Antimicrobial resistance and Australian wildlife

Fact Sheet

May 2024

Key points

- Antimicrobial resistance (AMR) is a significant and emerging global issue for humans, animals (including wildlife) and ecosystems and threatens the effective treatment and prevention of infections.
- Antimicrobial resistance is a One Health[1] challenge, as it is relevant to the health of humans, domestic animals, free-ranging and captive wildlife and the environment.
- Antimicrobial resistance in wildlife is well-documented, although wild animals are less likely to be directly exposed to antimicrobials than domestic animals or humans.
- Medical treatment of Australian wildlife should be carefully supervised by veterinarians, with the risks of AMR considered whenever treating and managing wildlife of all species.
- Antibiotics must **not** be used in Australian wildlife unless specifically prescribed by a registered veterinarian and "critically important antimicrobials (CIA) for human medicine" should **not** be used in wildlife.
- Biosecurity and infection prevention and control should be emphasised when working with wildlife, to prevent or minimise the risk of infection.

One Health implications

Antimicrobial resistance can reduce the effective treatment of microbial infections and may increase treatment costs (because higher doses or different, more expensive drugs or more impactful treatments must be used), thus negatively impacting human and animal health and welfare.

Wildlife and the environment: the role of wildlife and the environment in the spread of AMR, and the relative importance of the pathways by which wildlife may acquire AMR, is not fully understood. Antimicrobial resistance in wildlife is associated with proximity to humans or domestic animals. Generally AMR in wildlife has been associated with commensal[2] or indicator[3] bacteria with no clear direct health impacts on the host [1]. However, in some cases AMR may have an impact on the

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[1] One Health refers to an integrated, unifying approach that aims to achieve optimal and sustainable health outcomes for people, animals and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants and the wider environment are closely linked and inter-dependent (WHO 2023; https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance).

[2] bacteria which live on or in the host's body but do not affect the host's health

[3] types of bacteria used to monitor the presence of AMR which generally do not cause disease in the host

health of wildlife individuals and populations, by increasing untreatable infections and altering microbiomes. Wildlife may transmit and act as sentinels for AMR due to environmental contamination. These roles are likely to become more significant as wildlife, livestock and people are brought into closer contact through climate change and changing land use [2].

Domestic animals: AMR can negatively impact animal health and welfare, and reduce agricultural profit margins. Resistant organisms can spread from animals to people who are in contact with them and there is a strong link between AMR in humans and its occurrence in domestic animals [3], but no indication that AMR in wildlife is driving AMR in domestic animals (i.e. wildlife are "sink" rather than source of resistance) [4]. Food from animals with resistant organisms may also pose a risk to people.

Humans: AMR is a principal public health problem of the 21st Century threatening the effective treatment and prevention of an ever-increasing range of infections. AMR challenges must be addressed in the context of the anthropogenic impacts of climate change, biodiversity loss, and pollution and waste [5].

Mechanisms and drivers of antimicrobial resistance in wildlife

There are naturally-occurring antimicrobial molecules and antimicrobial-producing microbes in the environment, so AMR can be acquired by microbes through natural genetic mutation [6, 7]. However, AMR is mainly associated with exposure to antimicrobial drugs (or antimicrobial residues), which selects for AMR genes in the microbes. The microbes that are resistant will survive antimicrobial treatment and reproduce. Following the development of resistant microbes, resistance genes can be transmitted between microbes [6], in the absence of any antimicrobial compound being present [5]. The misuse and overuse of antimicrobials in humans, animals and plants are the main drivers in the development of AMR [8].

Antimicrobial resistance is commonly seen in many bacterial species, but development of multiple drug resistances (MDR; resistance to at least one agent in three or more antimicrobial categories) are of particular concern [9].

Although wild animals are less likely to be directly exposed to antimicrobials than domestic animals or humans, AMR is well documented in wildlife. Antimicrobial resistance in wildlife (both globally and in Australia) is increasingly linked to physical proximity to humans [2], or to anthropogenic pollution [10], which indicates **humans are driving the transfer of AMR organisms to wildlife** [9].

