THE RABBIT

http://www.aquavet.i2.com/Rabbit.htm

Anna Meredith MA VetMB CertLAS MRCVS

Head of Exotic Animal Services
Royal (Dick) School of Veterinary Studies
University of Edinburgh

With additional notes by
Lance Jepson MA VetMB CBiol MIBiol MRCVS
Honorary Lecturer in Exotic Animal Medicine
University of Liverpool Small Animal Hospital
INTRODUCTION

The rabbits is now the third most popular mammalian pet in the UK, and increasing numbers are kept as house pets and become part of the family. There is a corresponding increase in the expectations of rabbit owners for high quality veterinary care of this species. Unfortunately there is little, if any, tuition in this area in the veterinary undergraduate curriculum, and it is therefore the aim of this short course to provide a broad introduction to the biology, husbandry, common clinical conditions and veterinary management of rabbits.

The domestic rabbit (Oryctolagus cuniculus) originated from the European wild rabbit. There are many other species of rabbit, and these, along with cottontails, pikas and hares make up the Order Lagomorpha. Man's relationship with the European or ‘true’ rabbit was first recorded by the Phoenicians over 1000 years BC, when they termed the Iberian peninsula ‘i-shephan-im’ (literally, ‘the land of the rabbit’), which the Romans converted to the Latin form, Hispania, and hence the modern word Spain. The wild rabbit has long been hunted, but it is unclear exactly when domestication first took place. The Romans kept rabbits in walled enclosures (‘leporaria’) and there is evidence that they brought them to Britain, but they did not survive at this time. In Europe, and especially France, the domestication process was well under way by the fifth century, and in the twelfth century the Normans brought them to Britain, where they became established and remain as both a domestic and wild animal. Man also transported the rabbit throughout the world, often with devastating effect; absence of predators in Australia and New Zealand has led them to become a pest. However, the rabbit has not become established in the wild in North America.

With domestication came the development of different breeds and varieties (colours). All domestic rabbits are the same species as the wild European rabbit (Oryctolagus cuniculus). In 1995, 61 breeds and 531 varieties of rabbit were recognised in the United Kingdom, and more are constantly evolving by selective breeding and mutation. Many pet rabbits are cross-breeds.

Over the centuries, man has used the rabbit for food, sport, clothing, as a scientific model and a hobby (the rabbit ‘fancy’). The keeping of rabbits as pets developed in Victorian times, and their popularity has grown enormously, to the current situation where rabbits are the third most popular mammalian pet in the UK. Although traditionally kept as and thought of as a children’s pet, increasing numbers are kept by adults and as house pets, becoming as much a part of the family as the more traditional cat or dog.
RABBiT ANATOMY AND BIOLOGY

Rabbits are social, burrowing herbivores that are natural prey for a large number of carnivores. As a prey species they have evolved to be constantly vigilant, lightweight and fast-moving, with a highly efficient digestive system that enables them to spend the minimum time possible above ground and in danger of capture. For the same reason of not attracting predator attention, rabbit behaviour is not florid and overt and relies heavily on scent.

Life expectancy of the rabbit is 5-8 years, but some individuals live to 10 years or more.

Musculoskeletal system. The rabbit skeleton is light, making up only 7-8% of bodyweight. The front limbs are short and fine, in contrast to the long and powerful hind limbs. The plantar surface of the hind limb from the tarsus distally is in contact with the ground at rest. The spine is naturally curved. Body conformation varies greatly depending on the breed, from 1kg to 10kg, and from the squat or "cobby" shape of the dwarf breeds to the lithe and lean ("racy") Belgian Hare. Skull morphology can lead to disease, especially dental problems, in some breeds. For example some dwarf breeds have a mandibular prognathism which causes incisor malocclusion, and breeds with a foreshortened skull seem predisposed to nasolacrimal duct and dental problems.

Great care must be taken when handling rabbits. Osteoperosis is often present due to lack of exercise and low calcium intake, and a kick from the powerful hind legs can result in lumbar vertebral fractures (usually L6/L7).

The forelimb has five digits and the hind limb four.

The vertebral formula of the rabbit is C7 T12 L7 S4 C16. Thirteen thoracic vertebrae are seen in some animals.

Rabbit muscle is light pink in colour.

Dentition and oral cavity. The upper lip of the rabbit is cleft. The dental formula is 2/10/0 3/2 3/3. The incisors are used for grazing, and food is then passed to the back of the mouth for grinding. Incisors have enamel layer only on the anterior surface, which wears more slowly than the posterior surface, thereby maintaining a chisel shape for cutting herbage. The vestigial second pair of upper incisors are located directly behind the first pair and are known as "peg teeth". All teeth are open rooted, long-crowned and grow continuously. The cheek teeth are wider apart on the maxilla than on the mandible, and the lower teeth grow faster than the upper.

The oral commissure is small, and the oral cavity long and curved. Cheek folds across the diastema make visualisation of the cheek teeth difficult in the conscious animal. The tongue is large and has a mobile rostral portion and a relatively fixed thicker caudal portion (torus).

There are four pairs of salivary glands: parotid, submaxillary, sublingual and zygomatic.
**Skin** Female rabbits possess a large fold of skin under the chin known as the dewlap, from which they pull hair to line the nest before kindling. The toes and metatarsal areas are completely covered with hair, and there are no footpads. Scent glands are located on the underside of the chin, either side of the perineum (inguinal glands) and at the anus (anal glands). The inguinal glands are large and pouch-like and often contain a yellow/brown oily deposit.

Hair coat depends on breed. The normal coat consists of a short soft undercoat protected by longer guard hairs. The only hairless areas are the tip of the nose, part of the scrotum and the inguinal folds. In the Rex breed the guard hairs are shortened so do not protrude above the level of the undercoat. Satin breeds have an altered hair fibre structure that gives the coat a characteristic sheen. Angora rabbits have very long undercoat and guard hairs that are harvested for spinning into wool, and needs regular grooming to prevent matting.

The guard hairs are the first to emerge in new-born kits followed by the undercoat. By a few days this soft baby coat is well-developed, and it persists until about five or six weeks of age. An intermediate or pre-adult coat then replaces this, followed by the adult coat by about six to eight months of age. Thereafter most rabbits moult approximately twice a year, (spring and autumn) but this can vary. Moultting starts at the head and proceeds caudally. Pregnant or pseudo-pregnant does undergo a loosening of the hairs on the belly, thighs and chest, which are then easily plucked to line the nest and expose nipples.

Tactile vibrissae are present on the muzzle, which are used to help locate food and when underground.

Does possess four to five pairs of nipples on the ventrum. Nipples are absent in the male.

**Eyes and ears** The large eyes are located laterally (prey species) and rabbits have a blind spot in the area beneath the mouth, so food is detected by the sensitive lips and vibrissae. The lens is large and almost spherical, and the ciliary body is poorly developed, so accommodation is limited. The retina is merangiotic, with the optic disc lying above the midline of the eye and retinal vessels spreading horizontally out from it. The optic disc has a natural depression or cup. There is no tapetum lucidum.

A third eyelid is present and the Harderian gland is located just behind it. This gland has two lobes, the upper being white and the lower larger and pink in colour. The gland is larger in males, especially during the breeding season.

The nasolacrimal duct has a single lacrimal punctum in the medial aspect of the lower eyelid. From here there is a short (approx 2 mm) canaliculus coursing medially and ventrally into a funnel-shaped lacrimal sac, supported medially by the lacrimal bone. The duct then enters the maxilla through a semicircular foramen in the lacrimal bone. The duct has two sharp bends as it courses towards the nose, proximally in the maxillary bone and at the base of the incisor teeth. The duct narrows at these points, and this, plus the fact that the epithelium of the duct is
undulating, and the opening into the nasal meatus is very small, meaning that the nasolacrimal duct is very prone to blockage in the rabbit.

The ears are highly vascular and are involved in heat regulation, containing with large arterio-venous shunts. Ear size varies between breed, and those that hang down are referred to as "lops".

**Digestive tract.** Rabbits are hind-gut fermenters, adapted to digest a low quality, high fibre diet consisting mainly of grass. However, unlike other hind-gut fermenters, for example the horse, the rabbit has a very rapid gut transit time and eliminates fibre from the digestive tract as soon as possible. This permits body size and weight to remain low, which is advantageous in a prey species. In the wild feeding takes place mainly in the early morning, evening and at night.

The gastrointestinal tract makes up 10-20% of body weight. The stomach is thin-walled, and poorly distensible with a well-developed cardia and pylorus. Vomiting is not possible in the rabbit. Food and caecal pellets are always present in the stomach. The duodenum and jejunum are narrow, and at the end of the ileum there is the sacculus rotundus rich in lymphoid follicles, and also known as the ampullae ilei or ileocaecal tonsil. The caecum is very large, thin-walled and coiled, and has many sacculations (or haustrea). It terminates in the vermiform appendix, which is also rich in lymphatic tissue. The caecum lies on the right side of the abdomen. Caecal contents are normally semifluid. The colon is sacculated and banded. Colonic contractions separate fibrous from non-fibrous particles, and fibre moves rapidly through for excretion as hard faecal pellets. Antiperistaltic waves move fluid and non-fibrous particles back into the caecum for fermentation. Three to eight hours after eating, and thus mainly at night, soft, mucus-covered caecal pellets are expelled and eaten directly from the anus (a process known as caecotrophy, coprophagy, refection, or pseudorumination). Arrival of the caecotrophs at the anus triggers a reflex licking of the anus and ingestion of the caecotrophs, which are swallowed whole and not chewed. A muscular band of richly innervated tissue with a thickened mucosa, the fusis coli, lies at the end of the transverse colon and acts to regulate colonic contractions and controls production of the two types of pellets.

The most prevalent caecal bacteria are of the anaerobic gram-negative genus Bacteroides, Propionobacteria and Butyrivibrio bacteria. Gram negative ovals, fusiform rods, large ciliated protozoa (Isotrichia) and yeasts (Cynidomyces guttulatus) are also present. Coliforms are not present in normal animals.

The mucus covering protects the caecal pellet bacteria from the low pH of the stomach. Caecotrophs remain in the stomach for up to six hours with continued bacterial synthesis, and eventually the mucus layer dissolves and the bacteria are killed. This process of caecotrophy allows absorption of nutrients and bacterial fermentation products (amino acids, volatile fatty acids and vitamins B and K), and the redigestion of previously undigested food. A food item can thus pass twice through the digestive tract in 24 hours.
Composition of faeces and caecotrophs:

<table>
<thead>
<tr>
<th></th>
<th>Dry matter</th>
<th>Crude protein</th>
<th>Crude fibre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faeces</td>
<td>53%</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Caecotrophs</td>
<td>39%</td>
<td>34%</td>
<td>18%</td>
</tr>
</tbody>
</table>

The pancreas is diffuse and located in a pocket formed by the transverse colon, stomach and duodenum. A gall bladder is present, and rabbits secrete mainly biliverdin in the bile rather than bilirubin. The pancreatic duct and the bile duct are separate.

The liver has four lobes.

**Spleen** The spleen is flat and elongated and lies on the dorsolateral surface of the greater curvature of the stomach.

**Respiratory system** Rabbits are nose-breathers (mouth breathing is a very poor prognostic sign). The nose moves up and down in a normal rabbit (“twitching”) 20-120 times a minute, but this will stop when the rabbit is very relaxed or anaesthetised. The glottis is small and visually obscured by the back of the tongue. Reflex laryngospasm is common in the rabbit, which can complicate endotracheal intubation. The thoracic cavity is small, and breathing is mainly diaphragmatic. The lungs have three lobes, and the cranial lung lobes are small (left smaller than right). Large amounts of intrathoracic fat are often present. The thymus remains large in the adult rabbit and lies ventral to the heart, extending into the thoracic inlet.

