

Treating Pet Fish: A practical approach

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TREATING PET FISH: A PRACTICAL APPROACH

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Welcome to this brief presentation on treating pet fish. This is not an exhaustive review, but a practical approach to the subject based on my years of experience. Being faced with your first fish case can be rather daunting, and deciding how to treat the patient can be quite a challenge. Treating fish involves a bit more than dumping a load of chemicals into a tank or pond and hoping for the best. It requires a methodical approach, and here I will try to simplify a complicated subject. I hope that by the end of this presentation, you will have a clear understanding of the treatment options so you can confidently manage these interesting cases.



Fish live in a complex environment that changes over time and requires constant maintenance with a biological life support system or biofilter. The quality of the water has a significant impact on their health, and sub-optimal conditions are a frequent cause of poor health and disease. This often results in secondary disease and mortality caused by various pathogens that are ubiquitous in aquatic environments. It is therefore important that owners regularly test the water quality and maintain good husbandry to prevent health problems arising in the first place. From the smallest fish tanks to the largest ponds like this, some type of biofilter is required, and because of the wide variety of these, understanding the owner's system will help you to develop a practical plan of action.

Routine investigations

- **Water quality tests**

- ammonia
- nitrite
- nitrate
- pH
- salinity etc

- **Skin & gill scrapes**

- if excess slime or lesions
- wet prep examination
- no stain (kills live organisms)
- low power mag x40-100
- mainly for ectoparasites

- **Necropsy**

- examine within 1hr of death
- photograph everything
- samples for histopath into 10% neutral buffered saline

- **Histopathology**

- send to fish pathologist / lab for best interpretation

- **Diagnostic imaging**



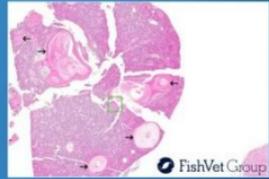
Water quality test kits



Wet prep microscopy



Post-mortem examination



Histopathology

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Where possible, it is important to identify the underlying cause of the health problem so the appropriate treatment can be given. Water quality testing requires measuring the level of ammonia, a nitrogenous waste produced by the fish, and its subsequent breakdown products, nitrite and nitrate. This can be performed using simple colourimetry test kits or small digital meters that are readily available online or at fish pet shops. Skin and gill scrapes taken from sedated live fish and examined as a simple wet mount by microscopy are standard procedures used to assess ectoparasite burdens. Post-mortem examination of fish that have, ideally, been dead for no more than an hour will provide useful diagnostic information and samples for histological assessment. Alternatively, severely affected fish should be sacrificed for histopath investigations. It is not uncommon for there to be several factors involved in fish disease. For example, poor water quality may precipitate an increase in ectoparasites, which result in concurrent bacterial and fungal infections. All pathogens will need to be treated, and the water quality improved.

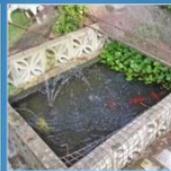
Environmental improvement

- **Maintain stable water conditions**

- perform regular water changes
 - aquaria = 20% per week
 - ponds = 30% once or twice/year
- max. 50% water change/day
- ensure adequate aeration
- control algae (causes pH & O₂ changes)
- avoid temperature fluctuations
- avoid harmful contaminants
- ensure objects etc are 'fish-safe'



Ensure good aeration



Control algal growth

- **Maintain good biological filtration**

- regular water quality testing
- ensure filtration is fit for purpose
- clean out detritus regularly
- avoid overfeeding (→ excess wastes)



Regularly remove organic detritus from the filter system

- **Remove stressors**

- avoid high stocking levels
- avoid unnecessary handling/ netting
- use netting over ponds to deter herons
- remove aggressive fish

- **Avoid 'prophylactic' medicines**

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Regardless of any pathogens that are found, improving the water conditions is essential and may even avoid the need for any chemical or drug use. Poor water quality is a major factor underlying many fish diseases, and unless this is improved, infectious diseases may be difficult to eradicate. Water quality can deteriorate for many reasons and is rarely visible to the naked eye. Testing is essential during any health problem, and ideally on a regular basis to prevent disease. Improvement requires significant water changes and removal of harmful contaminants. Ensuring the filter system is clean and functional is essential to maintain effective biological filtration and removal of fish waste. Without improvement of the environment, effective treatment may be limited and the disease prolonged. Stress is also a major contributor to health problems, so it is important to avoid overstocking facilities and netting or handling the fish unnecessarily. Equally, avoid using medications unless there is a specific need, since some chemicals may adversely affect the fish or cause further stress.

Emergency first aid advice

- **Test water quality (WQ)**
 - particularly ammonia & nitrite
 - stop feeding to reduce nitrogenous waste
 - ensure WQ is acceptable for the species
- **Change one-third of the water**
 - will reduce the impact of poor WQ
 - drain down → refill (not trickle in-out)
 - preferably at same water temperature
- **Add salt at 2g/litre (freshwater fish)**
 - reduces physiological/osmotic stress
 - reduces effect of high ammonia/nitrite
 - helps wound healing = mild antibacterial
- **Increase aeration**
 - use air stones, fountains or a venturi
 - helps fish with gill damage/disease
 - avoids hypoxia caused by some meds
 - remove excessive aquatic plants
- **Avoid indiscriminate use of medicines**
 - minimises oxygen depletion by some
 - minimises toxicity at high pH/temp
- **Move fish to new tank if poor response**



Change 1/3 & repeat every 3days



Add salt @ 2g/litre (=2ppt)



