Microbat Rehabilitation – Ten ways to boost your chances for a successful outcome

Author: Rachel Lyons – Rachel@wildcare.org.au

Abstract

Microbats are unlike any other species we rehabilitate. Over the years and after many losses, we have learnt to abandon many standard flying fox and marsupial rehabilitation concepts to achieve successful outcomes.

Microbat rehabilitation could be described as a new frontier, this is despite microbats comprising almost a fifth of all of the mammal species in Australia. We are learning the ropes with our precious wildlife vets by our side, sharing trials and tribulations with each other.

To our advantage, unlike many Australian mammal species, microbats are present in most continents of the world. With our microbat rehabilitator peers, particularly in Europe and in North America, we are able to share our collective knowledge and research.

This paper will outline 10 critical concepts that have significant influence in rehabilitating microbats to improve release survival in the wild.

1) Hydration and dealing with microbats naturally high blood urea concentration.

Microbats have large lungs and over 80% naked body surface, meaning they can lose large amounts of water very quickly (Altringham, 2011). The daily water turnover rates have been measured for several bats and is alarmingly high. One research experiment of an 8 g North American bat species indicated that daily fluid turnover was up to 67% of body mass or 5.36 ml (Neuweiler, 2000). Many bats can obtain their fluid intake from the food they eat alone, however most bats require additional fluid intake.

The blood urea concentration of insectivorous bats is 4-5 times higher than other mammals of similar size, and is highest immediately after feeding (Neuweiler, 2000). This is despite microbat kidneys having the same functional ability of other mammals. Fluid intake and adequate hydration acts to dilute the blood urea concentration to acceptable levels, however the huge metabolic rates and energy requirements of microbats also influence the situation (personal communications, T Bishop 2017).

Microbats deprived of fluid can die very quickly from urea poisoning often before any signs of obvious dehydration appear, particularly if the deprivation occurs immediately after feeding (e.g. injury during or after feeding preventing movement to watering location). As a result, all microbats regardless of typical dehydration signals, should be rehydrated via sub-cutaneous injection as a matter of course as soon as possible after admittance into care. The only exception to this rule is when microbats have been immediately disturbed from the roost and there is no possibility of injury or illness.

The amount of fluid required and the speed at which fluid absorption is needed to offset urea poisoning and/or dehydration, renders oral rehydration of microbats as generally ineffective. Many species of microbats will not drink sufficient amounts orally even at full health. Subcutaneous fluid injections should however only be undertaken by a veterinarian or experienced and vaccinated rehabilitator trained in fluid therapy.

2) The importance of glucose in microbat stabilisation.

Bats due to their high metabolic rate can very quickly and easily become hypoglycaemic and if left untreated can become hyperglycaemic due to the Somogyi effect (personal communication – T. Bishop, 2017). Blood glucose levels can continue to fluctuate without intervention, eventually leading to death.

All incoming bats should receive glucose as a component of initial fluid rehydration procedures (Per Coms Bishop 2017). Glucose should be provided over a number of days, particularly for bats that were admitted with moderate to severe dehydration, emaciation or those that have infection (Personal Communications – T. Bishop 2017). Stressy species of bat, including but not limited to Large Footed Myotis, Little Forest, Little Bent-wing and Long-eared Bats should also be provided with additional glucose through at least the first 72 hours.

3) Heterothermy and its implications for treatment and wound healing.

The thermoneutral zone for a microbat, where it consumes the least amount of energy and oxygen, is 30-35°C. Outside of this ambient temperature, the bat must consume large amounts of energy to maintain a constant body temperature of 35-39°C (Neuweiler, 2000).

Microbats have also developed an evolutionary solution to reducing energy requirements in times of cool temperatures and/or food shortages, called heterothermy. A heterothermic animal can consciously and in a regulated way, reduce their body temperature to save energy and then consciously return to normal temperatures (Neuweiler, 2000). Two purportedly different physiological and behavioural mechanisms for heterothermy are evolved energy saving solutions for microbats in situations where temperature is below their thermoneutral zone. These solutions being: torpor (diurnal lethargy) lasting up to several hours; and, hibernation lasting up to several weeks.

When a microbat is torporing or hibernating, their metabolic rate is significantly slower which has an impact on everything from wound healing duration through to medication metabolization.

Microbats require constant peak temperature of 30-35°C (or higher if a pup) during medication treatments for any treatment drugs to have designed effect without organ damage, and to facilitate healing as quickly as possible. Microbats undertaking treatment are best housed in temperature-controlled situations and provided ample nutrition to lessen the incidence of entering torpor.

