

Australian bat lyssavirus

Fact sheet

Introduction

Australian bat lyssavirus (ABLV) belongs to the same family as (but is antigenically distinct to) the rabies virus. ABLV causes similar clinical signs to rabies in affected people and animals. Bats are the natural reservoirs for the virus. Both flying-foxes and insectivorous bats (or 'microbats') may be infected. ABLV is of significant public health concern because infection causes an acute, fatal, neurological disease in humans.

Aetiology

The causative agent of ABLV is a virus: family *Rhabdoviridae*, genus *Lyssavirus* genotype 7 (van Regenmortel et al. 2000). Other lyssavirus genotypes (2, 4, 5 and 6) solely or mainly affect bats; classical rabies is genotype 1. There are two known sub lineages of ABLV, the yellow-bellied sheath-tailed bat variant and pteropid variant (Hooper et al. 1997; Gould et al. 2002; Barrett 2004).

Natural hosts

ABLV infections have been detected in all four of the mainland species of flying-fox in Australia:

- *Pteropus alecto* (black flying-fox)
- *P. scapulatus* (little red flying-fox)
- *P. poliocephalus* (grey-headed flying-fox)
- *P. conspicillatus* (spectacled flying-fox).

ABLV infection has also been confirmed in one species of insectivorous microbat, the yellow-bellied sheath-tailed bat (*Saccolaimus flaviventris*). Additionally, seroconversion has been identified in a total of seven genera within five of the seven families of Australian microbats: *Chaerephon* and *Austronomus* (family *Molossidae*), *Chalinolobus* and *Vespadelus* (family *Vespertilionidae*), *Hipposideros* (family *Hipposideridae*), *Macroderma* (family *Megadermatidae*) and *Saccolaimus* (family *Emballonuridae*) (Field 2005).

It should be assumed that all bat species are potential hosts of ABLV and all bats, regardless of their clinical state, should be handled as if potentially infected with ABLV. ABLV is most frequently detected in adult bats, however bats of any age may be infected with ABLV. In 2015, several 3-4 week old grey-headed flying-foxes developed neurological signs while in care and died as a result of ABLV. Large numbers of in-contact people

had been potentially exposed to the virus (NSW CVO 2015). The National Wildlife Health Information System (eWHIS) contains numerous other reports of dead or rescued juvenile bats testing positive for ABLV.

There have been three cases of ABLV disease in humans following a bite or scratch from a bat, all of which have been fatal (Allworth et al. 1996; Samaratunga et al. 1998; Hanna et al. 2000; Francis et al. 2014). Two horses with neurological disease, sharing a paddock in south-east Qld were found to be infected with ABLV in 2013 (Annand and Reid 2014). This was the first time ABLV had been detected in an animal other than a bat or human. In 2013 a dog in NSW that had caught and eaten a flying-fox tested antibody positive for ABLV (Wright 2013). It is probable that all mammal species are susceptible to infection because other lyssaviruses naturally infect numerous mammal species e.g. European bat lyssavirus-1 (Tjørnehøj et al. 2006; Dacheux et al. 2009).

In an experimental study, three cats and five dogs inoculated with ABLV seroconverted; all individuals survived although some showed mild transient behavioural changes. There was no evidence of virus excretion and no ABLV was detected at necropsy (McColl et al. 2007).

World distribution

ABLV has only been reported in Australia. Antibodies detected in bats in the Philippines indicate the presence of a naturally occurring lyssavirus related to ABLV. It is probable that variants of ABLV, or a similar virus, are present in bats in south-east Asia (Arguin et al. 2002; Gunawardena et al. 2016).

Occurrences in Australia

ABLV was first detected, in 1996, in a black flying-fox. While there are limited historical samples available, one retrospectively diagnosed case, also in a black flying-fox, occurred in January 1995 (Allworth et al. 1996; Speare et al. 1997; Samaratunga et al. 1998; Hanna et al. 2000).

ABLV infected bats have been reported from most states and territories of Australia (Table 1). Serological evidence suggests a wide geographical distribution in bats in Australia (Field 2005).