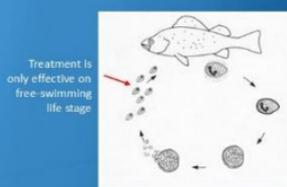
Increase aeration using air stones or fountain

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In some cases, there may be a rapid onset of disease, often with sudden mortality. It is important to minimise the problem as quickly as possible, before fish are transported to the clinic for examination. Water quality must be tested, and feeding reduced or stopped to prevent further waste excretion. Changing a third of the water refreshes poor water conditions and is best done by draining down and then refilling, rather than allowing water to trickle in and then out through the overflow. This can be repeated every 2-3days depending on the severity of the situation. In freshwater systems, add 2grams of salt per litre to reduce the toxic effects of high ammonia and nitrite levels. Increasing aeration with air stones or fountains helps oxygenate the water and improve circulation. Avoid adding any medication until a provisional diagnosis is made following examination of affected fish, since some chemicals may aggravate the problem. This simple advice is useful in most scenarios and will often slow down the progression of disease.

Specific medication – practical considerations

- **The pathogen**
 - in-contact fish should be treated if the pathogen is infectious
 - organism resistance to treatment (eg mycobacteria)
 - in vitro bacterial drug resistance to antibiotics may not reflect in vivo response
 - parasite life cycle with resistant stages (eg Ichthyophthirius/‘white spot’)
- **The patient**
 - small body size may preclude safe injections and require immersion medication
 - severe illness may preclude stressful handling and injection
 - most cases will need sedation for examination, weighing and treatment
 - anorexia and unpalatable drugs will limit use of in-feed medication
- **The environment**
 - biological filtration systems may be adversely affected by some medications
 - discharge consents may be required if large quantities of drugs are disposed
 - large ponds may need to be partially drained to catch fish for injection
 - even distribution of medication can be challenging in large ponds and lakes
 - large amounts of organic matter inactivates some immersion medications
 - non-target organisms in natural waters (eg copepods) impacted by some drugs may reduce the availability of food items for rearing fish fry



Ichthyophthirius life cycle



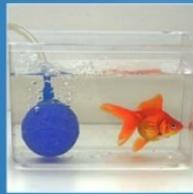
Environmental impact needs consideration

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Despite improving the water conditions, it is often necessary to use therapeutic agents to improve the health of sick fish. However, various practical aspects should be considered, such as features of the pathogen, the patient and the environment. Infectious pathogens require all in-contact fish and the environment to be treated, and this may include an understanding of ectoparasite life cycles. For example, only some stages may be susceptible to treatment, such as with ‘white spot’. Small fish can be more challenging to treat than larger ones, and in most cases, fish need to be sedated for a detailed examination with routine skin and gill scrapes taken. Indoor fish tanks are relatively simple to manage, whereas large outdoor ponds are also heavily influenced by weather conditions and other environmental factors. The use of some chemicals and trying to achieve therapeutic levels may be problematic, and safe disposal of medicated water needs consideration.

Routes of administration

- Aim to treat the fish, not the water
- Use the least stressful method
 - assess the risk-to-benefit ratio
 - must achieve effective therapeutic levels
- Methods of administration include:
 - immersion
 - short, timed dip
 - prolonged, permanent bath
 - in-feed
 - pre-medicated feed
 - surface-coated
 - gelatin-treated
 - ice cube method
 - bio-encapsulation
 - gavage
 - injection
 - intramuscular
 - intracoelomic / intraperitoneal
 - intravenous
 - topical application



immersion



in-feed



injection



topical

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Having improved the environment where possible and identified the cause of the disease, it is then a matter of selecting an appropriate treatment. The aim is to treat the fish using the most effective but least stressful method. There are several successful routes of administration, but each has its own advantages and disadvantages, which all need to be considered in each case.

Immersion Short, timed 'dip'

- Requires treating in a separate container
- Use water from the tank/pond of origin
- Requires accurate measuring of the drug
- Dip duration from established protocols
- Use for infectious diseases & anaesthesia
- Benefits include:
 - less drug required (smaller volume of water)
 - no impact on tank/pond biological filter
 - easy to remove fish if showing adverse reaction
- BUT is more stressful due to:
 - netting and transfer of the patient
 - water chemistry changes
 - eg Tricaine lowers pH → requires buffering
 - higher drug concentration
 - small confined environment
 - requires aeration (eg use air-stones)



A measured quantity of drug in a measured amount of water for a measured length of time



Treatment tank with filter, air-stone and water heater

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Short-term immersion of fish in a medicated solution is commonly called a 'dip'. Treatment is carried out in a separate container in a controlled manner that avoids potential harm to the biofilter or other unaffected fish. It requires using a measured quantity of drug in a measured amount of water for a measured length of time. Using water from the tank or pond of origin reduces stress caused by water chemistry changes, although some drugs may also have an impact on the water chemistry. Various established protocols are found in the literature and the BSAVA Formulary.

