 20 minutes.

Heart rate and rhythm
• Tachycardia – usually extracardiac, e.g. blood loss.
• Bradycardia – pressor, e.g. dobutamine 5–10 mg/kg/minute CRI, atropine.

NB1 – bradycardic cats do not cope well with aggressive fluid therapy.
NB2 – consider CNS injury.

• Arrhythmia – only intervene if significant effect on output – most arrhythmias are better untreated.

Perfusion
• Pale, hypotensive, normal PCV – fluid resuscitate:
  ○ Bolus colloid (5 ml/kg over 30 minute).
  ○ Crystalloid up to 70 ml/kg in first hour.
• PCV low – blood or blood substitute.

Common injuries to consider
• Soft tissue trauma – diaphragmatic, body wall or bladder rupture.
• Damage to liver, spleen, pancreas.
• Bruising – can be severe and difficult to assess without shaving.
• Appendicular fractures.
• Spinal cord and cauda equina damage.
• Bleeding.
• Lung trauma causing pneumothorax (may include rib fractures).
• Shock.
• Mandibular fracture/luxation.

1.7.3 Dyspnoea

![Diagram of Dyspnoea Algorithm]

Figure 1 Approach to the dyspnoeic cat. First published in Sturgess: Pocket Handbook of Small Animal Medicine (Manson Publishing, 2012). Reproduced by permission of the publisher.
1.7.4 Collapse

**EMERGENCY MANAGEMENT OF COLLAPSE**

- Abdominal and thoracic imaging
  - Echocardiography
- Physical examination
  - TPR
  - Muscular weakness
  - Stiffness
- Blood pressure
- Hydration
- Mental status
- Muscle tone
- Withdrawal – all 4 limbs
- Pulse oximetry
- Pallor
- Hyperthermia
- Muscle weakness
- Stiffness
- Hypoxia
- Hypoxemia
- Bradycardia
- Tachycardia
- Stupor/poor mentation
- Cerebral oedema
- Post seizure
- Space occupying CNS disease
- Poor cerebral perfusion
- Drugs and toxins
  - Hepatic encephalopathy
- Metabolic disease
- Sepsis
- Hypotension – poor cardiac output
- Hypovolaemia – poor peripheral perfusion
- Anaemia
- High sympathetic tone
- Heat stroke
- Neuromuscular disease, e.g. myasthenia
- Polyneuropathies
- Myositis
- Neurologic disease
  - Toxins – botulism, tetanus
- Obstructive respiratory disease
- Failure of gaseous exchange
- Heart block
- CNS damage
- Response to pain/anxiety
  - Tachydyssrhythmia
- Shock
- Blood loss, e.g. haemorrhage
- Fever
- Hyperthyroidism
- Drug and toxins
- Heart block
- CNS damage
- Obstructive respiratory disease
- Failure of gaseous exchange
- Heart block
- CNS damage
- Response to pain/anxiety
  - Tachydyssrhythmia
- Shock
- Blood loss, e.g. haemorrhage
- Fever
- Hyperthyroidism
- Drug and toxins
- Heart block
- CNS damage
- Obstructive respiratory disease
- Failure of gaseous exchange

**Secondary database**

- Ammonia
- Acid-base status
- Arterial blood gas
- Coagulation profile
- T4

**Minimum database**

- PCV and total solids
- *White cell count
- *Platelet
- Electrolytes
  - Calcium
- Glucose
- ECG and BP
  - (Renal and hepatic)
  - (CK and AST)

**Physical examination**

- TPR
- Mucosal colour
- Blood pressure
- Hydration
- Mentation
- Muscle tone
- Withdrawal – all 4 limbs
- Pulse oximetry

**Figure 2** Approach to the collapsed cat. First published in Sturgess: Pocket Handbook of Small Animal Medicine (Manson Publishing, 2012). Reproduced by permission of the publisher.