4) Understanding your species – microbats are not one and the same.

The two major sub-orders of flying foxes and microbats were believed to have separated about 64 million years ago, with the most recent evolutionary change within the suborders and families occurring 30 million years ago. Consequently, bats are considered ancient, with all families and genera that we know of today in existence in some form 30 million years ago (Churchill, 2008). Over this 30 million years, the species of microbat present today have evolved often very different adaptations to suit the habitat, and food they rely on.

Most notably for rehabilitation, microbat species have different flight characteristics. Flight speed, manoeuvrability and agility is related to wing shape, bat weights, feeding styles, roost types, prey species behaviour and forage habitat types. Flight characteristics dictate the rehabilitation needs of each species. Some species, typically the slow highly manoeuvrable flyers, will undertake sustained (5 min +) flight in small spaces (e.g. 3 x 3m). Other high speed but less manoeuvrable flyers need large areas (over 16 x 16m) to undertake sustained flight.

Australian microbat diets are also hugely varied and are species and location specific, with limited studies having been undertaken in Australian species to date. Orphan raising also requires different rehabilitation approaches for different species. Some species are born with eyes open, others not. Some pups cling to mum for the first weeks of life, other species park their pups with other bats, only returning to feed them when required. Different microbat families also have marked differences in milk composition (Lollar, 2010).

5) Socio-cognitive issues – structure, communication and avoiding stress.

A German study published in early 2011, using data collected over 20 years, confirmed what many microbat rehabilitators around the world had observed for many years - that highly complex social structures exist within local populations and colonies of bats. These high-level socio-cognitive skills, on par with the likes of elephants, dolphins and primates, enable bats to maintain lifelong personal social relationships and wider friendship networks with friends and relatives (Kerth, 2011).

The outcomes of the Kerth (2011) study has recently been supported by a study by Godinho et al. (2015) identifying strong and often exclusive social structures in Australian Gould's Wattle Bats. Microbats when removed from their home roost and taken various distances away have been observed to return even from several hundred kilometers away (Barbour, 1979). No doubt due to the strong social and personal bonds they have with other individuals in their roost groups.

The consequence of the above points has significant impact on the way rehabilitators raise and release orphans and how adult bats are rehabilitated and released. Adult and all bats older than a few weeks when entering care, should always be released within a very close distance (within 100 m) of where they were found. Most rehabilitated bats at release are not at their peak health, fitness and muscle strength due to being injured or ill. To require them to fly several or tens of kilometers to their original point of capture to join their roost mates is counterproductive to the purpose of rehabilitation. Special consideration should also be made to the releasing of microbats that arrived in care as very young pups. The close emotional relationships made with other bats in care should dictate the release arrangements.

6) Wonderful wings – how they heal and what damage can they sustain.

Microbat anatomy and physiology has evolved to suit the essential functions of flight and foraging style, and the delicate energy, fluid and thermoregulatory balances that accompany them. The wings and legs are typically the only skeletal aspects of a microbat that most rehabilitators will see without access to radiographs, and are also the most common bones that are damaged due to injury and developmental problems.

Unlike flying fox wing membranes, dieback with most microbat species is typically limited. Their ability to heal right back to the trailing wing edge is repetitively observed and provided they have access to initial veterinary medication treatment, good nutrition and are housed within their thermal neutral zone whilst healing, membrane healing can be remarkable.

The challenge is to achieve full flight function (flight lift and manoeuvrability) to enable capture of prey on the wing. Different species can handle bone injuries and membrane deficiencies (extent and location) better than others. The difference mostly relates to the type of wing shape and flight style they inherently have. Detailed membrane injury and bone viability guidelines have been developed based on historical experience (Lyons & Wimberley, 2017).

7) Developmental stage identification – knowing what dependant juveniles look like.

Juvenile bats achieve near adult size and weight relatively quickly and are often difficult to identify to the untrained eye. Prior to being able to fly, bats generally need to grow to 90-95% of their adult skeletal size and 70% of their adult mass (Altringham, 2011). Large numbers of juvenile bats, still reliant on maternal nutrition, enter care in spring and summer after premature or first flights.

The main definitive way to identify a juvenile is to ascertain the existence of cartilaginous bands on the joints between the metacarpals and phalanges. Very young microbats will have large bands/ gaps that appear white in colour when a light source is shone from behind the wing. Juveniles will have two white bands until several months of age in most species. Adults do not exhibit the bands as the cartilaginous gap is not obvious to the naked eye.