Immersion Short, timed 'dip'

- Anaesthetic agents
 - tricaine (MS222™)
 - 2-phenoxyethanol
 - alfaxalone
 - propofol
- Accurate measurement of drug & water
 - use digital scales for dry powder (tricaine)
 - micro-spoons are used by the author
 - use syringe for liquid agents
- Use air-stones to prevent hypoxia
- Depth of anaesthesia depends on:
 - concentration of drug
 - duration of exposure
- Be aware of idiosyncrasies
 - tricaine lowers pH → requires buffering
 - use digital pH meter + sodium bicarbonate
 - propofol → cloudy water & reduced visibility
- EUTHANASIA: use 10x anaesthetic dose



Stage I anaesthesia = sedation = reduced responses



Stage II anaesthesia = deep narcosis = lost balance



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An example of a short dip is for the sedation and anaesthesia of fish. This is commonly used as a management tool to examine the patient in detail out of water and to collect routine tissue samples for microscopic examination. Various

anaesthetic agents are available, but only tricaine and phenoxyethanol are licensed for use in fish. Neither has any use outside of fish work, so alfaxalone and propofol can be used when they are not available. Don't use volatile anaesthetic agents: they are too much of a health & safety hazard. An induction dose of the drug is added to aerated water, and the fish is kept in the solution until it reaches the required depth of anaesthesia. Stage I or II is usually sufficient, depending on the examination required. The longer the fish is immersed, the deeper the level of anaesthesia. Care should be taken to avoid accidental overdose, particularly when aiming for a level of surgical anaesthesia. The same agents can be used at 10 times the anaesthetic dose when euthanasia is required. I recommend that fish be left in this strong solution for 90 minutes to ensure they have died, and an ultrasound probe be used to confirm the heart has stopped beating.

Immersion

Prolonged, permanent 'bath'

- Treatment in tank/pond of origin
- Uses lower drug concentration in the water
- Bath duration from established protocols
- Use for infectious diseases
- Switch off UV, ozone, skimmers and remove carbon
- Benefits include:
 - less stressful to patients
 - all sub-clinical in-contact fish treated
 - treats off-host parasite life stages
- BUT :
 - add drugs in morning and observe for adverse effects
 - must ensure even distribution of drug throughout
 - possible negative impact on biological filtration
 - plants and algae may die → pollution → poor WQ
 - efficacy of drugs reduced by organic matter
 - maintaining therapeutic levels can be challenging
 - total pond+filter volumes are often unknown
 - often prohibitively expensive + wasteful use of drugs




water meter for ponds

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Prolonged or permanent immersion is commonly called a 'bath'. In most cases, it applies to the use of medicine being added to the tank or pond of origin at a lower dose than that used for a short 'dip' treatment. This route is primarily for the treatment of ectoparasites, particularly where some life stages live away from the host in the environment, such as with 'white spot'. However, there is some risk of harming the biofilter or aquatic plants, which may in turn cause a sudden deterioration in water quality. High levels of organic matter and activated carbon can adsorb some medicines and reduce their efficacy. Ultraviolet and ozone filtration systems may also degrade or inactivate some chemicals. The volume of large pond systems is rarely known unless a water meter was used to fill the pond when it was built or installed. However, the total quantity of some prescription medicines required in these ponds is often prohibitively expensive and wasteful.

In-feed

- Treatment in tank/pond of origin
- Uses smaller quantities of drugs (less wasteful)
- Dose rates from established protocols
- Calculations based on total bodyweight of fish
- Use for infectious diseases (mainly bacterial)
- Benefits include:
 - less stressful to patients
 - all sub-clinical in-contact fish are treated
- BUT :
 - only a few drug formulations are available in UK
 - vegetable oil is required to seal medicated pellets
 - small quantities require accurate measuring
 - only effective if fish are still eating
 - less effective if fastidious eaters or drug is unpalatable
 - withhold food for 24hrs may help stimulate appetite
 - usually requires daily feeding for 10–21 days
 - uneaten food must be removed after 5–10 minutes
 - calculating total bodyweight of fish is often imprecise
 - may require sedating a few fish to weigh accurately
 - not suitable for flake food diets



Surface-coating pellet food for 10-day course

1. Weigh out 10days of normal food ration
2. Add powdered drug (daily dose for total bodyweight of fish x10 days)
3. Mix thoroughly to achieve even distribution of drug throughout the food
4. Add vegetable oil (use 2–5% = 2–5mls per kg of food) to coat all pellets
5. Feed daily food ration (one tenth of total medicated food)
6. Store in air-tight container in refrigerator or cool dry place

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The benefits of in-feed medication are that it requires a smaller quantity of medicine, is less stressful, and treats all the fish in the population, assuming they are still eating well. It is primarily used for administering antibiotics by surface-coating the food and feeding daily for 10days or more. Only a few drug formulations are available in the UK that are suitable for this route. I recommend

the owner measure out 10days' of food ration, then add the drug required to the food for 10 days of treatment. Mix thoroughly and coat the medicated food with a small amount of vegetable oil to seal the drug to the pellet. A tenth of the medicated food is then fed to the fish daily. Some fish can be slow to eat the oily pellets, but most can be coerced to eat them. This method is not suitable for flake foods.