Transfer of AMR between humans, domestic animals and wildlife can occur through **shared, contaminated environments** [9]. Treatment of livestock and aquaculture systems with veterinary antimicrobials may result in AMR contamination of water sources or pasture [11]. Other sources of environmental AMR include contamination of water sources with human or livestock waste or application of manure from intensive livestock production to pasture [2, 12-15]. Microbes, antimicrobial agents and resistant genes may then be cycled and re-cycled through soil, ground water, marine water, wild animals, crops, shellfish and livestock [14].

Once AMR is present in the wild, wildlife can contribute to transmission of AMR across different ecosystems [7], including the aquatic and marine environments [16-20]. Free-ranging wildlife have the potential to act as reservoirs for AMR and resistant pathogens. Wild birds, predators and scavengers can move AMR across large distances [2]. Insects and pests (cockroaches, flies, rats and mice) can also act as vectors and transmit resistance [7].

Wildlife that spend time in captivity (e.g. through rehabilitation or captive breed for release programs) may receive antimicrobial treatment, or may be exposed to antimicrobial residues, resistant bacteria or resistance genes during their time in a captive environment. When released to the wild, they may carry these resistant microbes, providing an avenue for AMR to enter wildlife populations and the environment in general 19][21].

Presence of antimicrobial resistance in Australian wildlife

Evidence of AMR has been documented in both captive and free-ranging wildlife in Australia (Table 1); see also Power 2019 [9] for more details.

Table 1: Reports of antimicrobial resistance captive and free-ranging wildlife in Australia

Taxon	Status	Details	Reference
Mammals			
Various species	Free-ranging	Low but widespread prevalence in 77 species across 14 families, including platypus, koalas, wombats, dasyurids, macropods, potoroos, possums, gliders, bandicoots, mice and microbats	Sherley et al. 2000 [22], Gordon and FitzGibbon 1999 [23]; eWHIS
Macropods	Captive/ free-ranging Free-ranging	Yellow-footed rock-wallaby (*Petrogale xanthopus*) Black-flanked rock-wallaby (*P. lateralis*) Tammar wallaby (*M. eugenii)* Brush-tailed rock-wallaby (*P. penicillata)* Eastern grey kangaroo (*Macropus giganteus*)	Chen et al. 2014 [24], Chen et al. 2016 [25], Chen et al. 2015 [26] Power et al. 2013 [21] eWHIS
Pinnipeds	Captive/ free-ranging Free-ranging	Australian fur seal (*Arctocephalus pusillus doriferus*) Australian sea lion (*Neophoca cinerea*) New Zealand fur seal (*A. forsteri*)	Fulham et al. 2022 [10], Delport et al. 2015 [27] eWHIS
Bats	Captive/ free-ranging Free-ranging	Grey-headed flying-fox (*Pteropus poliocephalus*) Black flying-fox (*P. alecto*)	McDougall et al. 2019 [28] eWHIS
Birds			
Gulls	Free-ranging	Silver gull (*Chroicocephalus novaehollandiae*)	Tarabai et al. 2021 [29], Mukerji et al. 2019 [30], Wyrsch et al. 2022 [31], Oravcova et al. 2017 [32], Cummins et al. 2020 [33], Yerbury 2021 [34]
Penguins	Captive/ free-ranging	Little penguin (*Eudyptula minor*) Western rockhopper penguin (*Eudyptes chrysocome*)	Lundbäck et al. 2021 [35], Mukerji et al. 2020 [36] eWHIS