1.7.5 Urinary obstruction

**URINARY OBSTRUCTION**

- Female
- Male
- Risk of bladder rupture
  - No
  - Yes
- **Emergency decompression cystocentesis**

**Female**

- Unlikely to be physical
- Causes of dysuria – LUMN bladder, urethral spasm, reflex dyssynergia
- Hyperkalemia
- Post-renal azotemia

**Male**

- Evaluation of metabolic consequences
- Is the case safe to attempt catheterization and sedation if necessary?
- Yes
  - Catheterization fails:
    - Surgical options – perineal urethrostomy, laparotomy, tube cystotomy
  - Catheterization succeeds:
    - Fluid therapy and monitoring of electrolytes
- No

**Management of hyperkalemia if ≥ 7.5 mmol/l**

- Relieve obstruction
- 10% calcium gluconate (0.5–1 ml/kg slow i/v)
- Insulin and glucose*

**Should respond to relief of obstruction**

- Monitor urine output

**Attempting to gently pass a catheter retrograde**

- Copious lubrication, saline flushing as advance

**Figure 3** Approach to the obstructed cat. First published in Sturgess: Pocket Handbook of Small Animal Medicine (Manson Publishing, 2012). Reproduced by permission of the publisher.

*Insulin and glucose can potentially cause fatal hypoglycaemia; monitor blood glucose every 30–60 minutes for 3 hours and use neutral insulin.
1.7.6 Seizures

Treat metabolic cause
- Glucose – 0.5 g/kg slow i/v bolus
- Calcium gluconate (10%) – 1 ml/kg over 20–30 min
- Hyponatraemia – 0.9% saline
- Hepatic encephalopathy – lactulose enema i/v ampicillin

Diazepam (10 mg/2ml)
0.5–1 ml/10 kg i/v/per rectum
- Start oral phenobarbitone
- Repeat 2–3 times over 5–10 min

Phenobarbitone
- Up to 30 min to effect
- 16 mg/kg divided over 3–4 hrs

Diazepam (10 mg/2ml) – 0.1–0.5 mg/kg/hr
Propofol – 0.1–0.2 mg/kg/hr

Poor response

Figure 4  Approach to the seizuring cat. First published in Sturgess: Pocket Handbook of Small Animal Medicine (Manson Publishing, 2012). Reproduced by permission of the publisher.

1.7.7 CPCR

Personnel
- Ventilation and team leader.
- Cardiac compression.
- Administer fluids and drugs.
- Monitoring, record keeping.

Procedures
- Establish an airway using a cuffed endotracheal tube, if not possible then tracheostomy – allows controlled ventilation.
- Establish IV access.
- Maximise monitoring – pulse/heart rate and rhythm, respiration, temperature, mucosal colour, PLR, level of consciousness, ECG, pulse oximetry, end-tidal CO₂, electrolytes, blood gas and lactate.
KEY TOPICS IN FELINE MEDICINE

CARDIOPULMONARY – CEREBRAL RESUSCITATION (CPCR)

- Pulse no respiration
  - Establish airway and ventilate with oxygen 6–12/min
  - Ventilate – 12/min
  - Cardiac compression – 100/min
  - Monitor for return of spontaneous breathing or for further deterioration into cardiac arrest
  - Fluid resuscitate if hypovolaemic – up to 50 ml/kg/hr
    - Bolus of colloid 10 ml/kg
    - 1:1000 Adrenaline 0.5 ml intratracheal dose x4*
  - 0.125 ml repeat in 3–5 min
    - Intratracheal dose increase x4*

- No heartbeat or respiration
  - 1:1000 Adrenaline 0.125 ml repeat in 3–5 min
    - Intratracheal dose increase x4*

- No respiration, slow or weak pulse
  - Heartbeat returned
    - 0.6 mg/ml Atropine 0.35 ml i/v
    - 2–4 dose intratracheal
    - Tachycardia
      - 10 mg/ml Morphine 0.05 ml i/v
    - Bradycardia
      - either or both treatments
    - Multiform ventricular fibrillation
      - i/v Propranolol 0.1 mg*

- Consider direct cardiac compression

*NB – Volume based on a 5 kg cat

*Lidocaine can be used in cats but they are more sensitive to toxicity – 0.25–1 mg/kg slow IV followed by CRI @ 0.01–0.04 mg/kg/minute (place 10 ml of 20% lidocaine in a 100 ml bag of saline = 2 mg/ml for 5 kg cat given at 1.5–6 ml/hour)

Figure 5 Cardiopulmonary cerebral resuscitation (CPCR). First published in Sturgess: Pocket Handbook of Small Animal Medicine (Manson Publishing, 2012). Reproduced by permission of the publisher.