In-feed other methods

- **Pre-medicated feed** (not currently available in UK)
 - commercially manufactured food with antibiotics
 - requires veterinary prescription to manufacturer
- **Gelatin-treated food**
 - add required quantity of drug to cool gelatin+feed
 - add drug to commercial gel diet (eg Repashy)
- **Ice cube method**
 - add required quantity of drug to flake food+water
 - divide into daily portions and freeze the drug+food+water slurry in ice-cube tray
- **Medicated food items**
 - inject or conceal powdered drug in food items
 - mainly used for large carnivorous fish
- **Bio-encapsulation**
 - effectively, gut-loading prey items with drug
 - add drug to brine shrimp or bloodworm container then bathe for several hours, capture and rinse in fresh water before feed immediately to fish
 - Protocols for fenbendazole and several antibiotics can be found in the scientific literature



Commercially medicated food



Commercial gel diet for fish



Ice-cube method of medication



Artemia sp. live fish food

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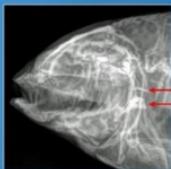
In the distant past, one pet food manufacturer incorporated oxolinic acid, an early quinolone, into pre-medicated koi pellets. They ceased production years ago due to changes in the medicine's regulations, but this method is still used to treat farmed food fish such as salmon and trout. Gelatin diets are now commercially available, mainly for tropical fish, but they can be used to incorporate antibiotics. Similarly, ice cubes made with a slurry of fish food and water can also include antibiotics, as can large food items used to feed carnivorous fish. Bio-encapsulation is similar to gut-loading prey items for tropical and marine fish that readily eat live brine shrimp, *Artemia*, or bloodworms, and there are several effective protocols for using this method in the scientific literature.

Gavage

- **Stomach-tubing / force-feeding**
 - use syringe+ soft plastic or metal tube
 - useful for feeding anorexic fish
 - use to administer unpalatable drugs
 - make up suspension of food or drug
 - use to administer contrast media for X-ray
- **BUT :**
 - requires physical handling and skill
 - stressful in conscious fish and risk of regurgitation if sedated
 - mainly for small numbers of individual fish
 - carp and goldfish have pharyngeal teeth and require metal tube feeding, but there is a risk of perforating the oesophagus



Selection of metal and plastic tubes for gavage



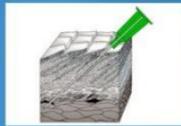
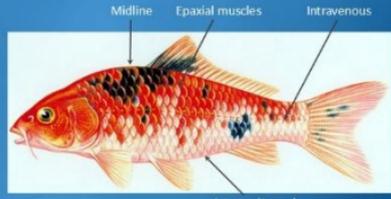
Lateral view of goldfish skull

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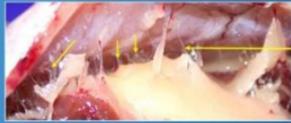
Gavage, or stomach tubing, is a method of force-feeding using metal or soft plastic tubing. It is useful for feeding anorexic fish or administering unpalatable drugs, as well as for contrast media such as barium for diagnostic imaging. Its limitations are that it requires handling and some degree of skill, and it is stressful to the patient. As a result, it is only useful when treating small numbers of fish. Carp and goldfish have pharyngeal teeth at the entrance to the oesophagus, as shown on this radiograph. As a result, they require a metal feeding tube to force-feed these fish, but this also carries the risk of perforating the oesophagus if the tube is not used carefully.

Injection

- Mainly for antibiotics
- Rarely requires site preparation (can damage skin)
- Injection sites
 - intramuscular
 - intraperitoneal/ intracoelomic
 - intravenous
- Benefits :
 - enables a precise dose to be given
 - drugs are absorbed more rapidly than other routes
 - useful if fish is anorexic
- BUT :
 - requires physical handling and weighing
 - best done if sedated
 - must avoid skewering scales and damaging epidermis
 - denticles and 'armoured' scales in some fish
 - drug leakage from site due to inelastic skin: use long needles and press over injection site on withdrawal
 - be aware of intracoelomic adhesions in koi
 - potential tissue damage:
 - enrofloxacin causes muscular inflammation
 - sulfonamides +gentamicin cause renal toxicity



Intramuscular injection:
angle the needle at a shallow 25-45 degrees to the surface, aiming forwards, to allow it to penetrate between the scales



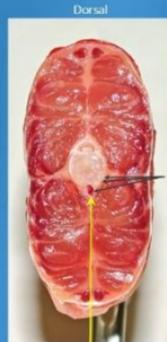
Intracoelomic adhesions in koi

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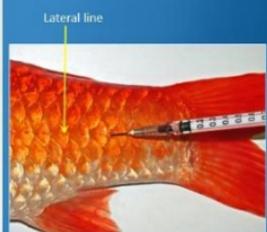
Administering drugs by injection is the most direct approach and is mainly used for antibiotics. Minimal site preparation is required since most skin disinfectants can damage the epidermis. It is important to direct the needle smoothly between the scales since they are located beneath the epidermis, and removing a scale in the process will create a skin defect and pose a risk of local infection. You do not want to withdraw the needle and find it has skewered a fish scale. Drugs are absorbed more rapidly using this route, but it requires physically handling and weighing the fish to ensure the correct dose is given. Although various routes are available, the intramuscular route is the most common. It is essential to use long needles to prevent the drug from being expelled from the site due to the lack of skin elasticity and subdermal space. Injections may be repeated every 24-72 hours, depending on the protocol, with the location of the injection site alternated, especially if there is local muscular inflammation. Similarly, in koi, care should be taken when giving intraperitoneal injections due to the extensive adhesions found in the coelomic cavity of these fish.