Correct developmental stage identification is essential in determining the viability of a patient and initial treatment. Microbat rehabilitators are increasingly diligent in attempting to reunite juvenile microbats that are in good condition, back with their roost mates as soon as possible.

8) Diets – avoiding problematic ingredients.

Natural microbat milk is difficult to replicate, particularly when considering there are so many different species of microbat, and that milk composition changes significantly over the stages of lactation (Lollar 2010). There have been very limited studies undertaken in Australia that have analysed the milk of Australian microbats. Significantly different compositions of milk exist for one family of bats called the Molossidae's compared to other microbat families (Lollar 2012). Molossidae bats have higher energy and fat needs and lower protein requirements.

Most captive milk replacement diets have been trialled extensively at the Bat World Sanctuary in Texas (USA), and for the last 10-15 years here in Australia by several rehabilitators. Independently, we have found increased incidents of bloat and metabolic bone disorder (MBD) with the use of bovine based milk formulas, even when homogenized (Lollar, 2012) & (Lyons & Wimberley, 2017). Preferred milk diets currently are goat milk based, with different supplementation provided for the different microbat family groups. Captive milk diet composition is an area where significant improvements still need to be made.

An emerging issue is the nutritional quality of mealworms, which form the basis of the adult microbat diet in care. The need to boost general mealworm nutritional value is ever present and various products are now being used to do so. The possible use of insect growth inhibitors (IGI) in commercial mealworm production to delay adult (beetle) stage and prolong shelf life, is however an additional concern. Mealworms affected by IGI have potentially lower calcium levels and softer exoskeleton which is a suspected contributing factor in several cases of microbat bone density and development deficiencies in the past few years. Substantiation of this issue is difficult due to the inability to confirm the use of IGI in the mealworm industry.

9) Pup rearing – basic do's and don'ts

- ***Temperature***

Infant microbats are unable to maintain their own body temperature (ideally 35-39ºC) until 3-5 weeks of age (species dependent). Due to their size and metabolism, microbat pups require an ambient (surrounding air) temperature of 32-38ºC (species and individual dependent) to keep them within optimal body temperature. Ambient temperature provision is much higher than that provided for other Australian mammals we rehabilitate. Newborn pups are likely to require ambient temperatures of 36-38 ºC and lightly furred pups graduate down to approximately 32-34 ºC.

- ***Feeding Frequency***

Overfeeding a microbat pup is VERY easy to do and regularly causes death. Pups do not have a well-developed 'I'm full' signal that stops them drinking. The amount fed per feed varies significantly between species and individuals. What a rehabilitator should be aiming for is the abdomen of the pup to be slightly rounded and close to the same width as the pup's rib cage after feeding.

Microbats need to be fed milk on demand when their stomachs are near empty, as opposed to standard 'marsupial' feeding regimes. This usually equates to approximately every 4-5 hours but varies depending upon the species, the age, the individual pup's condition and ambient temperature. Feeding a pup too often, before it has digested its previous milk feed, can contribute to often fatal conditions such as bloat. It is necessary to allow the stomach to reach near-empty state before feeding.

The amount of milk remaining in a furless pup is quite easy to view. Residual milk can be seen on the left side of their abdomen through their skin. Furred pups need to have their abdomen gently assessed by feel to establish if they are near empty. If a pup has not digested its milk within 4-5 hours, provided you have not over-fed it, it is either:

- being kept at too low a temperature and is torporing, OR
- it is dehydrated and its stomach is not functioning correctly as a result.

- ***Fluids***

Many species of pups, despite our best efforts to keep hydrated through the use of humidicribs and providing fluid ingestion via milk, may still suffer dehydration whilst in care. This is due, to the large naked surface area of a microbat (without their mother to snuggle into) and fluid loss through the skin. It is NORMAL to need to provide additional fluid support to a well feeding and healthy pup.

Due to the limited ability to supply additional fluids orally without jeopardising nutrient intake (their stomach size and volume processing ability is extremely restrictive), subcutaneous fluid may still need to be given regularly to nursing pups. The need to provide additional fluids, above and beyond milk provision, has been greatly reduced due to the recent advent of affordable humidicribs.