Taxon	Status	Details	Reference
Pigeons	Free-ranging	Rock dove (Columba livia) Bar-shouldered dove (*Geopelia humeralis*)	Mukerji et al. 2020 [36] eWHIS
Shorebirds	Free-ranging	Straw-necked ibis (*Threskiornis spinicollis*) Pied oystercatcher (*Haematopus longirostris*) Sooty oystercatcher (*H. fuliginosus*) Sharp-tailed sandpiper (*Calidris acuminata)* Sanderling (*C. alba)* Red-necked stint (*C. ruficollis)* Curlew sandpiper (*C. ferruginea*) Ruddy turnstone (*Arenaria interpres*) Bar-tailed godwit (*Limosa lapponica)* Double-banded plover (*Charadrius bicinctus*) Red-capped plover (*Ch. ruficapillus*) Mute swan (*Cygnus olor*)	Smith et al. 2022 [37] eWHIS
Seabirds		Crested tern (*Thalasseus bergii*) Caspian tern (*Hydroprogne caspi*) Great cormorant (*Phalacrocorax carbo*)	Smith et al. 2022 [37] eWHIS
Psittacines	Free-ranging Free-ranging	Rainbow lorikeet (*Trichoglossus haematodus*) Galah (*Eolophus roseicapilla*)	eWHIS eWHIS
Frogmouths	Free-ranging	Tawny frogmouth (*Podargus strigoides*)	eWHIS
Herpetofauna			
Chelonia	Captive/ free-ranging	Green turtle (*Chelodina mydas*)	Laborda et al. 2022 [7], Ahasan et al. 2017 [38]; eWHIS
Snakes and lizards	Captive Free-ranging	Eastern brown snake (*Pseudonaja textilis*) Bar-shouldered ctenotus (*Ctenotus inornatus*)	McWhorter et al. 2021 [39]
Frogs	Free-ranging	Southern bell frog (*Litoria raniformis*)	eWHIS

Factors that appear to contribute to establishment of AMR in Australian mammals, birds and reptiles include captive management [21, 27, 28, 35, 38], proximity to human habitation [7, 40], and association with humans and livestock or their environments [30, 31, 41-43]. Silver gulls (*Chroicocephalus novaehollandiae*) have been studied comprehensively in this context [22]. Due to their behaviour and ecology, including foraging at human refuse sites, they have the ability to accumulate and disseminate resistant bacteria over very large distances and they demonstrate a rich diversity of AMR and multi-drug resistance in gut flora, including evidence of AMR apparently derived from humans [29-33, 36].

Shorebirds of 12 species (including migratory species that breed in Australia and overseas) showed frequent evidence of AMR and resident birds were more likely to carry AMR bacteria than migratory birds [37].

Antimicrobial stewardship in Australian wildlife

An effective response to the continuing rise of antimicrobial resistance requires a One Health approach [44]. A major focus of managing AMR has been to reduce the inappropriate use of antibiotics in both humans and animals. There are no nationally-agreed guidelines for the use of antimicrobials in Australian wildlife, that are focused on minimising the spread of AMR. Knowledge of pharmacokinetics of antimicrobials in wildlife species remains limited and many antimicrobials are used in an "off-label" capacity in wildlife. Doses, frequency and duration of delivery and route of administration may be extrapolated from other wildlife or domestic species.

Recommendations for minimising AMR in Australian wildlife should be based on current knowledge and best practice in use of antimicrobials across both human (https://www.safetyandquality.gov.au/publications-and-resources/resource-library/therapeutic-guidelines-antibiotic-prescribing-primary-care-summary-table-2023) and animal (https://www.amrvetcollective.com/home/guidelines) sectors. Developing strong and achievable regulatory frameworks to reduce AMR relevant discharges into the environment is also important [5].