Intravenous injection

- Usually use caudal vein in peduncle
- Situated along ventral aspect of vertebral bodies
 - can use lateral or ventral approach
 - enter obliquely under scales until hit vertebral body
 - withdraw needle slightly and 'walk' down vertebra
 - pull back plunger periodically until blood drawn up
- Caudal vein is used for:
 - blood sampling (heparinise needle+syringe)
 - euthanasia with iv pentobarbitone
 - administer emergency drugs (adrenaline, atropine)
 - administer iv contrast media
- Rarely requires site preparation (can damage skin)
- Benefits :
 - immediate access to circulatory system
- BUT :
 - requires sedation/anaesthesia... and practice
 - requires long needles in large fish
 - can be difficult to tell if all drug has gone into vein, so pull back plunger after drug administered to check needle is still in the vein



Location of caudal vein



Lateral approach to caudal vein

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The caudal vein is the most accessible for intravenous use. It is located along the ventral aspect of the vertebral bodies in the peduncle, the part of the body that narrows towards a fish's tail. It is usually approached laterally, using the lateral line, the linear series of small pores on the side of a fish, as a landmark for the point of entry. Again, the needle is angled so that it enters between the scales and advanced until it hits the vertebral body. The needle is then withdrawn slightly, redirected more ventrally, and the process is repeated until the vein is entered. In addition to being used for blood sampling, intravenous pentobarbitone can also be administered here during euthanasia. Emergency drugs, such as adrenaline, can be given by this route, as is intravenous contrast media for diagnostic imaging. However, the procedure requires the fish to be sedated, and it takes practice to perform this routinely.

Analgesia

- A complex subject, and use in fish is still limited
- Fish have been shown to feel pain
 - = pain receptors, nerve pathways and CNS centres
 - they respond to painful stimuli
 - some analgesics reduce behavioural signs of pain
- Drugs used
 - opioids (morphine, butorphanol, buprenorphine)
 - NSAIDs (ketoprofen, meloxicam, ibuprofen)
 - local anaesthetics (lidocaine)
- Usually given as a single intramuscular injection
- Benefits :
 - some analgesic drugs have a perceived benefit
 - most appear to cause no harm
- BUT :
 - limited published literature
 - limited evidence of efficacy and beneficial effects
 - contradictory statements are difficult to interpret
 - important species differences have been reported
 - risk of unknown adverse effects if prolonged use
- Further research is required



Journal of the American Association for Laboratory Animal Science (2018) volume 57 (1), pages 5-12

Analgesia in fish is a complex subject, and the debate over whether or not fish feel pain raged for years until it was scientifically demonstrated in 2003. Fish have pain receptors, nerve pathways and centres in the brain to detect pain, and some analgesic drugs reduce behavioural signs of pain. However, despite their routine use in mammals, there is limited information about the properties of these drugs in fish, and as ever, further research is required. This paper is a useful review of the topic and warns about the important variations found between different species and the potential for adverse side effects. Most analgesic drugs are given by injection, although lidocaine can also be administered by immersion, particularly in very small fish. My personal choice in goldfish and koi has been to use butorphanol, although this will require dilution to make accurate dosing of some formulations easier in practice, particularly in fish weighing less than 500g. Analgesics should be used as a single injection in cases where you would consider a surgical procedure to be painful in other animals.

Topical preparations

- Used as surface antiseptics following debridement
- For treatment of traumatic and infected wounds
- Also used on surgical sites post-op
- Usually used in conjunction with systemic therapy
- Preparations
 - skin antiseptics (eg povidone iodine)
 - use diluted according to instructions
 - Friars' Balsam has mild antiseptic properties
 - platelet-derived growth factor becaplermin (Regranex®)
 - waterproofing sealants (Orabase™, Orabase™)
 - = gelatin+ methyl cellulose+ pectin
- Benefits :
 - enables focused treatment
- BUT :
 - requires physical handling, best if anaesthetised
 - washes away quickly on returning fish to water
 - unknown level of therapeutic benefit



Deep skin ulcer in a koi



Topical antiseptic products



Applying dil. povidone iodine



Waterproofing products



Topical products are applied to external surfaces, mainly to treat wounds and surgical sites. They tend to be mild antiseptics and are often used in conjunction with systemic medicines such as antibiotics. Infected wounds, such as bacterial skin ulcers, are carefully debrided under anaesthesia to remove necrotic tissue that delays wound healing. The antiseptic is applied to the site, which is then covered with a waterproofing sealant. My preference is for Orabase, a dry powder used in human stoma care, which is sprinkled over the area. Various other products have been used by hobbyists and veterinary professionals.

Choice of drug

- **Deciding factors**
 - Drug must be effective against the pathogen
 - Use the least stressful product and method
- **BUT :**
 - there are often limited formulations of drug available
 - some pathogens are unresponsive or no treatment exists (eg mycobacteria, microsporidia, viruses)
 - very few medicines are fully licensed for use in fish
 - few pharmacokinetic studies exist for fish medicines
 - potential for adverse effects on fish & environment
- **Over-the-counter, non-prescription medicines**
 - mostly active against external pathogens
 - VMD registered Exemptions for Small Pet Animals
 - efficacy data often considered commercially sensitive
 - most ingredients used in the hobby for decades
 - manufacturer often has data for many fish species
 - most are available in easy-dose containers to ensure accurate dosing and reduce accidental overdosing
- **This is the author's preferred first line of treatment since all POM-Vs are used off-licence and carry risks**



Typical range of proprietary medicines available in fish pet shops

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For obvious reasons, the choice of drug will depend primarily on the underlying pathogen, but also on the formulations available. Aim to use the least stressful route of administration where possible, but be aware that some pathogens have no effective treatment. Very few medicines are licensed for use in fish, and there are very few pharmacokinetic studies that help determine safe and effective dosages. As a result, my first line of approach for the treatment of external pathogens such as ectoparasites and fungi is to advise the use of over-the-counter, non-prescription products that are available in pet stores. These are all registered under the Exemptions for Small Pet Animals (ESPA) scheme by the Veterinary Medicines Directorate and have been used in the hobby for decades, so manufacturers have a good understanding of their use in many species. They come with clear instructions and easy-dose containers or measuring pipettes to help minimise accidental overdosing.