Table 1: ABLV infection in Australian bats as confirmed by FAT, PCR, IHC and/ or virus isolation[^], to 2015

Year	NSW	NT	Qld	VIC	WA	SA	Total
1995	0	0	1	0	0	0	1
1996	1	0	9	1	0	0	11
1997	7	1	27 ⁺	0	0	0	35
1998	1	0	26 ⁺	0	0	0	27
1999	0	0	6	0	0	0	6
2000	1	0	14	0	0	0	15
2001	0	0	9	1	4	0	14
2002	4	0	10	2	1	0	17
2003	6	0	3	2	0	0	11
2004	5	0	6	1	0	0	12
2005	6	0	5	0	0	0	11
2006	2	0	4	0	0	0	6
2007	6	0	2	0	0	0	8
2008	0	0	0	0	0	0	0
2009	2	0	8 ^a	0	0	0	10
2010	0	0	8	0	1	0	9
2011	0	0	4 ^a	2	0	0	6
2012	1	0	3	0	0	1	5
2013	3 ^a	0	11 ^a	0	0	0	14
2014	5	1	14 ^a	1	11 ^a	0	32 ^a
2015	10	1	11 ^a	0	0	0	22
Total	60^a	3	181^a	10	17	1	272^a

Source: 'Australian bat lyssavirus report' (Wildlife Health Australia 2016).

[^] ACT and Tas have not recorded any cases of ABLV infection that satisfy this case definition.

⁺ Higher numbers of ABLV infected bats were associated with peak years of testing in 1997-1998.

^a For some bats, one equivocal and one negative result (FAT/PCR) was recorded. These bats are not included in these figures as they were not confirmed to be ABLV infected.

* For up-to-date information see ABLV Bat Stats:

<http://www.wildlifehealthaustralia.com.au/ProgramsProjects/BatHealthFocusGroup.aspx>

Epidemiology

In general, the epidemiology of ABLV is known to be similar to that of other lyssaviruses, although aspects of the population dynamics are still not fully understood. In recent years, between five and several dozen lyssavirus-positive bats have been detected annually in Australia. Studies suggest that the prevalence of ABLV in Australian bat populations is low (Barrett 2004; Field 2005). A study of 475 wild-caught flying-foxes (Field 2005) found no evidence of current ABLV infection, and in another study there were no detections of ABLV infection in over 300 clinically normal, wild-caught flying-foxes and insectivorous bats (McCall et al. 2000). This is consistent with a population prevalence of less than 1%. In sick, injured or orphaned bats (which are also more likely to be in contact with wildlife carers or the general public) the prevalence of ABLV is higher (Field 2005; Barrett 2004).

The most important predictor for ABLV infection in flying-foxes is the presence of neurological signs. For microbats, species (*S. flaviventris*) appears to be the only identified risk factor (Field 2005).

ABLV is transmitted when the saliva of an infected animal is introduced via a bite or scratch, or by contamination of mucous membranes or broken skin. **Immediate action is required if people (or domestic animals) have been potentially exposed to ABLV (e.g. via a bat bite, scratch or other significant contact) [see Prevention and control]**. Other modes of transmission such as environmental contamination (aerosols, excreta, etc.) are of minor significance for rabies transmission and are expected to have a similarly minor role in the transmission of ABLV.

Clinical signs

Infection in bats and humans appears to follow a similar course to rabies in other mammals, with a relatively long, variable incubation period. A 10 to 29 day incubation has been reported in experimentally infected bats or in captive colonies exposed to infected bats (Fraser et al. 1996; McColl et al. 2002; Warrilow et al. 2003; Barrett 2004). This is followed by an acute, progressive and fatal clinical disease manifested as abnormal behaviour and paralysis.

Clinical signs are not always present in infected individuals (e.g. during the incubation period) and apparently healthy bats with normal behaviours may be infected with ABLV.