**Cardiovascular system** The heart is relatively small and lies cranially in the thoracic cavity. The right atrioventricular valve has only two cusps. The rabbit aorta has neurogenic rhythmic contractions.

**Urinary system** Rabbit kidneys are unipapillate. Urine is the major route of excretion for calcium. Serum calcium levels in rabbits are not maintained within a narrow range, but are dependent largely on dietary intake, with excess excreted via the kidney. Rabbit urine is often thick and creamy due to the presence of calcium carbonate crystals. It can also vary in colour from pale creamy yellow through to dark red (often mistaken for haematuria by owners), due to the presence of porphyrin pigments thought to be derived from the diet.

**Reproductive system** Does have no uterine body, two separate uterine horns and two cervices opening into the vagina. The vagina is large and flaccid. The mesometrium is a major site of fat deposition.

The placenta is haemochorial. Bucks have two hairless scrotal sacs either side and cranial to the penis. There is no os penis. The inguinal canals remain open throughout life (see Breeding below)
# Rabbit physiological data

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>180-300/minute</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>30 - 60 /minute</td>
</tr>
<tr>
<td>Body temperature</td>
<td>38.5 - 40.0C</td>
</tr>
<tr>
<td>Daily food consumption (pellets)</td>
<td>50g/kg</td>
</tr>
<tr>
<td>Daily water consumption</td>
<td>50 - 15-ml/kg</td>
</tr>
<tr>
<td>Daily urine production</td>
<td>10-35 ml/kg</td>
</tr>
<tr>
<td>Body weight adult (breed dependant)</td>
<td>1-6kg</td>
</tr>
<tr>
<td>Body weight new-born kit</td>
<td>30-80g</td>
</tr>
<tr>
<td>Life expectancy</td>
<td>5-8 years</td>
</tr>
</tbody>
</table>
RABBIT HUSBANDRY

Housing

Rabbits are traditionally kept outdoors in a hutch, but can also be kept indoors as a house pet.

Commercial hutches available from pet shops are invariably too small, certainly for sole accommodation. Hutches are invariably made of wood, although metal and plastic hutches are available and laboratory rabbits are kept in these. Wood has the advantage of being cheap, but can be gnawed and absorbs urine so can smell if there is insufficient bedding or infrequent cleaning. Hutch design can be variable, but the essentials are a dry, draught-free secluded nest area and an area for exercise. A solid fronted nesting area and mesh fronted living area are usually provided.

Hutches should always be as large as possible, with at the very least sufficient room to fully stretch up on the hind limbs and stretch out. If confined to the hutch for long periods of time the rabbit should be able to perform at least three "hops" from one end to the other. Exhibition rabbits are often kept in sheds with banks of wooden hutches stacked in three tiers. The bottom hutch should be at least 20cm above the floor. Litter boards can be placed across the bottom of the opening of the hutch to prevent bedding falling out when the door is opened.

Outdoor hutches should be raised off the ground and be protected from wind and rain. A felted roof sloping towards the back is suitable, or louvred shutters that can be closed in particularly inclement weather. Direct sunlight should be avoided as heat stress and stroke occurs easily. Rabbits cannot sweat, and do not increase water intake when very hot. Rabbits tolerate cold better than heat, and will shiver when very cold as they do not have brown fat deposits. Good ventilation is essential to prevent respiratory disease.

Bedding must always be provided, in the form of a layer of newspaper or wood shavings (not sawdust) plus straw, or straw alone. When offered a choice, laboratory rabbits prefer to sit on straw rather than shavings.

Water bottles can be attached to the outside of the mesh front with a wire clip. Ceramic or metal feeding bowls are most hygienic and will not be gnawed, and hay can be fed loose or dispensed from a rack or net. Wire mesh hayracks can be used to divide adjacent hutches. Food hoppers and automatic water valves are often used for large groups and in commercial or laboratory situations.

Cleanliness is essential to prevent disease, and the entire hutch should be completely cleaned at least once a week. Wet, soiled bedding can cause ulcerative plantar pododermatitis ("sore hocks") and high ammonia levels predispose to respiratory disease. Outdoor rabbits must be checked every day, with special attention paid in summer months to the perineal area, where caking of caecotrophs or sitting in wet soiled bedding can predispose to myiasis ("flystrike").
Lack of caecotrophy and caking of caecotrophs in this area is often erroneously interpreted as diarrhoea. The cause can be obesity, spinal pain, or dental disease.

An exercise area must always be provided in addition to hutch accommodation. This can be in the form of a mobile run or ark or a permanently fenced area of grass. Alternatively, a shed or garage can be used to provide a floor-pen. Raised shelves or platforms are readily used. If outside, it should be remembered that does will dig deep burrows, and measures to prevent escape should be taken, such as paving the edges of the pen, or sinking wire mesh below ground level. Rabbits can jump well and covering the run or pen with a mesh top will prevent escape, as well as providing protection from potential predators such as cats and dogs.

Contact with wild rabbits should be prevented, in order to minimise the risk of disease transmission by direct contact (eg Viral Haemorrhagic Disease) or vectors such as the rabbit flea (eg Myxomatosis) and suitable fly and mosquito control should be considered in summer months.

House rabbits should have a secure cage area where they can be restrained when the owner is not present. Wire cages with plastic bases are suitable. Exercise around the house should be encouraged. Rabbits naturally urinate and defaecate in one place, and thus are easily house trained to use a litter tray, by repeatedly placing them in the tray on acquisition. It may be necessary initially to place some droppings in the tray. Wood or paper based litter should be used as the Fuller's earth products can be harmful if ingested. Electrical cables must be protected from chewing, and poisonous houseplants such as the Dumb Cane (Dieffenbacchia) avoided. Chewable toys are enjoyed by house rabbits, for example cardboard boxes, old telephone directories, or commercial cat or bird toys. Hay should always be available. House rabbits will readily learn to use "cat-flaps" to gain indoor/outdoor access.

Due to their natural prey status, rabbits should always be provided with appropriate "bolt-holes" such as empty cardboard boxes or pieces of drainpipe to use if alarmed.

Rabbits are social animals and should be provided with a companion wherever possible. Littermates can be kept together but should be neutered if of opposite sexes. Unrelated females will usually tolerate each other if sufficient space is provided, but they can fight. Introduced intact bucks will fight and inflict severe injuries. All introductions should be supervised, and neutering minimises the risk of conflicts.

It is not recommended that rabbits be kept with guinea pigs, as bullying by the rabbit can occur. If these two species are kept together an area that the guinea pig can retreat to that is inaccessible to the rabbit should be provided. It should be remembered also that rabbits can harbour Bordetella bronchiseptica, which is pathogenic to guinea pigs.

Other house pets can be well tolerated, but dogs and cats should not be left unsupervised with rabbits.
Commercially farmed rabbits are kept very differently from pets, mainly in single-tier systems with mesh floors and no bedding. A MAFF Code of Recommendation for the Welfare of Rabbits (1987) recommends minimum cage sizes. Laboratory rabbits are kept either individually in cages or in groups in floor pens, in accordance with strict husbandry and welfare guidelines under the Animals (Scientific Procedures) Act 1986. Bedding and various environmental enrichment devices are increasingly used.

**Diet**

In the wild rabbits are essentially grazers, although they will forage on low-level leaves and shoots. The composition of grass is approximately 20-25% crude fibre, 15% crude protein and 2-3% fat. Commercial rabbit diets are often too low in fibre and too high in protein, fat and energy. Indigestible fibre (lignocellulose) stimulates gastrointestinal motility and has a protective effect against enteritis. Diets low in fibre and high in available carbohydrate cause caecocolic hypomotility, prolonged retention of digesta, increased volatile fatty acid production and adverse alterations in pH and microflora. This leads to diarrhoea and the "mucoid enteropathy" syndrome, especially around the time of weaning. The energy requirements of a rabbit can be met very rapidly on a concentrate diet, as compared to the situation in the wild, where the majority of the time budget is spent feeding. This can lead to dental disease due to lack of wear, obesity, and boredom-associated problems such as stereotypic behaviour and aggression. In addition, many rabbits are selective eaters and leave the grass-pellet component of a commercial mix, favouring the grains and pulses. These favoured items are low in calcium, and this can again lead to bone and dental disease (see Harcourt-Brown, and chapter on dentistry).

The best diet for a rabbit is grass and good quality grass hay (e.g. Timothy) with a small amount of a good quality high fibre (18 to 24%) commercial diet with protein levels around 18%. Alfalfa hay can be given, especially to growing animals, but care should be taken if alfalfa pellets are also fed as alfalfa is high in calcium and large amounts in the diet could predispose to urolithiasis. Fresh vegetables and small amounts of fruit can also be provided, but fruits high in simple sugars should be avoided. Commercial rabbit mixes, consisting of pulses, grains, grass pellets and biscuits, should not be fed ad lib, as this leads to selective feeding and obesity. A rabbit in good condition should have palpable ribs and vertebrae. Hay should always be available and can be fed from racks or nets to increase time spent feeding. The importance of hay in maintaining gastrointestinal and dental health cannot be overemphasized. Carrots or other root vegetables can be suspended from the cage roof to act as an edible toy and increase time spent eating.

Sudden changes in diet should be avoided, as should frosted or mouldy food, and lawnmower clippings. Rabbits enjoy sweet foods, but sugar-rich treats should not be fed, although they may be of use if tempting and anorexic animal to feed.
Kits show interest in solid food at about 2 weeks of age, and coprophagy starts at about 3 weeks. Stomach pH in non-weaned kits is 5.5-6.0, but this drops to 1.0 to 2.0 after weaning. Coprophagy usually commences 3-8 hours after feeding.

Water intake is fairly high, at about 10% of body weight. Drinking bottles are easier to keep clean than water bowls, and avoid wetting of the dewlap, which can lead to a moist dermatitis.

**Breeding**

Onset of puberty depends on breed, but is at approximately 4-5 months in the female and 5-8 months in the male. Within a breed, does tend to be slightly larger than bucks, but bucks have broader heads. Smaller breeds mature earlier than larger ones. Does tend to be more territorial than bucks and so the doe should be taken to the buck or to neutral territory for breeding, to avoid aggression.

Rabbits are reflex ovulators. There is no definitive oestrous cycle, but periods of receptivity usually occur for 12-14 days, followed by 2-4 days of non-receptivity while new follicles are developing. However, this can be highly variable, and some does will become receptive every 4-6 days during the breeding season (January to September.) When receptive, a doe will become very active, rub her chin on objects and exhibit lordosis and the vulva becomes congested and reddish-purple. Sexually mature bucks will mate at any time. Courtship behaviour is brief (approximately 30 seconds) and involves sniffing, licking and following of the doe. Enurination, the spraying of a jet of urine at the doe, is common sexual behaviour. Copulation is very brief and involves a vigorous thrusting intromission which often leads to the buck falling backwards or sideways and vocalising. Ovulation occurs ten hours after copulation. Does may also mount each other, and this or an infertile mating can induce ovulation and lead to a pseudopregnancy, which lasts approximately 18 days. Pregnancy can be detected by palpation two weeks after a successful mating. Normal gestation is 30 - 32 days, and litter size varies usually between 4 and 12 kits, with the larger breeds producing larger litters. Nest-building behaviour involves burrowing if possible, and pulling of fur from the dewlap, flanks and belly to line the nest and expose the nipples. Parturition usually occurs in the early morning, and the kits are altricial. Passive immunity is acquired by placental transfer before birth. Rabbit milk is exceptionally nutritious and nursing is for only a few minutes once, or occasionally twice a day. This brief nursing period is often misinterpreted by owners as mismothering, but is entirely normal. The parental bond is maintained by scent, with the doe marking her kits with her chin and inguinal gland secretions.