Attention to hydration levels and dehydration signals, even when pups are drinking normally, is critical. Key dehydration signals in pups can include decreased plumpness in the skin, loss of silky feeling when gliding pups skin across the shoulder blades, tenting of skin on torso, dryness on the wing membranes and sometimes decreased urinary output.

10) Flight practice – it really is a case of 'do' or 'die'!

The ability to undertake sustained flight prior to release is critical. Microbats hunt on the wing and need to be able to do so immediately upon release.

In order to give microbats the greatest chance of survival, prior to release they ALL must:

- be able to undertake sustained flight of the style and speed relevant for their species and to have done so for a suitable length of time (1 month typically) to gain strength and fitness;
- be able to catch their natural food on the wing; and
- be of good weight and adult size for the species.

When an adult microbat has been without flight for more than a week, or a juvenile bat has been raised in captivity, prior to release it first must spend time in a flight aviary to build muscle tone and aerobic fitness. While the flight cage minimum size varies between species, most require a minimum flight aviary cage size of 7 x 7 m. Species that fly within vegetation, such as the Gould's Long-eared Bat, can build sufficient flight strength in smaller aviaries of 3 x 3 m in size. Other larger species such as Yellow-bellied Sheath-tailed bats fly very fast with low manoeuvrability and need much larger flight aviaries to undertake sustained flight, larger than any available in Australia at present.

Post survival research in relation to pre-release practices in hand-raised microbats is restricted to studies undertaken in Europe. While the study by Kelly (2008) had a small sample size, its results are consistent with expectations. Tracked bats provided with limited time in fight aviaries and/or flight practice within a small aviary were found either grounded or perished, presumably from myopathy, within 3 days of release. Only those that had extended flight practice in larger cages (relevant to the species) demonstrated survival in the wild. Unfortunately, the availability of sufficiently sized pre-release flight aviaries is lacking in most areas of Australia for the majority of species.

Further Information

The *Australian Microbat Rehabilitation Forum* is a Facebook group and is a friendly place to share microbat rehabilitation issues, knowledge and experience with over 600 members world-wide. Within the 'Files' section of the Forum is always the latest version of '*Introduction to the Care and Rehabilitation of Microbats*' – an Australian Rehabilitation Manual authored by Rachel Lyons and Trish Wimberley.

References

Barbour, D. a. (1979). *Bats of America.* Lexington: University of Kentucky Press.

ltringham, J. (2011). *Bats, From Evolution to Conservation.* New York: Oxford University Press.

Churchill, S. (2008). *Australian Bats.* Crows Nest: Allen and Unwin.

Godinho, Lisa & F. Lumsden, Linda & Coulson, Graeme & Griffiths, Stephen. (2015). *Network analysis reveals cryptic seasonal patterns of association in Gould's wattled bats (Chalinolobus gouldii) roosting in bat-boxes*. Behaviour. 10.1163/1568539X-00003315.

Kelly, A & Goodwin, S & Grogan, Adam & Mathews, Fiona. (2008). *Post-release survival of hand-reared pipistrelle bats (Pipistrellus spp).* Animal Welfare. 17.

Kerth, e. a. (2011). *Bats are Able to Maintain Long-term Social Relationships Despite the High Fission-fusion Dynamics of their Groups.* Proceedings of the Royal Society of Biology doi:10.1098/rpsb.2010.2718.

Lollar, A. (2010). *Standards and Medical Management for Captive Insectivorous Bats.* Texas, United States of America: Bat World Sanctuary.

Lyons, R. & Wimberley, P. (2017). *Introduction to the Care and Rehabilitation of Microbats (Focusing on Species of South East Queensland*). Pomona, Queensland: Wildcare Australia.

Neuweiler, G. (2000). *The Biology of Bats.* New York: Oxford University Press.

RACHEL LYONS has been rehabilitating various species of wildlife for over 20 years and is based in the Noosa Hinterland, Queensland. Rachel has been a Workshop Trainer and Species Coordinator with Wildcare Australia (South East Queensland) for 14 years and Trauma Carer for 12 years.

With an extensive background in the conservation/ecological management sector (her day job), Rachel has a keen interest in ensuring ecological principles and natural history is adequately incorporated into wildlife rehabilitation practices. Rachel's interest in microbats started over 15 years ago when she learned of the absence of scientifically sound information regarding care and rehabilitation of the various species in Australia. She set about researching as much as she could and in 2011 collaborated with Trish Wimberley of the Australian Bat Clinic to develop a full day training workshop and extensive manual on Microbat Rehabilitation.