The following clinical signs in bats should raise a high index of suspicion of ABLV infection (especially if occurring with species and presentation risk factors as described in Epidemiology):

- excitation/ frenzy/ agitation
- aggression including unprovoked attacks on people and fighting with other bats
- unusual vocalisation or abnormal function of mouth
- inability to fly, especially with loss of hind limb function
- seizures/ tremors.

Bats with apparent respiratory difficulties should also be treated with increased suspicion for ABLV infection.

The two horses that were infected with ABLV both presented with clinical signs consistent with lyssavirus including pyrexia, depression and hind limb ataxia progressing to recumbency (Annand and Reid 2014).

Diagnosis

Case definitions in all species of animals are listed in the AUSVETPLAN Disease Strategy: Australian bat lyssavirus (Version 3.0), Table 1.4 (Animal Health Australia 2009).

Diagnosis on the basis of clinical signs and gross necropsy alone should not be considered definitive. Definitive diagnosis for ABLV is by laboratory detection of viral antigens or RNA. Brain or spinal cord are the preferred tissues for detection of ABLV infection. The fluorescent antibody test (FAT) provides rapid and reliable diagnosis of any lyssavirus infection in brain or other neurological tissue but is not specific for ABLV. Further testing is required to definitely identify the lyssavirus as ABLV and to differentiate the variant.

Serology is a valuable tool for ABLV surveillance at a population level but does not confer a clinical diagnosis, only evidence of exposure to lyssavirus or another cross-reacting antigen. Serology in a clinically well animal should not be used as a basis for assessing the potential future risk of the animal transmitting ABLV to others.

Antibody levels during the incubation period may be below detectable thresholds. While ante-mortem confirmatory diagnosis of clinical cases is possible (e.g. virus or RNA detection in saliva or cerebrospinal fluid),

virus may not be consistently present in samples other than brain, and ante-mortem testing is not considered a reliable tool for exclusion of ABLV infection (Animal Health Australia 2009).

Clinical pathology

No specific clinical pathological changes are recognized in ABLV infections.

Pathology

There may be no gross changes in bats that die from ABLV however poor body condition, a full bladder and/or food impaction in the mouth may be detected in bats with ABLV infection. The presence of other gross lesions may be as a result of ABLV-induced behavioural changes (e.g. trauma).

Histologically, there may be a non-suppurative meningoencephalitis, with perivascular lymphocytic cuffs, gliosis, meningitis, neuronal degeneration, intracytoplasmic vacuolation and neuronal intracytoplasmic eosinophilic inclusions (Negri bodies), and sialoadenitis, but the extent and severity of these lesions are variable and may be absent (Hooper et al. 1999; McColl et al. 2002; Barrett 2004).

Differential diagnoses

In one study, neurological syndromes in flying-foxes were attributed to: ABLV (32%); spinal and head injuries (29%); and neuro-angiostrongylosis (infection of the brain with the nematode parasite *Angiostrongylus cantonensis*; 18%) (Barrett 2004). Rabies (exotic to Australia), trauma (e.g. broken wing bones, head and spinal injuries), toxoplasmosis, lead poisoning and other toxicities, and other causes of neurological disease should also be considered (Skerratt et al. 1998; Sangster et al. 2012).

Laboratory diagnostic specimens

Submitters should contact the state/territory laboratory for advice on sample collection. In general, specimens should be chilled (preferably *not* frozen) and forwarded on ice to the relevant state or territory veterinary laboratory (or, in Qld where there has been human contact [bite, scratch, etc.], to Queensland Health Forensic and Scientific Services). Carcasses should be submitted whole, regardless of whether the head or parts of the skull are missing. Unless the operator is vaccinated and experienced, the head or brain should not be removed before submission due to the potential for self-inoculation. If the brain is to be removed, the laboratory should be contacted for advice on sample collection and storage.

Other tissues (salivary gland, spinal cord, and peripheral nerves and ganglia) can be tested but are less reliable for detection of ABLV than brain. The state/territory laboratory may forward specimens for testing or confirmation to the Australian Animal Health Laboratory.