Kits emerge from the nest at about 2-3 weeks of age and can be weaned at 4-5 weeks.

**Identification**

For exhibition purposes, rabbits are permanently marked with metal rings placed around the hind leg just above the tarsus. Some breeders use one side for bucks and the other for does but
there is no requirement for a particular side to be used. Rings are sold only by the British Rabbit Council, and come in ten different sizes appropriate for the different breeds. Ring numbers are registered against the purchaser, and if the rabbit is sold, the ring number is transferred to the new owner. Unrung rabbits are automatically disqualified from exhibition. Tattooing on the inside of the ear can also be used to permanently identify individuals.
Rabbit behaviour is significantly different to that of cats and dogs due to their prey status. They have poor display of greeting behaviour, pain and fear. Scent is much more important than sight, and each animal has an individual scent profile. They can distinguish between familiar and unfamiliar humans, and between human gender. Socialisation of young rabbits is often overlooked. Kits emerge from the nest at about 2 weeks old and are weaned at 4-5 weeks old, but are generally not homed, and therefore handled to any great extent, until about 6-8 weeks of age.

Rabbits are highly social. In the wild they live in warrens usually containing 70 or more individuals, but this is broken down into small groups of 2-8. Foraging takes up most of the time in the wild, in the early morning and at night. Rabbits should not be kept singly unless the owner can devote a lot of time to them, but in neutered groups or pairs. They will spend a lot of time engaged in mutual grooming and lying together. Does are more territorial than bucks and as they reach sexual maturity may become aggressive towards the owner and other animals. Does may also bite, dig and chew flooring and household items, spray urine and mount other rabbits. If outdoors on soil the doe may excavate deep tunnels.

As mentioned above, toys should be provided. However work on environmental enrichment for individually kept rabbits found hay to be far superior to other objects (grass cubes, gnawing sticks or a box) in preventing abnormal behaviour such as excessive fur licking, sham chewing and bar biting. In groups of young rabbits, providing hay significantly reduced the amount of dorsal alopecia and gastric hair found at slaughter. It also completely eliminated forehead alopecia - the rabbits stopped plucking fur from their cagemates' forehead.

A well-socialised pet rabbit will beg for treats, "hum" and circle the owner, stand on its back legs and lick the owners' hands and arms. They are inquisitive and enjoy exploring. Picking up objects with the teeth and throwing them is also common, as is exploratory chewing (beware electrical cables).

A rabbit in pain will be immobile with a hunched posture, and may tooth-grind and show increased aggression. Thumping with the hind leg is an alarm call. Fear elicits either complete immobility, or a flight response, with often frantic attempts to escape, which can be accompanied by screaming.

Rabbits have not been bred for positive behaviour traits, and behavioural problems are not uncommon. Individual rabbits have distinct "personalities", from timid to aggressive. In general, the smaller breeds tend to be more highly strung. Aggression is generally learnt (ie the owner leaves the rabbit alone if it behaves aggressively). Other causes of aggression are territorial behaviour, boredom, pain, improper socialisation and negative association (ie a previous aversive or traumatic situation). Behavioural aggression can be successfully treated in many cases using similar techniques to those used in dogs.
CLINICAL TECHNIQUES

Physical examination

Correct handling is vital - rabbits should be held by the scruff and with the body weight supported. Twisting and kicking out by the powerful hind legs must be avoided, or serious back injury can result.

Turning the rabbit onto its back results in a "trance-like state (tonic immobility). This is a useful technique and can be employed single handed with the rabbit cradled in one arm, but it should always be remembered that it is stressful for the rabbit and should be used for the minimum time possible. Under no circumstances should painful procedures be carried out using this technique as restraint.

Rabbits should never be picked up by the ears. A non-slip surface should be used when carrying out a physical examination, and ideally an assistant or the owner should hold the rabbit to prevent it jumping off the table. To examine the ventrum sit or roll the rabbit onto its back. Rabbits often resent their mouth and incisor teeth being examined, and this is often more easily achieved in this position, as is the measurement of rectal temperature. A methodical physical exam should be undertaken as for any other species. Proper examination of the cheek teeth requires sedation or general anaesthesia, although a cursory inspection can be carried out using an otoscope.

Most of the clinical techniques employed in dogs and cats can be directly applied to the rabbit. Correct handling is essential and a non-slip surface should be used. As with any animal, a systematic clinical examination, carried out in a consistent fashion, is important.

Oral examination is often resented. The sole use of an otoscope is not recommended as small lesions, eg tooth spurs, can easily be overlooked. Sedation or anaesthesia is required to look at the mouth properly and should be accompanied by radiography of the skull for a full assessment of the teeth. Commercially available incisor gags and cheek retractors are available and are strongly recommended. As part of the examination, run one's fingers over the ventral mandibles - overgrowth of mandibular cheek tooth roots can often be felt as multiple raised points, and tooth root associated abscesses masked by fat or the dewlap, may be picked up.

Ocular examination is an important part of the clinical exam. Purulent discharge from the nasolacrimal duct punctum is often present. The optic nerve is above the horizontal midline of the eye, and retinal vessels spread outwards from the optic disc. Rabbits have no tapetum lucidum.

Special attention should be paid to the ears (Psoroptes cuniculi), hocks (plantar pododermatitis), and perineal area (accumulation of caecotrophs, myiasis). The abdomen is thin walled and palpation is easily achieved. The caecum lies on the right side. Uterine neoplasia is very common in the older unmated doe.
Accessible veins for **blood collection** are the marginal ear vein, jugular vein, cephalic vein and saphenous vein. Sedation is sometimes required for jugular collection, and access is difficult in does with large dewlaps.

**Cystocentesis** can be achieved in a conscious rabbit, using a method similar to that in the cat. Rabbit urine is alkaline, contains albumin, calcium carbonate and ammonium magnesium phosphate crystals and is often pigmented.

<table>
<thead>
<tr>
<th>Urine specific gravity</th>
<th>1003 - 1036</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine average pH</td>
<td>8.2</td>
</tr>
<tr>
<td>Urine crystals normally present</td>
<td>Ammonium magnesium phosphate, calcium carbonate</td>
</tr>
<tr>
<td>Casts, epithelial cells, bacteria</td>
<td>Absent to rare</td>
</tr>
<tr>
<td>Leucocytes, erythrocytes</td>
<td>Occasional</td>
</tr>
<tr>
<td>Albumin</td>
<td>Occasional (young rabbits)</td>
</tr>
</tbody>
</table>

**CSF** can be collected under anaesthesia in lateral recumbency by flexing the head and inserting a needle in the midline halfway between the cranial edges of the wings of the atlas and the occipital protruberance.

**Radiography and radiology.** Sedation is necessary for radiography. Bone quality is often poor in rabbits due to disuse osteoporosis and/or dietary calcium deficiency. The most common reason for radiography is assessment of dental disease, and accurate positioning (DV and lateral) of the skull and knowledge of the skull anatomy is mandatory. Contrast radiography of the nasolacrimal duct is a useful technique to assess its patency and any impingement by tooth roots. The ventral border of the mandible should be smooth with an obvious cortex, and the cheek teeth should have a normal "zigzag" occlusion. You are referred to the In Practice article by France Harcourt-Brown (September 1997) for a detailed account of normal and abnormal skull radiology, and a discussion of dental disease. Skull radiography is also indicated in the assessment of middle ear disease.

The thoracic cavity is small with the heart located cranially, and with a very small retrosternal lucency. There is often a lot of subcutaneous and pericardial fat present, and this, combined with superimposition of the front limb, can lead to both overdiagnosis of cranial pneumonia, or masking of lung disease. Pulmonary nodular neoplasia is common in older intact does (metastases of uterine adenocarcinoma).

The abdomen can vary widely in radiographic appearance. Gastric trichobezoars are common and can be either of significance or normal. The large caecum is located in the right
hemiabdomen. There is often a lot of abdominal and retroperitoneal fat present which can mimic masses. Increased gas distension will occur with both ileus and obstruction, and contrast studies are useful to distinguish these. Urolithiasis and bladder "sludge" are easily detectable radiographically.

**Ultrasonography** is a useful technique in the rabbit. The large amounts of gas often present in the GI tract can make interpretation difficult.

**Nasolacrimal duct cannulation** is performed under sedation and the instillation of local anaesthetic drops into the eye. A rigid or flexible cannula is inserted into the punctum and sterile saline used to flush the duct. Water-soluble contrast medium can be instilled.

Intravenous injections can be made into the marginal ear vein, and indwelling catheters are also well tolerated. Intraosseus catheters can be placed in the greater trochanter of the femur or proximal tibia.

The placing of a nasogastric tube is extremely useful in the management of anorexic rabbits. However it does involve anchoring the tube to an Elizabethan collar which may not be tolerated too well. Consider this technique with anorexic rabbits, especially if overweight, as there is a risk of ketosis.
COMMON CLINICAL CONDITIONS

RESPIRATORY DISEASE

Pasteurellosis

Pasteurella multocida is a gram-negative short rod that is almost ubiquitous in the nasopharynx of pet rabbits. Animals can be symptomless carriers, have subclinical disease, or overt disease which is often stress-related. Rabbits develop little immunity after infection with this bacterium and thus are unable to mount an appropriate immune response. The prevalence of asymptomatic carriers is high (approximately 30-90% of apparently healthy rabbits). The classic clinical manifestation is upper respiratory tract disease ("snuffles") with a serous or whitish yellow mucopurulent nasal and ocular discharge. Crusting is often seen on the inner aspect of the front legs as the rabbit attempts to clean away the discharge. Rhinitis and sinusitis are present, and in chronic cases there is turbinate erosion and atrophy.

Other clinical manifestations include:

- pneumonia
- pleuritis
- otitis media and interna
- conjunctivitis and dacryocystitis

Pasteurella can also cause septicaemia, abscesses, pericarditis, osteomyelitis, metritis, mastitis, orchitis, and epidymitis.

Transmission is mainly by direct contact with nasal secretions from infected rabbits and may be greatest when rhinitis induces sneezing and aerosolization of secretions. The bacteria can survive for days in moist secretions or water. P. multocida gains entry to the respiratory tract primarily through the nares, and once infection is established, may colonize also the paranasal sinuses, middle ears, lacrimal ducts, thoracic organs, and genitalia. Occasionally rabbits harbor chronic infections of internal tissues or organs, such as middle ears or lungs, without any signs of rhinitis and are negative for P. multocida by nasal culture.

P. multocida is often endemic in rabbit colonies and the acquisition of infection in young rabbits is correlated to the prevalence in adult rabbits. If young rabbits are removed early from infected adults, the chance of infection for the young decreases.

Colonization and disease is influenced by factors related to both host and pathogen. Different strains of P. multocida have been isolated from rabbits. They are classified by capsular type and serotype; A:12 is the most common in rabbits in the U.S., but A:3 and other A and D serotypes exist. More severe disease has been associated with A:3 and D strains. Bacterial
capsular polysaccharides are important in inhibiting phagocytosis; lipopolysaccharides confer resistance to complement and bactericidal activity of serum. Pili (fimbria), which are filamentous appendages elaborated by bacteria, have receptors that may help P. multocida stick to and colonize mucous membranes. Toxin production is another factor which influences virulence; toxin produced by bacteria can cause disease by itself and in sites removed from where the bacteria reside. This has been shown with purified toxin from P. multocida. A syndrome of atrophic rhinitis or degeneration of the nasal turbinates has been associated with toxin-producing strains of P. multocida in rabbits. Both capsular types D and A have been shown to produce toxin. Preexisting or simultaneous infections with other respiratory bacteria such as Bordetella bronchiseptica (often a commensal), may influence the ability of P. multocida to colonize and debilitate the tissues.