The following issues should be considered when addressing use of antimicrobials in Australian wildlife:

- Antibiotics should not be used in Australian wildlife unless specifically prescribed by a registered veterinarian.
- "Critically important antimicrobials for human medicine" should not be used in wildlife [45].
- Biosecurity and infection prevention and control (e.g. hygiene, asepsis, isolation, work flow practices, appropriate housing and husbandry) should be emphasised when working with wildlife, to prevent or minimise the risk of infection (see the National Wildlife Biosecurity Guidelines https://wildlifehealthaustralia.com.au/Portals/0/ResourceCentre/BiosecurityMgmt/National_Wildlife_Biosecurity_Guidelines.pdf).
- Husbandry recommendations for wildlife in care may include
  - individual housing of animals receiving antimicrobial therapy
  - reducing the number of animals in co-housing enclosures
  - preventing direct contact between animals from different co-housed groups
  - dedicated equipment for each enclosure
  - frequent cleaning and disinfection of equipment and enclosures
  - wearing gloves and changing them between enclosures and animals
  - frequent hand hygiene
  - preventing contact with free-ranging wildlife or domestic animals [46].
- The need to treat wildlife with antibiotics (including the choice of a suitable antimicrobial) should be confirmed through early, thorough and appropriate clinical and diagnostic investigation by the veterinarian (including microbiology and culture and sensitivity).
- The appropriate drug, dose, frequency, duration and method of delivery should be determined by the prescribing veterinarian, based on the information gathered above.
- Patients receiving antibiotic therapy should be regularly reviewed by the veterinarian.
- Extension or changes to treatment regimens should only occur after appropriate case review by the veterinarian.
- The use of other modalities for management of wounds (and in similar situations) in wildlife should be considered, for example best practice wound management, including the use of

topical antiseptics surgical debridement and advanced wound care products. Where possible, topical antibiotics should be used over systemic antibiotics.

- Antibiotics should not be used for any other non-antimicrobial purpose, unless backed by scientific evidence (and prescribed by a registered veterinarian for this purpose).
- AMR surveillance helps to generate information that assists in the evaluation of antimicrobial stewardship programmes, interventions, and the effectiveness of policy [47].

Surveillance and research

Wildlife Health Australia administers Australia's general wildlife health surveillance system, in partnership with government and non-government agencies. Wildlife health data is collected into a national database, the electronic Wildlife Health Information System (eWHIS). Information is reported by a variety of sources including government agencies, zoo based wildlife hospitals, sentinel veterinary clinics, universities, wildlife rehabilitators, and a range of other organisations and individuals. Targeted surveillance data is also collected by WHA. The national wildlife disease surveillance program captures data on AMR in free-ranging wildlife. See the WHA website for more information https://wildlifehealthaustralia.com.au/Our-Work/Surveillance and https://wildlifehealthaustralia.com.au/Our-Work/Surveillance/eWHIS-Wildlife-Health-Information-System.

Most surveillance programs focus on AMR in livestock and human clinical cases, with environmental perspectives, including wildlife, generally omitted [48]. Wildlife populations may act as sentinels for environmental contamination and may be useful targets for AMR surveillance programs. Surveillance of wildlife can inform on risks to human and animal health, thereby assisting in evaluation of current management practices and identifying suitable interventions [49].

Key knowledge gaps include:

- how AMR moves between wildlife, the environment, food and humans
- the relative importance of wildlife in the maintenance and dispersal of AMR
- the extent of AMR within the Australian free-ranging wildlife population and the environment
- usage of antimicrobials for the treatment of wildlife cases in rehabilitation.
- potential impact of AMR on the health of wildlife species.

A One Health approach is required to better understand the environmental dimensions of AMR and inform science-based decisions and actions [5, 50].

For more information on AMR and the development of the National Antimicrobial Resistance Strategy for Australia, see the Australian Government Department of Agriculture and Water Resources (www.agriculture.gov.au/animal/health/amr) and Department of Health (www.health.gov.au/internet/main/publishing.nsf/Content/ohp-amr.htm).

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Wildlife Health Australia recognises the Traditional Custodians of Country throughout Australia. We respectfully acknowledge Aboriginal and Torres Strait Islander peoples' continuing connection to land, sea, wildlife and community. We pay our respects to them and their cultures, and to their Elders past and present.

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