It is essential that all clinical details are recorded, including a reliable taxonomic identification of the bat. If the species cannot be confirmed at the time of necropsy, photographs, along with the skull and carcass, should be retained for later identification by an experienced taxonomist.

Laboratory procedures

The following laboratory tests are employed in ABLV diagnosis:

Definitive tests (detecting virus) include:

- Pan-lyssavirus (non-specific) FAT on fresh or frozen brain or other nervous tissues
- Polymerase Chain Reaction (PCR) assay (e.g. TaqMan) on fresh brain
- Conventional PCR assay on fresh/ frozen brain or other nervous tissues, saliva, salivary gland, cerebrospinal fluid
- virus isolation in neuroblastoma cell cultures or mice using fresh / frozen tissues
- immunohistochemistry on fixed brain or nervous tissue.

Supportive tests (detecting exposure or prior infection - primarily useful for population dynamics and to further investigate the natural history of infection) include:

- serum neutralisation tests for rabies and ABLV
- competitive enzyme-linked immunosorbent assay on serum and plasma (Animal Health Australia 2009).

Treatment

There is no specific treatment for ABLV once the disease develops and it is almost invariably fatal. Immediate action following potential exposure to an infected bat is of the utmost importance (see Prevention and control).

Prevention and control

Only rabies-vaccinated people who are experienced in handling bats and wearing appropriate personal protective equipment (PPE) should handle, rescue or examine a bat. Rabies vaccination is presumed to provide cross-protection against ABLV in humans and animals (Barrett 2004). Pre-exposure vaccination is recommended (following a risk assessment by a medical practitioner) for people whose occupation or recreation activities place them at increased risk of being bitten or scratched by bats (Communicable Diseases Network 2014). Consult the current edition of The Australian Immunisation Handbook for further information about rabies vaccination (ATAGI 2016).

In the event of a bat bite, scratch or other significant contact, **apply immediate first aid** and **seek URGENT medical attention**. Bite or scratch wounds should be **immediately** washed thoroughly with soap and copious water for approximately 5 minutes and a virucidal antiseptic (e.g. povidone-iodine, iodine tincture, aqueous iodine solution or ethanol) applied after washing (Communicable Diseases Network 2014). Bat saliva in the eyes or mouth should be rinsed out immediately and thoroughly with water. Post-exposure prophylaxis may be administered to people with suspected or confirmed ABLV exposure. Contact your doctor or the local public health agency for more information and advice.

If contact between a bat and other animal has occurred, wash the wound where possible (as for human exposure) and **seek urgent veterinary advice**. Post-exposure prophylaxis (vaccination) may be available for domestic pets with suspect or confirmed exposure to an ABLV-positive bat. Contact a local veterinarian or the state/territory biosecurity agency for more information.

ABLV is endemic in wild bat species and control is not possible. Prevention of transmission should be based on avoiding potential contact with bats wherever possible, particularly those showing neurological signs. Community members should not handle bats. If a sick or injured bat requires help, contact a wildlife care organisation or your local veterinarian. If bats must be handled, every effort should be made to avoid being bitten or scratched. In captive bat colonies (including those at wildlife rescue facilities), transmission can be

minimised by avoiding contact with wild bats, keeping a closed colony, practicing all-in-all-out stocking and quarantine of incoming bats (Department of Agriculture and Fisheries 2015).

If a bat is suspected to be infected with ABLV, the state/territory biosecurity agency should be contacted for advice about testing.

The Qld government Department of Agriculture and Fisheries has a document “Australian bat lyssavirus guidelines for veterinarians” <https://www.daf.qld.gov.au/animal-industries/horses/horse-health-and-disease-management/information-for-veterinarians/australian-bat-lyssavirus-handling-guidelines> and a similar NSW government document is available

http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0007/513547/Australian-bat-lyssavirus-guidelines-for-veterinarians.pdf.

Surveillance and management

The AUSVETPLAN for ABLV should be referred to for more information (Animal Health Australia 2009). ABLV is not an OIE-listed disease and Australia maintains ‘rabies-free’ status because the genotype of ABLV is recognized by the OIE as sufficiently distinct from classical rabies and the epidemiology of ABLV poses negligible risks to trade.