Ability of the rabbit to resist P. multocida infection depends, in part, on health of the exposed mucosa, and probably on rapid production of mucosal antibodies (IgA) which will inhibit growth of the bacteria. High levels of humoral antibodies (IgG) are not associated with elimination of infection but rather with chronic infection. Thus measurement of P. multocida IgG antibodies in serum is helpful in detecting infections inaccessible to culture in the live rabbit. Attempts to induce immunity and protection using bacterins, potassium thiocyanate extracts or attenuated live bacteria have failed to prevent pasteurellosis over time. However, some unvaccinated, untreated rabbits exposed to P. multocida resist infection altogether and of those with infection a significant number resist disease.

Dacryocystitis and blockage of the nasolacrimal duct requires cannulation and flushing of the duct. This is easily achieved under sedation and with the application of local anaesthetic to the eye. Packing the nasolachrymal duct with Fucithalmic Ointment (Leo) may be of benefit due to its persistence. There is however an interesting caveat to the Pasteurella story - in a recent survey of fifty-six rabbits exhibiting superficial ocular infections, and from which 98 swabs were submitted, the following results were obtained: -

Staphylococcus spp 27% of all isolates
Pasteurella spp 14% of all isolates. Only 3 (5%) were P. multocida
Acinetobacter spp 14% of all isolates
Pseudomonas spp 7%. P. aeruginosa was isolated once (2%)
Enterobacter spp 5%
Branhamella catarrhalis 3%
Corynebacterium spp 5%
Proteus spp 3%
Another nine organisms were isolated once only. In 28 (50%) of rabbits, dental disease was recorded. This may suggest a change in the ocular bacterial flora, possibly due to changing husbandry practices, or it may be a reflection of the importance of underlying predisposing factors such as dental disease allowing secondary colonisation by a variety of commensals.

Less commonly, epiphora occurs when too many tears are produced for the system to handle - entropion and distichiasis may be commoner than we think.

Treatment is difficult, and complete elimination of the organism is rarely achieved in practice. The underlying stressor should be addressed, (eg poor ventilation and ammonia build-up, overcrowding, bullying) and systemic antibiosis based on culture and sensitivity testing should be instituted. An extended course (6-8 weeks) is often required. In severe cases, supportive therapy will also be required (fluids, mucolytics, oxygen, nutritional support).

10 Practical Points about Pasteurella multocida in Rabbits

1. Not all rabbits carry P. multocida although insofar as UK pet rabbits is concerned one should regard it as probably ubiquitous.

2. If removed from sources of infection early, a rabbit may never acquire P. multocida infection.

3. Not all rabbits with P. multocida become ill - subclinical infections.

4. P. multocida is still the most common cause of respiratory disease, primarily rhinitis, in rabbits.

5. Some P. multocida strains are more virulent than others, but most clinical laboratories cannot differentiate strains.

6. Chronic infection and disease can occur in areas of the body inaccessible to culture.

7. Hidden infections sometimes may be detected by radiology, or serology.

8. Some rabbits are able to resist or clear mild infection without treatment.

9. Rabbits with disease due to P. multocida infection should be treated with appropriate antibiotics.

10. Some rabbits with chronic infections or deep abscesses may not improve but be stabilized with antibiotics. Many owners are willing to use antibiotics on a long term basis.
**Other respiratory diseases**

Bordetella bronchiseptica is another common inhabitant of the respiratory tract, but is not normally associated with respiratory disease. Secondary Staph. aureus infections can also be found.

Myxoma virus causes nasal and ocular discharge, and one form does produce predominantly respiratory signs, although this is rare.

Viral Haemorrhagic Disease produces tracheal and lung haemorrhage and sudden death.

**GASTROINTESTINAL DISEASE**

**Gastric trichobezoars**

This condition has been traditionally thought to be due to excessive grooming and ingestion of hair, but the presence of hairballs is now thought to be a relatively normal finding. The true problem is reduced gut motility/ileus, leading to loss of fluid from the stomach and a dehydration of the stomach material, leading to a mass which can no longer be passed. The underlying aetiology is unclear, but lack of sufficient fibre in the diet seems to play an important role - indeed as mentioned above, provision of hay significantly reduces the amount of fur ingested.

The rabbit eventually stops eating and drinking possibly due to a feeling of fullness in the stomach. When there is no food coming into the system the GIT motility slows to nearly a standstill. Add to this a diet too high in protein or carbohydrate and the result can eventually be disastrous. Diets too high in protein and/or carbohydrate can result in changes in the caecal pH and thus the bacterial flora growing there. These fragile communities are altered allowing the growth of bacteria such as Clostridium spiriformes which can result in death due to the production of iota toxins. The clinical presentation is of severe depression, anorexia, dehydration abdominal pain and sudden death due to gastric or intestinal perforation. The hairball is often palpable, but radiography and contrast studies may be required. Treatment is aggressive fluid and supportive therapy and motility modifiers. Liquid high fibre food is given by syringe or naso-oesophageal tube two to three times daily. Ground rabbit pellets or powdered alfalfa powder can be mixed with blenderized green leafy vegetables and an oral electrolyte solution for these feedings. Medications to stimulate the GIT and analgesics may also be used. Liquid paraffin and the enzymes papain, bromelin or pineapple juice can be tried to attempt to break down the hairball matrix and assist passage. These enzymes will not dissolve the hair however. Analgesia should also be given to control the abdominal pain. Surgical intervention is often attempted but should be avoided if possible as affected animals are poor surgical candidates, and the hairball itself is secondary.

The real keys to treating this problem are: hydration of the stomach/cecal contents and getting the GIT moving again.
Diarrhoea is a common presenting sign in rabbits, and it can often be difficult to establish a definitive cause. The rabbit’s digestive physiology means that any slight change in gut microflora, pH, or motility will lead to diarrhoea. Stress and dietary causes are common, such as movement and a sudden change in diet, the feeding of lawnmower clippings, mouldy or frosted food. Overgrowth of clostridial species in the gut (Cl. spiriforme) leads to the release of an iota-toxin and an enterotoxaemia. Bacterial enteritis due to enterotoxic E.Coli and Staph.(rare) does occur in neonatal and young weaner rabbits.

Overgrowth of Cl. spiriforme is often iatrogenic, caused by the inappropriate use of certain antibiotics such as penicillin, ampicillin, amoxycillin, clindamycin, lincomycin, cephalosporins and erythromycin, which kill the normal microbial flora and allow clostridia to proliferate. Many antibiotics suppress the healthy population of intestinal bacteria resulting in "dysbiosis" which leads to an enterotoxemia, and/or diarrhea and can potentially take the life of the rabbit. Disease is caused when an overgrowth of pathogenic bacteria produce toxins and damage the cecum and colon, as well as affecting other body systems. Clostridium spiroforme, a bacterium normally present in the rabbit's lower intestinal tract in very small numbers, is the most common cause. E. Coli and other pathogenic bacteria may also proliferate and be the cause of disease.

As a general rule, most of the bacteria in rabbit gut flora are Gram positive bacteria, and/or anaerobic bacteria. The chance of the antibiotic causing enteritis or enterotoxemia is greater if it is administered orally, rather than by injection.

A diet rich in simple carbohydrates (sugars, starches such as grain and refined flour, as well as high-sugar-containing fruits such as grapes or bananas) will increase a rabbit's chance of developing enteritis when taking antibiotics. This is because of the destabilizing effect simple carbohydrates have on the normal bacteria and because Clostridium spiroforme needs simple carbohydrates to produce its toxin. In young rabbits this can be a particular problem as they have poor amylase activity which may lead to an incomplete carbohydrate utilisation such that excessive levels of fermentable carbohydrates arrive at the caecum. A diet high in fibre, such as grass hay, will decrease the chance of antibiotics upsetting the rabbit's flora because the fibre increases the motility (motion) of the cecum and colon. With some commercial diets, much of the fibre is provided by cereals, which are also high in protein. It has been suggested that with such diets the fibre encourages peristalsis such that the cereal proteins arrive at the caecum incompletely digested. In the caecum fermentative anaerobes break down these proteins to ammonia which causes a rise in pH. Once over a pH of 6.0 many normal commensals fail to grow and as a pH of 7.0 is approached direct ammonia toxicity occurs, fibre digestions ceases and pathogen colonisation can take place.

Antibiotics in the macrolide family, such as clindamycin, erythromycin and lincomycin; the penicillin family, such as ampicillin and amoxicillin, as well as several other antibiotics have been reported to cause enteritis in rabbits. Less likely, but capable of causing problems is the...
cephalosporin family of antibiotics. Antibiotics that rarely if ever cause problems include the quinalone family, such as enrofloxacin (Baytril); the potentiated sulfa drugs, such as trimethoprim-sulfamethoxazole; sulfa drugs such as sulfadimethoxine; and the aminoglycoside antibiotics such as amikacin.

Signs that a rabbit has enteritis include one or more of the following symptoms: anorexia depression or lethargy, abdomen distended with gas, a abdominal pain and diarrhoea with or without blood, or even no faecal production.

Treatment of enteritis and enterotoxemia consists of aggressive supportive care and efforts to increase cecal and colonic motility, and to discourage the growth of pathogenic bacteria and the production of toxins while supporting the growth of normal flora. Correction of dehydration and maintenance of normal hydration are of paramount importance. Intravenous or intraosseous fluids are often indicated. Motility modifiers such as metaclopramide and cisapride are extremely useful and seem to act synergistically when used together, plus a diet high in fibre, force fed if necessary, give the most favorable results. Give multivitamins if coprophagy is absent. Analgesia should be given if there is evidence of abdominal pain. The use of probiotics (lactobacillus) is controversial, as the low pH of the stomach will inactivate these bacteria. Transfaunation of caecal pellets from a healthy rabbit (collected by placing an Elizabethan collar overnight) does seem to be of use in re-establishing gut flora, as the bacteria are protected by the mucus covering of the caecotrophs. The use of cholestyramine ("Questran") to absorb clostridial toxins can be of benefit. Antibiotics have limited value in treating the disease and are used primarily as "supportive" therapy.

Prevention of enterotoxemia depends on maintaining optimal husbandry and minimising stress. Feed a diet with no less than 18% to 20% fibre from a good quality grass hay. Sudden changes in the diet should be avoided. Weaning rabbits should have feed, including hay, available from three weeks of age, and early or forced weaning should be.

**MUCOID ENTEROPATHY.**

The term "mucoid enteropathy" is now used to describe a poorly understood condition in 4-14 week old rabbits, characterised by the presence of thick gelatinous mucous production in the colon. Affected animals are depressed, dehydrated and exhibit abdominal pain. The caecum is often impacted. Both diarrhoea and constipation can characterise clinical signs of ME, which is quite confusing to the owners. The constipation is caused by a buildup of mucous forming a plug leading to a transient intestinal obstruction. Anorexia, depression, abdominal distention, grinding of the teeth (sign of pain), and perineal staining are also common. It is thought that hyperacidity of the caecum from changes in volatile fatty acid production/absorption, or excessive fermentation of carbohydrates is involved, plus alterations in the normal flora.