Online resource
www.bsavalibrary.com/content/formulary/exotic-pets

Comprehensive list of proprietary medicines currently in UK

- BSAVA list is also available to non-members
- over 150 products are listed alphabetically by manufacturer
- 'active against' information as stated on the pack or enclosed leaflet can search for a commercial product or active ingredient (use Ctrl-F)
- list is useful for identifying the suitability of products used by clients

I compiled a list of over 150 of these proprietary products, listing the active ingredients and the pathogens they are used against, based on information supplied by the manufacturers. If you look at the formulary web page and click on the *Proprietary Fish Medicine vendors* on the right side, this will take you to this list of manufacturers and products. You can then scroll down the page or use Ctrl-F to bring up a search box in the top right corner. This is useful for finding products used by clients and identifying if they were suitable for the current health problem.

Antibiotics

Problem areas

- most bacteria are ubiquitous in the aquatic environment
- most bacterial disease is caused by secondary infection
- most aquatic bacteria are Gram-negative rods
- external ulcerations are inevitably contaminated
 - results in multiple species on culture
 - identifying the causal agent can be challenging
 - bacterial synergism may suppress some species
- aseptic sampling requires a swab from kidney or spleen
 - not all bacterial infections are systemic (internal)
- bacterial culture can be problematic
 - requires lower temperature and longer incubation
 - some require specific culture media
 - bacterial antibiotic 'resistance' is common
 - this is likely to be a feature of aquatic bacteria
 - it is less likely to be due to antibiotic misuse
 - limited understanding of MICs in pet fish bacteria
 - culture and sub-culture may take several days (=too long)
 - most diseases require prompt treatment
 - interpretation of culture & sensitivity in pet fish is poor
 - pet shop owners/dealers commonly request antibiotics without proper veterinary involvement or investigation

Antibiotic choice

- all antibiotics are used off-licence in ornamental fish
- there are limited formulations of suitable antibiotics
- choice is often based on personal experience+ knowledge



Sampling from the posterior kidney in koi



Multi-drug resistance on tryptone soya agar

Examples available in UK

Injection

- ceftazidime (Fortum)
- danofloxacin (Advacin)
- enrofloxacin (Baytil etc)
- florfenicol (Nuflor)
- marbafloxacin (Marbocyl)
- oxytetracycline (Engemycin etc)
- trimeth.+sulfa. (Noradine etc)

Immersion

- enrofloxacin (Baytil etc)
- oxytetracycline (Aquatrim)
- trimeth.+sulfa. (Trimefazimine)

Oral/ in-feed

- florfenicol (Florocol)
- erythromycin (poultry oral pdr.)
- enrofloxacin (Baytil etc)
- oxytetracycline (Aquatrim)
- trimeth.+sulfa. (Trimefazimine)

BSA*TA

I feel it is important to discuss the use of antibiotics in pet fish because it can be a difficult area, and one where hobbyists may phone up to request prescription drugs without veterinary investigation. This is partly due to our profession's limited knowledge of pet fish health and our reluctance to get involved with these animals in the past. Antibiotics are often seen as a 'silver bullet' for all fish diseases by hobbyists, and they can be quite forceful in their demands for prescription drugs because they have used all the other drugs they can get legally. As I have discussed, treating pet fish diseases successfully can be challenging and requires a thorough investigation of the environment and the patient. Having said that, antibiotics are very useful drugs and essential for treating many bacterial infections. However, there are several problem areas that I have listed here, the most important being the technical difficulties in identifying the causal agent and its sensitivity to antibiotics. The Gram-negative pathogens commonly found in many fish diseases often require the use of drugs classed by the European Medicines Agency as category B and C antibiotics, such as quinolones and cephalosporins. Antibiotic formulations are limited, but I have listed a few common examples here in the UK on the right, although the final choice may often depend on personal experience and what you have in the drug cupboard.

Indirect factors

Pharmacokinetics

- species differences
- temperature impact
- gastric emptying
- binding agents
- concurrent treatment
- environmental factors
- drug characteristics
- duration & frequency
- dose rate calculations

Supportive treatment

- isolation facilities
- appropriate nutrition
- immuno-stimulants

Control & prevention

- selection of healthy stock
- quarantine new stock
- water quality must be optimal
- biosecurity & disinfection
- correct nutrition & supplements

J. vet. Pharmacol. Therap. 20, 124-128, 1997. PHARMACOKINETICS
Pharmacokinetics of enrofloxacin in the red pacu (*Colossoma brachypomum*) after intramuscular, oral and bath administration

G. LEWBAERT*, S. VASSEY*, J. BERRY, S. DAVIS, S. DAVIS, J. BERRY, C. WILKINSON, D. DAVY, A. SMITH, T. PHILLIPS & J. PHILLIPS
Pharmacol. Therap. 20, 124-128, 1997.