ABLV is a nationally notifiable disease in both animals and humans (Department of Health 2015; DAWR 2016). Trace-back activities, quarantine, clinical monitoring and euthanasia may be instigated in domestic animals confirmed with, or suspected of, ABLV infection. Surveillance for ABLV is mainly passive; bats associated with human or animal contact, or showing neurological signs, are submitted for laboratory testing. Increased surveillance may be undertaken if ABLV is diagnosed in a non-bat species. Wildlife Health Australia maintains a national dataset of ABLV testing in bats (see Statistics).

Links to other ABLV information resources may be found on the WHA website www.wildlifehealthaustralia.com.au under Resources; Disease and disease agents; Australian bat lyssavirus, and on the WHA Bat Health Focus Group page.

Statistics

Wildlife disease surveillance in Australia is coordinated by Wildlife Health Australia. The National Wildlife Health Information System (eWHIS) captures information from a variety of sources including Australian government agencies, zoo and wildlife parks, wildlife carers, universities and members of the public. Coordinators in each of Australia's States and Territories report monthly on significant wildlife cases identified in their jurisdictions. NOTE: access to information contained within the National Wildlife Health Information System dataset is by application. Please contact admin@wildlifehealthaustralia.com.au.

Wildlife Health Australia maintains a national dataset of ABLV testing in bats. A six-monthly summary of the data is available through the WHA publication ABLV Bat Stats <http://www.wildlifehealthaustralia.com.au/ProgramsProjects/BatHealthFocusGroup.aspx> (Wildlife Health Australia 2016).

Research

Key questions for investigation include:

- Are other species of wildlife susceptible to infection with ABLV? Could maintenance cycles be established in any of these species and what are the conditions under which this might occur? How would such events be identified, prevented or controlled?
- How effective are conventional rabies vaccines in protecting against ABLV? If efficacy is lower than homologous rabies virus protection, then how should vaccination regimens for ABLV be modified to take this into account?
- What is the pathogenesis of neurological disease following infection of the host?

Human health implications

ABLV is a notifiable human disease and any potential human ABLV exposure is notifiable in all Australian jurisdictions. People should not handle bats unless they have been effectively vaccinated and trained. ABLV infection causes an acute, fatal, neurological disease in humans. Three humans have died from ABLV following the bite or scratch of a bat and there is no effective treatment following the onset of clinical disease.

Deaths from ABLV infection may only be prevented by proactively taking preventive action. First aid should be commenced immediately if there is any suspicion of exposure to ABLV, and health care providers should be contacted urgently (see Prevention and control). For more information, (including first aid) for medical practitioners, veterinarians and the general public consult:

Rabies, Australian bat lyssavirus and other lyssaviruses – Information for consumers (Department of Health)
<http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-rabies-consumer-info.htm>

Rabies and ABLV Series of National Guidelines (SoNG)
<http://www.health.gov.au/internet/main/publishing.nsf/Content/cdna-song-abvl-rabies.htm> (Communicable Diseases Network 2014).

The Australian Immunisation Handbook
<http://www.immunise.health.gov.au/internet/immunise/publishing.nsf/Content/Handbook10-home~handbook10part4~handbook10-4-16>

Conclusions

Bats are the natural reservoirs for ABLV. Bats (both flying foxes and microbats) of any age or species should be considered at risk for ABLV infection, and clinical signs are not always apparent in infected bats. ABLV infection in humans occurs very rarely, however the consequences of infection are severe (death). ABLV is a notifiable human and animal disease. Pre-exposure prophylaxis, specific training in the handling of bats and appropriate use of personal protective equipment is considered essential for people having contact with bats. Contact between bats and other animals should be prevented. Further research into species susceptibility, transmission dynamics, pathogenesis in bats and other species, and efficacy of rabies vaccines could better quantify and mitigate the risks of ABLV to humans, bats and other animals.

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