The feeding of plenty of good quality hay and little concentrates is preventive, again emphasising the importance of a high fibre diet. Treatment is aimed at supporting the patient and returning the gastrointestinal tract back to normal function: fluid therapy, probiotics (?)
and plenty of hay (if the rabbit is eating. If not, force feed.) Motility stimulating drugs like Metoclopramide may also be used. It has recently been discovered that some cases of apparent mucoid enteropathy are due to a dysautonomia (see below).

**Dysautonomia** In 1996 Whitwell (Vet Record, Sept 28th 1996) reported a true dysautonomia in rabbits causing caecal impaction, anorexia, depression and death in weanling rabbits. Mesenteric autonomic ganglia showed chromatolysis-like degenerative changes and neuronal vacuolation, similar to the picture in equine grass sickness.

**Coccidiosis** There are two presentations of coccidiosis in rabbits - an intestinal form, and a hepatic form. Eimeria species commonly cause enteric disease in large groups of rabbits, especially in young animals. Hepatic coccidiosis caused by E. stiedae is also common. The most important species of intestinal coccidia are Eimeria perforans, E. magna, E. media and E. irresidua, although the exact species involved may not be as important as the health status of the rabbit. Rabbits become infected by ingesting faeces containing the coccidia oocyst. This can happen when the rabbit cleans its feet or fur that has been contaminated with the feces of another, infected rabbit. Although rabbits are cecotrophic, it is generally accepted that cecotropes do not contain infectious oocyst.

Clinical signs of intestinal coccidiosis vary widely depending on the age of the rabbit, the organism involved, the degree of infection and the relative susceptibility of the animal (affected by age, stress, diet, etc.). Signs are more often seen in young rabbits with their immature immune systems. Weight loss, mild intermittent to severe diarrhea which may contain mucous or blood, and resulting dehydration may be seen. Animals with severe diarrhea may develop intussusception, a blockage of the intestines caused by a telescoping of the bowel on itself.

Deaths caused by coccidiosis are most often attributed to dehydration and secondary bacterial infections. Treatment and prevention of intestinal coccidiosis are as for hepatic disease. Currently there are no vaccines available against coccidiosis. Prevention depends on keeping rabbits in hygienic conditions and avoiding infected feces, or food and water contaminated with feces. New rabbits, especially those with an unknown past, should be quarantined for at least 30 days before they are introduced to other rabbits.

Diagnosis is based on the detection of oocysts in the faeces and prevention and treatment is achieved with sulpha drugs, and good hygiene. Treatment limits multiplication of the organism until immunity develops.

Hepatic coccidiosis caused by E. stiedae may be found in any large groups of rabbits, from rabbitry to foster home. In mild infections there may be no symptoms or there may be only mild to moderate retardation of growth, but the disease may be fatal, especially in young rabbits. Heavily infected rabbits show signs related to the interference of liver function and blockage of bile ducts. These rabbits stop eating and become debilitated; either diarrhea or
constipation may be noted late in the disease. Occasionally there is ascites and jaundicing. Radiography may confirm this. Liver enzymes may be raised, suggesting a diagnosis of hepatic (liver) coccidiosis.

Confirmation of the disease is based on finding oocysts in a fecal or bile sample. Numerous drugs have been used to prevent and treat E. stiedae. Potentiated sulphonamides drugs appear to be the most effective. All the rabbits in an infected rabbitry or household must be treated until the disease has run its course. The major role of these drugs is to control the organism until the rabbits’ immunity develops, and immunity resulting from mild infections may be lifelong.

**SKIN DISEASE**

**Ectoparasites**

*Cheyletiella parasitovorax* Rabbit fur mite. A non-burrowing mite, just visible to the naked eye. Lesions are not severe, with crusting/scaling along the dorsum, mild pruritus and partial alopecia in heavy infestations. NB Cheyletiella is a zoonosis. The life cycle is about 5 weeks. Diagnosis is easily made with the “sellotape test”. Treatment of choice is ivermectin.

*Listrophorus (Leporacarus) gibbus* A non-burrowing fur mite that is non-pathogenic even in heavy infestations. It is not zoonotic.

*Psoroptes cuniculi* Rabbit ear mite. Non-burrowing mite that causes intense irritation - head shaking, scratching of the ears, hyperaemia - and the production of exudate leading to thick crust formation filling the auditory canal. Lesions can spread to the face and neck, and the eardrum can perforate leading to a purulent otitis media (secondary bacterial infection) and meningitis. Mites can be visualised on otoscopic examination, or by microscopic examination of aural debris. Treatment can be with acaricidal ear drops or ivermectin. Thick crusts should be softened with mineral oil or propylene glycol before being removed, otherwise the lining of the ear canal can be damaged.

*Sarcoptes cuniculi* and *Sarcoptes scabiei* Occasionally reported but very rare.

*Spillopsyllus cuniculi* Rabbit flea. Important as vector for myxomatosis. Cat fleas can occasionally live on rabbits. Treatment as for dogs and cats. NB no products licensed for rabbits, and adverse reactions to the isopropanalol vehicle in “Frontline” have been reported.

*Haemodipsus ventricosus* Rabbit louse. Can cause anaemia and pruritis, but rare in pet rabbits

**Myiasis** Flystrike is common in rabbits in summer months. Strike is usually primary (ie intact skin) and flies are attracted by faecal accumulation around the perineum and especially in the folds either side of the genitals. This is invariably due to lack of coprophagy which can be due to a number of factors - dental disease, obesity, back problems, old age. Initial treatment involves clipping of the fur and cleaning of the area, with manual removal of the maggots and
flushing of the area with dilute antiseptic/antiparasitic solutions. Treatment should be aggressive with supportive therapy given for toxic shock, and ivermectin will kill any larvae that emerge from unremoved eggs. Bathe with chlorhexidine or a povidene-iodine cleanser. Give fluids s/c or i.v. or i.p. plus ivermectin i.m. @200mcg/kg to kill those maggots out of reach. Guarded prognosis. The underlying cause of the faecal accumulation must then be addressed.

**Fungal skin disease**

Trichophyton mentagrophytes can cause hair loss and crusting lesions. Zoonosis, and treatment is as for other species.

**Bacterial skin disease**

**Abscesses** Pasteurella multocida and Staph. aureus are usually isolated, with Proteus, Pseudomonas and Bacteroides occasionally found. Entry is via a skin wound, or more rarely secondary to bacteraemis. Facial abscesses are invariably secondary to dental or nasolacrimal duct disease and radiography of the skull is vital for any facial abscess in order to obtain a prognosis. Rabbit pus is thick, tenacious and very difficult to remove, and there is usually a thick abscess capsule. True subcutaneous abscesses are treated by lancing and aggressive flushing with antiseptic solutions, or surgical removal, plus appropriate antibiotic therapy. Underlying bony involvement carries an extremely poor prognosis.

Pseudomonas aeruginosa ("moist dermatitis/blue fur disease") Common in overweight and female rabbits with a large dewlap, or in animals with severe dental disease and excess salivation. The wet fur becomes infected with Pseudomonas and turns a characteristic blue colour. Treatment involves clipping the affected area, and applying antiseptic solution (eg dilute chlorhexidine), plus addressing the underlying cause.

Treponema cuniculi ("rabbit syphilis"). This spirochaete causes redness, oedema, vesicles, ulcers, scabs and proliferative lesions around the perineum, and also around the face from autoinnoculation. Transmission is venereal and by direct contact. Affected does can infect kits at birth. Rabbits can be asymptomatic carriers, with overt disease precipitated by stress. Clinical signs are very characteristic, but definitive diagnosis involves microscopic visualisation of the organism from scrapes on a dark field background, or with special silver stains on biopsy. It is often self-limiting, but effective treatment is with penicillin once every 7 days for 3 doses. All exposed rabbits should be treated. Rabbit syphilis is not zoonotic.

**Viral skin disease**

Myxomatosis. The myxoma virus is a pox virus, spread by a flea vector, direct and indirect contact. Clinical signs are oedema of the head, ears, eyelids and genitalia, a milky oculonasal discharge, and later diffuse oedematous cutaneous swellings (pseudotumours). The rabbit is usually lethargic and febrile. Prevention is by vaccination and vector control. Vaccination is not
always effective, but if vaccinated animals contract the virus they have less severe clinical signs and often survive with good supportive care. Severe cases should be euthanased.

**Plantar pododermatitis ("sore hocks")** This is a chronic ulcerative granulomatous dermatitis of the metatarsal area seen in overweight inactive rabbits kept on wet bedding or grid floors. Hereditary factors are also thought to be involved and Rex rabbits are particularly affected as they lack the protective guard hairs. Secondary infection with Staph. aureus occurs, which can progress to an osteomyelitis. Treatment involves addressing the initiating cause, plus debridement and cleaning of the lesions, topical and systemic antibiotic therapy and the application of dressings.

**SCHMORL'S DISEASE** *Fusobacterium necrophorum*

**Clinical Signs:** abscesses, skin ulceration/dermatitis - lesions common on face (because of cecotrophy) and on the feet. Lesions are necrotic and foul smelling.

**Diagnosis:** characteristic lesions and culture.

**Treatment and Control:** Clean wounds with a good antiseptic solution (povidone iodine); perform culture and sensitivity for anti microbial therapy (can use enrofloxacin or tetracycline while awaiting results); Excise all abscesses.

**CELLULITIS** *Staphylococcus aureus* and *Pasteurella multocida*

**Clinical Signs:** fever (104 F and higher), edematous swellings that are inflamed and painful and usually found on the head, neck, or chest. These lesions may develop into abscesses.

**Treatment:** Enrofloxacin (Baytril) at 5 mg/kg PO or Sub-Q Bid for 14 days

**UROGENITAL DISEASE**

**Urolithiasis and cystitis**

Rabbits absorb all dietary calcium from the gut and excrete excess via the urine. This predisposes them to cystic, urethral and ureteral and renal calculi. Affected rabbits are generally inactive, overweight and fed a high concentrate diet and/or alfalfa hay, or have been given vitamin/mineral supplementation. A secondary cystitis is often present, and any rabbit with recurrent cystitis should be radiographed. Often a large amount of radiodense "sludge" can be seen in the bladder. Diagnosis is made by radiography.

**Red Urine** Haematuria in rabbits may be rare, but red urine is not. A rabbit's urine varies in colour from the normal pale yellow to dark yellow, carrot orange, brown, or bright red. Red urine is not a medical problem. The colour usually returns to normal within one to three days, although I have had a couple of rabbits take three to four weeks before their urine returned to the pale yellow colour. White urine may be due to excess calcium in the diet. Dark urine
resulting from heat stress or dehydration may require fluid therapy. Red urine (due to excessive urinary pigments) may occur due to any of the following:

- While on antibiotics
- After eating carrots, spinach or other veggies containing beta carotene (porphyrinuria).

However, hematuria can occur due to disease anywhere in the urogenital system. An unspayed female rabbit might show a bloody discharge from her vulva, or drops of blood after urination, which could be confused with urine. Either of these occurrences could be a sign of uterine neoplasia. An unneutered male rabbit could have genital neoplasia or trauma. A simple dipstick test should allow differentiation between haematuria and normal pigmentation.

With haematuria due to kidney disease, straining to urinate may not occur. Straining is the most common sign of urinary bladder disease. A rabbit straining to urinate assumes an unusual stance, that is sitting for an unusually long period of time on the tip toes of the back feet, with the tail very high in the air. If possible, immediately change the litter box so you will be able to determine if is producing urine. May only produce a drop or two of urine at a time because of the frequency with which is attempting to urinate.

In the case of difficult urination, a urinalysis is in order. If haematuria occurs along with straining, disease of the urinary bladder is likely and additional tests may be necessary; for instance radiography, urine culture or blood tests.