J. vet. Pharmacol. Therap. 28, 117-119, 2005. SHORT COMMUNICATION
Pharmacokinetics of florfenicol in the red pacu (*Piaractus brachipomus*) after single dose intramuscular administration

G. A. LEWBAERT*, M. G. PAPICH* & D. WHITE-SMITH*
Department of Clinical Science and Molecular Biomedical Sciences, College of Veterinary Medicine, North Carolina State University, Raleigh, NC, USA



Ensure optimal water quality



Maintain good biosecurity



Don't buy sick fish

BSA*TA

The characteristics of absorption, distribution, localisation in tissues, biotransformation and excretion of drugs are collectively known as pharmacokinetics. This is important in the treatment of any animal, but there is little data available for pet fish. In the few published cases, single routes of administration may have been studied, often in uncommon pet species, such as these papers where pacu, a large South American tropical fish, were used. Care should be taken when extrapolating some data because of species differences and other factors I have listed here. Treating fish in isolation facilities and feeding appropriate diets and immunostimulants is also helpful. As always, prevention is by far the easiest approach to maintaining good health, and the basic principles of ensuring good water quality and biosecurity should be followed, in addition to avoiding the purchase of sick fish.

Other considerations

• Failure to respond

- severity of disease is often greater than appreciated
- initial disease superseded by more serious disease
- incorrect diagnosis
- use of inappropriate medication
- pathogen resistance
- inactivation of drug by chelation/UV/ozone etc
- inadequate drug uptake (eg anaemia)

• Adverse reactions

- miscalculation of dosages
- toxic medication
- increased toxicity (high temp. & pH, low hardness)
- toxic impurities (eg formalin)
- nephrotoxicity (eg gentamicin, sulfonamides)

• Legislation

- off-licence use of drugs under "the cascade"
- informed consent & signed consent forms
- medicines regulations and supply of POM-Vs
- disposal of medicines and potential environmental harm (eg malachite green into natural waters)

Consent for treatment with unlicensed products or off-label use of veterinary products

Under UK legislation where there are no suitable drugs specifically authorised for the treatment of a particular species (all ornamental fish) or a particular medical condition in that species, a medicinal product authorised for a different medical condition, or for use in another species or humans, or under certain circumstances a specially prepared unauthorised product, or a medicine imported from another country under a Special Treatment Authorisation may be used for the treatment of your fish with your consent. These procedures will only be used when I consider them to be the most appropriate treatment.

Client: _____
Address: _____
Phone: _____
Species: Ornamental fish --

Acceptance of Risk

I understand that while the fish described above are under the care of this veterinary surgeon there may be occasions when it will be necessary to use authorised human or veterinary medicines (or specially prepared unauthorised medicines or medicines imported from another country under a Special Treatment Authorisation) not authorised for use in ornamental fish or which are authorised for use in this species but not for the particular condition for which the treatment will be given.

I have been made aware that there may be known or unknown side effects associated with the use of these drugs and in giving my permission for their use, accept any attendant risks.

I am over 18 years old

BSAVA

A failure to respond to treatment is common when treating fish patients, mainly because most are more ill than is appreciated. In addition, what may start as one problem may have become complicated by another secondary disease. The limited clinical examination that can be performed on fish also reduces the likelihood of an accurate diagnosis, particularly for internal diseases. These major factors often result in a higher mortality than I would normally expect in other exotic animals brought in to my practice, and it is important to convey this to the client and manage their expectations. However, despite this gloomy prospect, it is possible to avoid catastrophic fish losses and have some rewarding moments that make the professional effort worthwhile. You can only do your best. It is also important to be prepared for adverse reactions and be aware of the relevant legislation, including the use of signed consent forms.

Reflective question

A new koi keeper phones the practice and asks for some help with his koi that have developed skin ulcers. He is new to the hobby and built his pond recently. He has a limited understanding of fish husbandry and has tried various over-the-counter medications to no avail.

How would you proceed?



To help you reflect on what you have learnt in this session, I thought you could consider how to deal with a common problem in koi, namely, the treatment of skin ulcers. These are challenging cases and require a thorough investigation with a robust plan of action.

So the question is — *a new koi keeper phones the practice and asks for some help with his koi that have developed skin ulcers. He is new to the hobby and built his pond recently. He has a limited understanding of fish husbandry and has tried various over-the-counter medications to no avail.*

How would you proceed?

It is not always easy to identify the event that triggered the ulcerations, but more often than not, fish will be presented with severe body ulcers, and sometimes after several fish have died. I thought I would show you a couple of examples of these fish while you figure out what you would do. Here are some clues. You need to think about what to do with the environment, what to do with the affected fish, and how to manage the rest of the population.

Treating skin ulcers in koi

- Test water quality
- Change one-third of water volume
- Add salt at 2 grams/litre — remove salt-intolerant plants
- Change one-third of water every 3 days+ top-up salt level
- Aerate with air stones, fountain, waterfall or venturi

Ok. These cases need prompt action because the response to effective treatment in fish can be very slow. Starting with the environment. I would test the water quality using my own kits and equipment, even if only to confirm the results from the owner's test kits. Test for ammonia, nitrite, nitrate and pH. New owners are not always aware of why they need to do this, or even have the kits. Check the filter system for any sludge which can produce toxic hydrogen sulphide and have it cleaned out if necessary, but avoid over-zealous cleaning of the filter media, which is responsible for the biofiltration. I always recommend changing a third of the water, if this hasn't already been done, even if the water quality tests are fine. This is because there may be other harmful contaminants in the pond that the kits don't pick up, such as insecticides, paint residues, and runoff from new brickwork. It is best to drain the pond water down by a third, then refill it to ensure that the correct amount of water has been changed, rather than trickle water into the pond constantly and let the water drain out through the overflow. I recommend adding salt at 2grams per litre and removing any salt-intolerant plants, if there are any: keep them in a water butt or buckets until the salt is reduced by further water changes after the fish have recovered. Until then, it may be necessary to change a third of the water every three days and top up the salinity with a third of the original quantity of salt that was added. A small digital salinity meter can be used to ensure the salinity is maintained at 2grams per litre, which is 2 parts per thousand. Aerating the water by adding air stones or fountains helps to circulate the water and ensure there are no areas with low oxygen or a buildup of pollutants in parts of the pond with poor water flow. This may all seem rather over-the-top, but I find it useful for most koi pond problems and an effective supplement to medication.