**Bladder Stones and "Sludge"** Pet rabbits are commonly affected with urinary stones or more properly "calculi." These calculi present themselves in two common forms as large stones (at times reaching sizes more than an inch in diameter) and as very small sand or crystals (smaller than a grain of sand). The small calculi are typically present in large numbers and are collectively referred to as "calciuria," "sand" or "sludge."

The exact cause of calculi formation is poorly defined. Both urinary tract infection and the contribution of a high calcium diet are strongly suggested. Other contributing factors include any change in the rabbit that makes it difficult to completely empty his bladder. These include neurological problems such as disc disease or back trauma, abdominal adhesions related to the castration or spaying of the rabbit, inguinal hernias and congenital abnormalities of the bladder. Some cases may be related to a behavior of not urinating frequently (such as a rabbit that will not urinate in his cage and thus goes all night without urinating).

Signs of calciuria in the rabbit are poor appetite or anorexia, frequent and sometimes painful, straining urination and, in some cases, the passing of sand-like stones. The rabbit may be reluctant to move have a hard or painful abdomen and "hunched-up" posture caused by a painful, overly distended bladder. A sandy urine precipitate may be found on the fur between the legs, on the tail or seen where the rabbit has urinated.
The diagnosis of calciuria in rabbits is made by combination of urinalysis, abdominal radiographs, stone analysis, urine cultures and blood tests. Urine for urinalysis and bacterial culture is best collected into a sterile syringe using a urinary catheter or by "cystocentesis" where a syringe needle is passed through the abdominal wall into the bladder. Radiographs will tell if the stones are limited to the bladder or if the patient has stones in the kidney(s) or ureter(s) as well. Stones in the kidneys or ureters present a much worse situation.

Stone analysis helps determine the underlying cause of the stone formation. In most cases there is an underlying bladder infection that must be completely corrected to prevent the stones from returning. In other cases, the stones may be related to very high levels of calcium in the rabbit's diet or to other metabolic abnormalities.

The most important aspect of treatment for a rabbit with urinary calculi is to remember that calculi are a symptom of an underlying problem. Stones or sludge calculi must be removed surgically or flushed from the bladder and the rabbit started on appropriate antibiotics. Correction of the underlying problem may also involve changing the diet to remove sources of excess calcium and management changes that facilitate frequent and complete urination. Treatment may also involve supportive care, such as hospitalization for fluid therapy.

Prevention of urinary tract calculi is best accomplished by assuring good urinary tract health through proper hygiene. Equally important is replacing or diluting high-calcium foodstuffs in the diet. This includes alfalfa hay and alfalfa-based pellets.

Rabbits absorb calcium efficiently from their gut in proportion to the calcium concentration in the diet. Therefore, high blood calcium concentrations (3.0-4.0 mmol/l) are commonly found in rabbits on a calcium-rich diet, such as alfalfa.

The primary way for the rabbit to control calcium concentrations is through excretion of calcium into their urine. It is therefore important to assure adequate water intake so that urine is not concentrated. A safe, private location for the rabbit's litter box as well as frequent periods and adequate space for exercise all help to increase the frequency of urination. Urinary acidifiers are of no use as rabbits naturally have alkaline urine.

**Uterine hyperplasia and adenocarcoinoma**

Uterine adenocarcinoma is the most common tumour of intact female rabbits, with incidences of 50-80% in certain breeds over 4 years old. Ageing changes and endometrial hyperplasia often precede adenocarcinoma, as in man. Local invasion and metastases are common. Clinical signs are haematuria or a serosanguinous vaginal discharge, cystic mammary glands and later weight loss, depression and respiratory signs due to pulmonary metastases. The enlarged uterus is palpable. Treatment is ovariohysterectomy, with chest radiography to look for metastases. If present, the prognosis is extremely poor. Routine neutering at 6 months will prevent this disease and should be encouraged as part of a preventive health programme.
DENTAL DISEASE

Dental disease is probably the most common reason for presentation of a rabbit to the veterinary surgeon, although this fact may not be immediately apparent. Anorexia, weight loss, facial abscesses, lack of grooming and caecotrophy and flystrike should all alert the practitioner to the possibility of dental disease, and a full dental examination should be carried out.

All of the teeth grow continuously throughout the rabbit’s life. This is because grass is very abrasive and wears down the teeth during chewing. Also grass has such a poor nutritional value that rabbits must spend a long time grazing each day just to meet their energy needs. In the wild rabbits will spend at least one hour at dusk and again at dawn just grazing. It is only once they have had their fill of grass that they will seek out the choicer pieces of food such as dandelions, fruits and berries and so on. So the cheek teeth are kept in check by wear during chewing, whilst the incisors (front teeth) are worn down by their opposite number.

The commonest reason that rabbits are presented is because of problems with their teeth, and apart from occasional exceptions, this is because they are fed an inappropriate commercial diet. Most of the pre-packaged rabbit foods are too high in energy and are not sufficiently abrasive. This means that the rabbit only need chew for a short while before it has exceeded its actual energy needs, and so the teeth do not get worn down.

Incisor malocclusion can be congenital or acquired. The congenital form is a result of a mandibular prognathism and is most commonly seen in dwarf breeds. Management is by regular burring of the incisor teeth, or by incisor removal (see below). Clipping of the teeth with nail clippers should be avoided if possible. Acquired incisor malocclusion is thought to be due to either nutritional osteodystrophy leading to loosening and distortion of the tooth root, or secondary to premolar and molar malocclusion due to a lack of wear. A combination of these factors is probably often the case. In mild cases trimming and improvement of diet can sometimes restore normal occlusion. In some cases the incisors break off completely and fail to regrow.

Premolar and molar malocclusion is very common, and again is thought to be due to lack of wear, or nutritional osteodystrophy, or a combination of both. The first thing that happens is that the cheek teeth (the molars and premolars) start to overgrow until the upper and lower rows are forced together. Nothing can be seen from the outside at this stage, although the rabbit may begin to lose weight. Further growth occurs forcing the mouth open slightly so that an incisor malocclusion develops and they start to overgrow and lengthen. The upper incisors curl back into the mouth and the lower incisors will often grow straight out. This is usually the stage when a problem is noticed but as you can see there are often severe changes by this time. The crowns overgrow and tip and sharp spurs are produced which impinge on the soft tissues, causing pain and secondary infection. These spurs usually occur on the lateral aspect of the upper teeth and the medial aspect of the lower teeth. The lower teeth tip inwards and can grow across the mouth, trapping the tongue. If the rabbit remains untreated, further problems
occur because the cheek teeth, now permanently forced against their opposite number, continue to grow by a lengthening of the roots. Such rabbits will develop a lumpy jaw as the mandibular bone tries to remodel around these roots, but in severe cases the roots may erode their way out through the bone and can also impinge on the orbit and nasolacrimal duct. This is very painful for the rabbit and often the mandibular roots become infected and a large abscess will form. Secondary tooth root infection and osteomyelitis is a common finding in advanced disease, and carries a grave prognosis.

In some individuals the incisor roots will overgrow. This causes two problems with the upper incisors. The first is that the roots will curve and may come down through the hard palate - a very painful condition. The second is a dacryocystitis (see below).

Dental caries can also result in uneven wear. Assessment of the cheek teeth requires a detailed examination under deep sedation or anaesthesia, and skull radiography. Spurs should be burred or filed away, and in severe cases coronal reduction down to gum level by burring is the most effective treatment. Very loose teeth can often be removed orally. Correction of the diet to increase fibre content (grass and hay) and, if necessary, improve calcium levels is absolutely essential. Supplementation with vitamin/mineral supplements is generally not recommended as excess calcium will predispose to urolithiasis. Calcium homeostasis is still poorly understood – it may well be that parathormone is more concerned with preventing excessively high serum calcium levels than increasing them per se.

As mentioned above most of these problems are due to incorrect diet.

I strongly recommend a diet of grass and hay plus leafy greens such as dandelion leaves. These are foods high in fibre and natural abrasive compounds. Rabbit food can be given IN SMALL QUANTITIES as a source of vitamins (although the rabbits own large bowel bacteria supply it with most of its needs) but one must make sure that the rabbit eats every last piece of food. Wait until it has eaten it all before refilling the bowl, and resist the temptation to throw away the parts that the rabbit does not appear to like. This is because some commercial rabbit foods are made in such a way that the calcium routinely added to the diet is present in the pelleted parts only and these are often rejected by the rabbit. As a result, although the rabbit is given a balanced diet, what it eats is a diet very poor in calcium!

**MUSCULOSKELETAL AND NERVOUS SYSTEM DISEASE**

**Osteoporosis**

Common in inactive caged rabbits and those on a low calcium diet (see above under husbandry). Can lead to pathological fractures of the spine and limbs, especially if the rabbit is improperly handled.
**Muscular dystrophy**

Hypovitaminosis E will cause degeneration of muscle fibres (white muscle disease). Affected animals have raised CPK and cholesterol levels. This is rare in pet rabbits but can be caused by prolonged and improper storage of feed.

**Fractures**

Fractures in rabbits are usually traumatic and/or secondary to osteoporosis. Spinal fractures or luxations due to kicking out or twisting are usually at L6/L7. Diagnosis is by radiography, and a full neurological examination should be carried out. As in other species, the loss of deep pain and sphincter control carries a grave prognosis. Mildly affected animals can respond to medical therapy and cage rest.

**Hindlimb paralysis/paresis** - Damage to a rabbit's back by any kind of trauma can lead to partial or complete paralysis of the hind limbs (see above).

**Cause:** The most common cause of back trauma is when a rabbit is being restrained and it kicks out suddenly or twists. Even when the best restraint is used, it is still possible for this situation to occur. The force of the kicking or twisting can literally fracture vertebrae (spinal bones) in the back traditionally L7/sacrum. The fractured vertebrae are then unstable resulting in severe bruising or severing of the spinal cord. Rabbits can also sustain this kind of trauma (although rarely) when running or playing. Consider possible osteoporosis from long years of inadequate exercise in a hutch - an atrophy of disuse!

**Signs:** Complete or partial paralysis is immediately evident after the injury. There may be a loss of bladder and bowel control.

**Diagnosis:** This condition is diagnosed by demonstrating the damaged vertebrae on radiography. Occasionally the vertebrae will subluxate during the injury, cause damage to the spinal cord and then go back into place by the time the x-ray is taken. These cases can be difficult to diagnose unless high detail x-ray film is used or a myelogram is done.

**Treatment:** With severe cases, consider euthanasia. Cases that have only mild to moderate damage to the spinal cord or that still experience some feeling in the toes and maintain bladder or bowel control have a chance of recovery. These rabbits should be confined to a cage for a period of 6 to 8 weeks to facilitate healing of the fractured bones. It may be necessary to use anti-inflammatory drugs such as corticosteroids for the first few days after the injury. Many of these rabbits will regain at least partial if not total neurological function and live a good quality of life.

**Spondylosis of the lumbar spine** is a fairly common disease of rabbits over 4 years of age, particularly females of medium to large breeds.
**Cause:** The vertebrae in the lumbar or back area gradually develop little bony protrusions that can eventually bridge to the adjacent vertebrae resulting in the fusion of the two. No one knows the exact reason this happens, but it is likely an aging process. It can be aggravated if a rabbit is carrying excess body weight (obese). This is not life threatening and can progress for years.

**Signs:** The fusing of the vertebrae decreases the flexibility of the spine and prevents the rabbit from being able to jump and run as easily. Before these bony "spurs" fuse completely, they can rub on each other and cause some pain. The pain may come and go dependent on things such as the weather and how much exercise the rabbit got the day before. Rabbits affected with this disease "shuffle" rather than hop and on some days can become very reluctant to move at all. As the disease progresses, it may be difficult for the rabbit to get in and out of the litter box and he may soil himself.

**Diagnosis:** The diagnosis is based on finding the bony changes on radiography.

**Treatment:** Consider NSAIDs such as carprofen, or alternatively corticosteroids. Many also feel it is helpful to regularly massage or apply heat to the back. Gentle massage over the muscle areas of the back only (NEVER directly over the bone) can warm the area and help decrease muscle tightness. If a rabbit enjoys massage, or the application of warmth, then by all means use it. In addition, if the rabbit is obese, it is necessary to reduce the workload on the back by reducing the weight. As the disease progresses, it will be necessary to keep the hind quarters clean from urine and stool and to provide soft, absorbent bedding to prevent "bed sores" and pododermatitis (foot pad infections). Rabbits with any disease that causes weakness of the hind limbs will not be able to keep their ears clean by scratching. Check the ear canals at least once weekly for excess wax accumulation.

**Splayleg**

This is an inherited disease (simple autosomal recessive) seen in young rabbits where one or more limbs cannot be adducted. There is no treatment.

**Fits/epilepsy**

Idiopathic epilepsy occurs in some breeds of blue-eyed white rabbits. Pasteurella encephalitis can also cause fitting.

**Torticollis**

Extension of a purulent otitis media into the inner ear is the most common cause of torticollis or head tilt. This is invariably due to Pasteurella multocida infection spreading up the eustacian tube from the nasopharynx. Occasionally otitis media and interna can be a result of an initial otitis externa (secondary to an ear mite infection). The tympanic bullae will be full of thick pus, which will show as a soft tissue density on radiography. Otoscopic examination often reveals a
ruptured eardrum and pus. Associated signs include nystagmus, ataxia and rolling. Treatment is difficult, but if caught early, antibiotic therapy can be beneficial, or at least halt progression of signs. Bulla osteotomy is possible in rabbits, via a lateral approach, but success is variable and post-operative complications frequent.

The major differentials for torticollis in rabbits are:

1. Encephalitozoonosis (see below)
2. Trauma
3. Cerebrovascular disease. Mineralisation of meningeal blood vessels can occur.
4. Neoplasia
5. Toxicities

Encephalitozoonosis

Encephalitozoon cuniculi (Nosema cuniculi) is an intracellular microsporidian parasite that targets the nervous and urinary system. It is spread by ingestion of spores shed in the urine, and is very common, especially in dwarf breeds. Up to 80% of rabbits seropositive for E. cuniculi! Most infections are asymptomatic, but it can cause a focal non-suppurative granulomatous meningoencephalitis. An ELISA test is available to detect antibodies, but is of little use as many animals will be positive. Signs are very variable depending on the area of the brain or spinal cord affected. Clinical presentation can include any combination of the following: unilateral or bilateral facial paralysis, weakness or paralysis in one or more limbs, head tilt, circling, rolling, nystagmus, loss of appetite, behavior changes, depression, seizures and sudden death. As a guide, neurological signs (head tilt, posterior paresis), the absence of tympanic bulla involvement on radiography and a positive titer are highly suggestive of a diagnosis of encephalitozoonosis. There is no effective treatment although albendazole is reportedly of use in an outbreak. Corticosteroids are sometimes used to minimize nerve damage but are possibly immunosuppressive? . Undertake supportive care.

Prognosis: Very guarded.

SYSTEMIC DISEASES

HEAT STROKE Rabbits are very sensitive to the heat and when overheated for prolonged periods of time may develop respiratory difficulty as well as a mild oronasal blood tinged discharge. Cool baths and steroids should be used to stabilize the animal. Alcohol rubdowns and dexamethasone IV help to rapidly reduce body temperature. Cool enemas and antimicrobial therapy may be required if condition is severe

Pregnancy toxaemia/ketosis

As in other species, obese pregnant animals are usually affected, but obese males and non-pregnant females can also succumb. Two forms occur - a toxic form in pregnant animals where
foetal displacement causes impaired uterine blood supply followed by ischaemia, foetal death and DIC, and a true metabolic form initiated by a stressor such as transport or fasting. If rabbit becomes inappetant then fat stores mobilised with resultant ketone build up. Clinical signs are depression anorexia, abortion, salivation, convulsions, coma and death. Diagnosis - sometimes can detect ketones in urine, otherwise blood test. On PM individual is obese plus fatty liver (pale and yellow), as are kidneys. Stomach empty.

Treat with fluid therapy plus glucose. Can try propylene glycol and corticosteroids. Post mortem shows hepatic lipidosis. Treatment involves administration of glucose or dextrose-containing fluids or propylene glycol, and corticosteroids. Prevention is by avoiding obesity and minimising stress.

**VIRAL HEMMORRHAGIC DISEASE**

This disease was discovered in China in 1984, then spread to Europe. It arrived in the UK in 1992 in southern England, and has since spread to Scotland and Northern Ireland. It is caused by a calicivirus, and affects rabbits greater than 2 months old. Transmission is by aerosol, birds and fomites. Incubation is 1-2 days, and disease is usually hyperacute, with rabbits usually found dead with blood stained fluid at the nose and mouth. In the acute form rabbits are febrile, depressed, anorexic, and then show respiratory signs, convulsions, epistaxis and death. Mortality is usually 100%. At PM a necrotising hepatitis is seen, and haemorrhages in all organs, especially lungs. Control is by vaccination, commencing at 8-12 weeks old with annual boosters. The virus is killed by 0.5% sodium hypochlorite. The virus is no longer notifiable.

**SHOPE FIBROMA VIRUS:** Leporipoxivirus (Poxviridae)

**Clinical Signs:** Subcutaneous benign tumors that are not attached to the underlying tissue. The tumors generally occur on the legs, feet, muzzle, and around the eyes. Tumors may persist for several months before regression.

**SHOPE PAPILLOMA VIRUS:** Papilloma virus (Papovaviridae)

**Transmission:** The mosquito is believed to be a vector.

**Clinical Signs:** Warts on the eyelids and ears that are easily scraped off.

**Diagnosis:** Histopathological examination of specimen.

**ORAL PAPILLOMA VIRUS:** Papillomavirus

**Clinical Signs:** Wart-like growths found on the underside of the tongue, usually white in appearance. Believed to occur in immunosuppressed rabbits.

**Treatment:** None needed- lesions regress as immune system rebounds
Neoplasia

UTERINE ADENOCARCINOMA Perhaps the most common neoplasm of rabbits. The patient presents with a history of reproductive problems including dystocia, ectopic pregnancy, stillbirths, and early abortions. Sometimes the only problem may be persistent small litters. Treatment is to perform an OVH, but usually by the time of clinical detection this highly malignant tumor has already metastasized (with a predilection for lung and colonic tissue). Obviously, prevention by sterilization is preferred, and it also helps to alleviate the current problem of overpopulation of the domestic rabbit.

LYMPHOSARCOMA This neoplasm is usually only seen in young rabbits. There is believed to be a genetic predisposition described as homozygosity for an autosomal recessive non sex-linked gene. This tumor is usually found on the liver, kidneys, and spleen. Generalized lymphadenopathy is also observed. Prognosis is poor and treatment is usually futile.

SQUAMOUS CELL CARCINOMA The rabbit is usually infected with the Shope papilloma virus. A simple papilloma forms, and if not removed by about six months after it has surfaced, will develop into a squamos cell carcinoma which can metastasize to any organ via the hematogenous route. Prognosis is better for early detection and removal.

ANAESTHESIA AND ANALGESIA

Rabbits have an unnecessary reputation for being difficult to anaesthetise. With the correct techniques, there is no reason why rabbits should not be safely and successfully anaesthetised. The main problems are their high susceptibility to stress and underlying respiratory disease.

Pre-operative care

It is not necessary to fast rabbits before anaesthesia, as they are unable to vomit. However, they can safely be fasted for 2-4 hours to reduce gut fill. Anaesthetic candidates are often dehydrated and hypoglycaemic (eg if anorexic for any reason) and this must be corrected first. Fluids can be given orally, subcutaneously or intravenously. Rabbits with overt respiratory disease are a high risk, and ideally this should be treated before anaesthesia is attempted. Remember that many pet rabbits have inapparent lung disease and damage due to Pasteurella infection.

Anaesthesia

Premedication is essential in rabbits as they are easily stressed. A high percentage have serum atropinesterase, so glycopyrrolate at 0.01mg/kg sc can be used as an anticholinergic. Suitable premedicants are fentanyl/fluanisone (the author's drug of
choice), medetomidine, xylazine, acepromazine, diazepam or midazolam. Face mask induction without prior use of premedication should be avoided at all costs. Rabbits breath hold when exposed to all volatile agents, even at low concentrations, for periods up to 2 minutes. Stress releases catecholamines, and halothane sensitises the myocardium to these, so it is a lethal combination. Fentanyl/fluanisone or another premed., followed by mask induction results in a smooth onset of anaesthesia. Alternatively and injectable combination can be used. The author (AM) prefers fentanyl/fluanisone plus midazolam, which gives 30-40 minutes surgical anaesthesia. Partial reversal with retention of analgesia can be achieved with buprenorphine or butorphanol. Alternatively medetomidine (200 mcg/kg) plus ketamine (20mg/kg) and butorphanol (0.1-0.3mg/kg) is preferred by LJ. The addition of butorphanol prolongs anaesthetic time from about 30 minutes to about 80 minutes. This combination can be partially reversed with atipamezole at 1mg/kg. When using an injectable regime it is prudent to administer oxygen concurrently by face mask. Rabbits are easily intubated by either a direct or blind technique, and this is always preferable to the use of a mask. An Ayres T-piece circuit or Bain circuit should be used.

The use of doxopram hydrochloride as a premed is controversial. Certainly it improves respiratory rate and depth but it will significantly increase the rabbit’s oxygen requirement.

**Intra-operative care**

Depth of anaesthesia should be monitored by use of the ear-pinch. Standard monitoring equipment - ECG, pulse oximeter - should be used wherever possible. Eye position is not useful in the rabbit, and the palpebral reflex is not lost until the animal is dangerously deep.

**Post-operative care**

This is as for any other species. Rabbits should be kept warm but not over hot. Continued fluid therapy may be necessary, and the rabbit should be monitored closely until it is eating again. Force feeding may be required. After intra-abdominal surgery, gut stasis can be a problem and the use of metaclopramide and/or cisapride is indicated.

**Analgesia**

Alleviation of post-operative pain is essential, and very important in getting the animal eating and drinking again (eg after incisor extraction). Buprenorphine or butorphanol are useful opioid agents, and they will reverse the respiratory and cardiovascular depressant effects of fentanyl while maintaining analgesia. Buprenorphine lasts longer (8-12 hours) The NSAID carprofen is also highly effective.
COMMON SURGICAL PROCEDURES

REASONS FOR NEUTERING RABBITS

1. Prevention of Pregnancy

2. Prevention of Uterine Adenocarcinoma - This is the most compelling medical reason to spay female rabbits. In some rabbit populations the rate of uterine adenocarcinoma can approach 80% of all the females. Uterine adenocarcinoma can spread rapidly to other organs of the body such as the liver, lungs and even the skin and it is not treatable once it reaches this point. Rabbits under two years of age rarely develop this disease so it is best to get your little one spayed before this age.

3. Prevention of Other Uterine Disease - Although cancer is the most common disease of the rabbit uterus we see many cases a year of other uterine disease such as pyometra, uterine aneurism and endometritis. Like uterine adenocarcinoma, these conditions are all more common in female rabbits over two years of age.