Treating skin ulcers in koi

- Test water quality
- Change one-third of water volume
- Add salt at 2 grams/litre — remove salt-intolerant plants
- Change one-third of water every 3 days+ top-up salt level
- Aerate with air stones, fountain, waterfall or venturi
- Anaesthetise affected fish, debride and dress the ulcers
- Remove loose scales and exposed bone
- Apply dilute povidone-iodine + waterproofing compound
- Weigh the fish to calculate drug dosages
- Inject antibiotics i.m. using LONG needles
- Perform skin & gill scrape exams — treat ectoparasites if present
- Euthanise severely ulcerated fish, then necropsy & histopath



Debride the ulcer



Apply povidone-iodine



Apply waterproof compound

Regarding the affected koi, I would anaesthetise the worst cases and treat the lesions. This involves debriding the ulcer using forceps to remove loose scales and exposed bones. The ulcer is then swabbed by gently wiping away any debris with

a gauze swab, since any remaining necrotic tissue will slow down wound healing. I apply diluted povidone-iodine with cotton buds or more gauze swabs, depending on the size of the ulcer. Wipe away any excess and apply a waterproofing agent, which in my case is Orahesive, a dry powder mixture containing pectin, gelatin and methylcellulose. Weigh the fish and calculate the correct dose of antibiotic, inject it carefully into the dorsal epaxial muscles between the scales, deep into the muscle, using long needles. For large koi, I use 40mm needles to reduce the risk of drug leakage through the injection site and apply digital pressure to the site as I withdraw the needle. Obtain skin and gill scrapes from the fish using light pressure with a cover slip or a scalpel blade to take samples of the mucus layer on the skin. Do not scrape hard as you would do with a terrestrial animal. All you need here is a small sample of the surface mucus to examine. Examine the sample under low power with a drop of pond water and look for live ectoparasites. If these are present, the pond will need treatment with an over-the-counter proprietary medicine available from the fish pet store. Severely ulcerated fish where there is penetration into the body cavity or extensive exposure of bone around the head should be euthanised since most of these fish will not recover. Admittedly, it takes experience to know which will survive and recover, but removing severely ulcerated fish will reduce the bacterial burden in the pond and benefit other fish. If possible, it is advisable to perform a post-mortem examination and take samples for histopathology to look for underlying disease problems, including koi herpes virus. I have always found it challenging to interpret bacterial culture and sensitivity of swabs taken from external lesions because of the technical aspects I discussed earlier. However, culture and sensitivity may be required if there is poor progress or no response to treatment.

Treating skin ulcers in koi

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- Weigh the fish to calculate drug dosages
- Inject antibiotics i.m. using LONG needles
- Perform skin & gill scrape exams — treat ectoparasites if present
- Euthanise severely ulcerated fish, then necropsy & histopath
- Medicate food with antibiotics if >1 fish affected
- Feed medicated food for 14-21 days
- Repeat debridement after 5-7 days, if necessary
- Heat water to 25°C/ 77°F to speed healing — in isolation facility



Debride the ulcer



Apply povidone-iodine

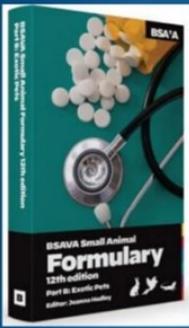


Apply waterproof compound

Finally, it is important to treat the remaining koi in the pond. If there is only one ulcerated koi, and it is a small lesion, which may even be due to a traumatic injury, then it could be treated separately in an isolation facility. Here, the water conditions can be manipulated more easily with salt and even using water heaters to raise the temperature to 25°C to speed wound healing. However, if several koi are affected, it is likely to be a bacterial infection, probably caused by a Gram-negative rod such as *Aeromonas* or *Pseudomonas*. In which case, all the koi should be given medicated food, which is prepared in the manner that I described earlier. From my experience, the medicated food should be given for 14 – 21 days in ulcer cases, but if there is a poor response, then it may be necessary to change the antibiotic. Fish that are not feeding may need to have repeat injections.

I do not claim to guarantee a good result every time with this protocol because you should never underestimate the severity of this disease. It is not uncommon to have a high mortality rate, which is why I adopt this rather ruthless approach.

Thank you for listening...



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BSAVA

As I said at the start, treating pet fish is a complex subject. Hopefully, I have shed some light on the most important aspects that will encourage you to start treating these animals more confidently. So, what final piece of advice can I give you? Well. Show compassion to the owners. These fish are their pets, and some owners are as emotionally bonded to them as with any other pet. Fish owners appreciate a caring approach, even if the case is hopeless and the end inevitable.

Fish medicine is a fascinating subject, and you already have a good understanding of many aspects of animal health and skills that will help you. Don't underestimate what you can do to investigate and treat these cases. The BSAVA Formulary for exotic pets contains much of the information that is currently available, with extensive references on the drugs used in pet fish available online and on the BSAVA app.

Thank you for listening.