4. Prevention of False Pregnancies - Can be very stressful for the rabbit who goes through all the motions of being pregnant including nest building, milk production and aggressive protection of its territory. This aggression can be taken out on the caretakers and cagemates and can make the pet very difficult to handle during this period. Some rabbits experiencing false pregnancy will develop a decreased appetite and have gastrointestinal disturbances as well.

5. Prevention of Mammary Gland Disease - Mammary neoplasia is not common in female rabbits, but when it occurs it can spread rapidly and be very difficult to treat. It is preventable if the pet is neutered before two years of age. It is interesting to note that the most common type of mammary cancer is mammary carcinoma and it is almost always associated with uterine cancer. The other common mammary gland disease is mammary dysplasia or cystic mammary glands. This is a benign condition, where the mammary glands fill with a cystic material. It can be uncomfortable to the pet. Neutering a female rabbit before two years of age will prevent both of these diseases.

6. Prevention of Aggressive Behavior - Both male and female rabbits can display aggressive behavior when they reach sexual maturity. They don't want to be touched or picked up and they act like they want to destroy everything in sight. However, they can often take out their aggression on the owner or their cagemates. There may be more biting, striking, lunging and chasing. It is best to neuter just before or shortly after sexual maturity to keep this behavior to a minimum.

7. Prevention of Urine Spraying - Both male and female rabbits can spray urine on vertical surfaces to mark their territory. Intact mature males do this at least 10 times more frequently than females. In addition, sexually mature male rabbit urine can develop a very strong odour
that is unpleasant to many humans. If this behavior is allowed to continue for months or certainly years, it may be impossible to retrain the pet, if it is neutered at a later date, to learn to use the litter box again. Therefore, it is best to "nip it in the bud" and have them castrated just prior to shortly after sexual maturity.

8. Prevention of Testicular Disease - Disease of the testicle is rare in the male rabbit, but it can occur. Most commonly we see abscesses (often from bite wounds from other rabbits), hematomas and neoplasia.

**AGE TO NEUTER**

The best age to neuter is shortly after sexual maturity. Depending on the breed, this could range from 4 to 6 months and with giant breeds up to possibly 9 months.

**Rabbit Castration**

The anaesthetised rabbit is placed in dorsal recumbancy. The scrotal skin is very susceptible to trauma and is readily damaged by clippers. If in doubt, pluck the scrotal hairs away. Rabbits have a wide inguinal canal and it is not unusual for one testicle to be drawn up into the inguinal canal. Gentle massage should restore it back to the scrotum. Following routine preparation, castration can be performed by either an open technique or closed technique.

**Open Castration.**

The tunica albuginea is incised and the testicle gently "popped" out. The testes are very friable and are readily damaged, particularly if accidentally incised.

The epididymal-gubernacular junction is separated, either by ligation or digital pressure. The spermatic cord and vessels are clamped, and each is ligated individually, and then resected. One of the most serious complications post-operatively is that of herniation. To avoid this the tunica must be sutured (Vicryl). Preservation of the epididymal fat pad may also help to reduce the risk of herniation.

**Closed Castration.**

The tunica is not incised in this method. Instead the testicle is twisted and the section of tunica containing the spermatic cord, vessels and epididymis is ligated with either circumferential or transfixing sutures. The testicle is then removed routinely.

Skin closure is best achieved by a subcuticular pattern, whereby the rabbit is unable to remove the sutures post-operatively.
**Rabbit Vasectomy.**

In some cases, vasectomy may be the preferred option. This can be performed via a scrotal or pre-scrotal incision. As an alternative, the vasa deferentia can be accessed via a caudal midline ventral incision. The vasa are located around the bladder neck, but are often obscured by a fat pad close to the bladder. The vas deferens is double ligated before transection. The laparotomy incision is closed routinely.

**Rabbit Ovaro-hysterectomy.**

The surgical approach is by a ventral midline incision from the umbilicus to the pubis. The uterus is located and exteriorised allowing access to the ovaries. Most rabbits have a degree of periovarian fat which aids in manipulation of the ovaries. Ovarian remnants will reimplant and become functional. The ovarian ligament with ovarian vessels is ligated and transected on each side. In older rabbits there is often a considerable amount of fat associated with the broad ligament and the ovaries. If large, the vessels in the broad ligament may need to be individually ligated.

In most rabbits a single circumferential ligature at or immediately caudal to the cervixes (rabbits have a double cervix) is all that is required.

In large individuals, or pregnant females, then each uterine vessel should be ligated individually, plus a transfixing ligature placed at the cervix, before resection of the uterus. Closure is routine.

Experimentally ovariectomy is sometimes required. This can be achieved by a standard ventral midline incision as above, but as an alternative the ovaries may be approached through paired dorsal incisions. The rabbit is placed in sternal recumbancy and a midline dorsal incision is made at the level of the lumbar vertebrae. Each ovary is then accessed by displacement of the incision laterally followed by blunt dissection of the muscle layers lateral to the vertebral wings. The ovaries lie immediately behind the kidneys (which are readily palpable) in the same surgical plane. The ovarian ligaments are ligated as above, plus the proximal Fallopian tube is ligated and transected. The procedure is repeated for each side. Closure of the skin is routine.

**Incisor removal**

Incisor removal is indicated in cases of congenital mandibular prognathism, and in acquired cases of incisor malocclusion where there is not also severe premolar and molar disease. It offers a permanent solution to incisor overgrowth and repeated trimming. Under general anaesthesia the periodontal membrane is broken down using a blunted hypodermic needle, or a specialist elevator, until the tooth is completely loose. It is then grasped and gently extracted, following the line of curvature of the tooth - minimal traction should be applied. If the sockets bleed excessively they can be packed with haemostatic material. With good post-operative
analgesia, the rabbit should be eating within a few hours. Food is prehended easily with the lips, and rabbits cope extremely well after this procedure.

**Abscesses**

This is a common problem that afflicts the pet rabbit. In rabbits, abscesses can be caused by a wide variety of bacteria including *Pasteurella multocida*, *Streptococcus spp*, *Pseudomonas spp* and *Staphylococcus spp*. One should not assume that *Pasteurella* causes all infections in rabbits. Rabbits can form abscesses in nearly any organ of the body and in skin and bone. The most common causes of rabbit abscesses are bite wounds that become infected, tooth root infections and tear duct infections. Tooth root and tear duct infections lead to abscesses on the face and head. Rabbits do not form liquid pus that drains easily when the abscess is lanced. Rabbit pus is very thick, about the consistency of toothpaste, because there is an enzyme missing that can break the necrotic debris into a more liquid form. The consistency of the pus makes it difficult to clean it thoroughly from a wound. In addition, it is not uncommon for a rabbit abscess to develop finger-like projections over time. These can spill into surrounding tissue extending the infection. It is exceedingly difficult to keep these infected "tracks" clean. There are many thoughts on how best to handle rabbit abscesses and much depends on the location of the infection, the cause of the infection and the general condition of the pet. It is vital to maintain your rabbit on a healthy diet high in fibre and low in starches and fats, allow daily exercise and a clean environment to reduce stress-related immunosuppression. It may be necessary to perform diagnostic tests to investigate the cause of the abscess, such as radiographs of the head, chest or abdomen, and blood tests to determine underlying causes. No matter what treatment is selected, rabbit abscesses have a higher probability of coming back than abscesses in cats, dogs or humans. This is due to such things as the thick, tenacious nature of the pus, the propensity for abscesses to invade surrounding, and because the cause of the abscess (such as a tooth root infection) may not be addressed.

It is not always possible to surgically remove an abscess due to its location, other disease in the pet (making anaesthesia or lengthy surgery dangerous) or restraints on the finances of the owner. In these cases the abscess can be opened, cleaned out thoroughly and flushed with an antiseptic solution. Usually, this procedure is carried out under anaesthesia, unless the abscess is very small. The wall of the abscess can be cultured, as described previously. These wounds must be left open to be flushed at least twice a day for several weeks. If the abscess closes too quickly, it will merely fill up with pus again. Other accepted methods of dealing with lanced abscesses include packing caustic material into the cleaned cavity to kill the bacteria, and injecting the wall of the abscess with antibiotics on a weekly basis.

Complete surgical removal of abscesses is the treatment of choice wherever possible. The thick capsule must be removed in its entirety. If unable to remove completely, aggressive surgical debridement should be attempted. The use of calcium hydroxide and antibiotic-impregnated methyl methacrylate has been reported to be of use in the treatment of bony abscesses and osteomyelitis. Injection of gentamicin into the capsule wall has also been reported to be
effective. If the abscess was only lanced and drained, then antibiotic therapy might continue for weeks to month

**General points**

Suture material provokes a marked caseous and suppurative inflammatory response in rabbits. Modern monofilament absorbable suture materials are preferable to catgut for this reason. Subcuticular sutures for skin closure are recommended, as skin sutures are invariably chewed and Elizabethan collars poorly tolerated. Alternatively, tissue glue or skin staples can be used.

Rabbits are very prone to the formation of intra-abdominal adhesions, and great care must be taken not to damage or irritate abdominal organs. Verapamil (calcium channel blocker) is reported to be of use in the prevention of adhesion formation (200 micrograms/kg po or slow iv at surgery and then every 8 hours for up to nine doses)

### RABBIT FORMULARY

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cephalexin</td>
<td>11-22mg/kg (may cause enteritis)</td>
</tr>
<tr>
<td>Enrofloxacin</td>
<td>5-10mg/kg bid</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>2.5mg/kg bid</td>
</tr>
<tr>
<td>Penicillin</td>
<td>40,000 IU/kg q7days for rabbit syphilis</td>
</tr>
<tr>
<td>Trimethoprim/sulphadiazine</td>
<td>30mg/kg bid</td>
</tr>
<tr>
<td>Sulphadimethoxine</td>
<td>15mg/kg po q12h for 10 days(coccidiosis)</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>0.2-0.4mg/kg q7-14days</td>
</tr>
<tr>
<td>Fenbendazole</td>
<td>5-10mg/kg po q2wks</td>
</tr>
<tr>
<td>Glycopyrrolate</td>
<td>0.01-0.02mg/kg sc</td>
</tr>
<tr>
<td>Barium</td>
<td>10-14ml/kg po - GI studies</td>
</tr>
<tr>
<td>Cisapride</td>
<td>0.5mg/kg bid</td>
</tr>
<tr>
<td>Metaclopramide</td>
<td>0.2-0.5mg/kg bid</td>
</tr>
<tr>
<td>Drug</td>
<td>Dosage</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Loperamide</td>
<td>0.1mg/kg po q8hrs</td>
</tr>
<tr>
<td>Oxytocin</td>
<td>0.1-3.0 IU/kg</td>
</tr>
<tr>
<td>Fentanyl/fluanisone</td>
<td>0.2-0.5ml/kg</td>
</tr>
<tr>
<td>Medetomidine</td>
<td>0.25-0.5mg/kg</td>
</tr>
<tr>
<td>Midazolam/diazepam</td>
<td>0.5-2.0mg/kg</td>
</tr>
<tr>
<td>Buprenorphine</td>
<td>0.05-0.1mg/kg tid</td>
</tr>
<tr>
<td>Butorphanol</td>
<td>0.1-0.5mg/kg q4hrs</td>
</tr>
<tr>
<td>Ketamine</td>
<td>25-50mg/kg</td>
</tr>
<tr>
<td>Carprofen</td>
<td>4-5mg/kg sd</td>
</tr>
</tbody>
</table>

**FURTHER READING**
