



## ORIGINAL ARTICLE

# Communicating the risks of handling bats: analysing approaches used by Australian stakeholders in the context of Australian bat lyssavirus

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Australian bat lyssavirus (ABLV) is a member of the *Lyssavirus* genus of the *Rhabdoviridae* family and is found in Australian bat species. It is of public health concern because of the rabies-like syndrome it causes in humans, resulting in government health and wildlife agencies using varied communication approaches to inform targeted audiences about zoonotic risks associated with handling bats. Despite these warnings, the number of reports of human-bat interactions remains high. This paper details a survey conducted to analyse the approaches utilised by a range of stakeholders to educate and communicate warnings to their target audiences. The survey focused on identifying the target audiences, communication methods used, along with the message frequency, content, and perceived effectiveness. Analysis of the top three messages delivered by stakeholders revealed that over half were information-focused messages and over a third, instruction-focused. Stakeholders identified the need to balance messaging about bat handling risks with information regarding the vulnerable status of bats and their environmental significance. Whilst the most common and (perceived) effective method of communication was one-on-one discussions, it was also identified to be ineffective for targeting mass audiences leading stakeholders to recognise the need to adapt to more efficient means of communication. The outcomes of this study may be useful to improve risk communication strategies regarding ABLV in Australia.

**Keywords** ABLV; Australian bat lyssavirus; bats; risk communication; zoonotic risks

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Australian bat lyssavirus (ABLV) is endemic in the bat population throughout Australia and was first discovered in 1996.<sup>1,2</sup> The virus belongs to the *Lyssavirus* genus of the *Rhabdoviridae* family, which also includes the classic rabies virus.<sup>2</sup>

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Prevalence of ABLV among healthy bats is thought to be as low as <1%, however the prevalence in injured or sick bats can range from 5% to as high as 10%.<sup>3–5</sup> The latter is concerning because the Australian public, wildlife rehabilitators, and animal health professionals alike are more likely to encounter sick and injured bats.<sup>6</sup> ABLV is a public health concern and has similarities to rabies virus in that it: (1) can manifest as a fatal neurological disease if a person is scratched or bitten by an ABLV positive bat but does not seek post-exposure prophylaxis, and (2) is transmitted from bats to humans via infected bat saliva either through a bite or scratch wound.<sup>7</sup> Besides ABLV, bats are identified as reservoirs for several other zoonotic pathogens including those in the *Paramyxoviridae* (Nipah virus and Hendra virus), *Coronaviridae* (Severe Acute Respiratory Syndrome Coronavirus [SARS-CoV] 1 and 2 and Middle East Respiratory Syndrome Coronavirus [MERS-CoV]) and *Filoviridae* families (*Ebolavirus* and *Marburgvirus*).<sup>8,9</sup> To date, there have been three confirmed fatal cases<sup>10–12</sup> and one suspected ABLV case<sup>13</sup> reported in people and two in horses,<sup>14</sup> all occurring in Queensland.

Because of the fatal outcomes associated with ABLV infections, government health departments and various other government agencies, wildlife rehabilitators, and bat handlers have been communicating messages to the general public regarding the risks associated with bat contact or handling especially if the bat is sick or injured.<sup>15</sup> Despite these communication attempts, members of the public have apparently continued to interact closely with bats even if aware of the risks of ABLV infections.<sup>7,16</sup> Between 2007 and 2011, there was a four-fold increase in people receiving post-exposure treatment in New South Wales (NSW) due to bat contact, with a rise from 31 to 131 people.<sup>17</sup> Furthermore, the NSW Annual Zoonoses Report identified that the number of local exposures continued to increase annually with 174 people requiring post exposure prophylaxis treatment due to contact with bats in 2018.<sup>18</sup>

In a survey of 821 adults in NSW aged 16 years and older, 14% of the participants stated they had handled bats in the past, while 25% of the participants said they would handle injured bats if confronted with one despite being aware of the risk of infection and fatal consequences.<sup>15</sup> The study attributed the ongoing public interaction with bats, despite the risks, as resulting from empathising with animals and wanting to alleviate their suffering.<sup>15</sup>

Certain environmental and social factors have also contributed to the increased opportunity for people to come in contact with bats.

Increasingly, human activity is encroaching on bats' natural habitat, with a loss of habitat and food due to land clearing.<sup>19</sup> In addition, agricultural crops and planting in private gardens (e.g. fruit orchards and flowering/fruited trees in gardens) are creating new bat food sources drawing them closer to human populations.<sup>19</sup> Furthermore, extreme heat events linked to climate change have resulted in heat stress events leading to mass bat deaths, with increased potential for human exposure when well-intentioned people try to recover surviving or recently deceased animals.<sup>19,20</sup>

Considering the above factors, it has become increasingly important to ensure that the ABLV-related risk messaging by stakeholder groups is relevant, accurate and effective, and targets the appropriate audiences utilising the most appropriate communication strategies. As a first step towards developing recommendations to achieve these messaging requirements, this study surveyed different stakeholder groups such as government health departments and other agencies, along with wildlife rehabilitators regarding their ABLV communication strategies in order to: (1) identify the audiences that stakeholders target, (2) analyse communication methods stakeholders are using to deliver these messages, and (3) develop a framework for stakeholders to use when formulating messages for the targeted audiences.

## Materials and methods

### Ethics

Ethics approval for this study was granted by the University of Sydney Human Ethics Committee (protocol number 2018/097).

### Study design and participant recruitment

All participants (stakeholders) were eligible to take part in this cross-sectional study if they identified themselves as being involved in informing an audience about the ABLV risk associated with handling bats. Stakeholders included people working in government agencies, academia/research, veterinary professions, wildlife health/rehabilitation, medical practice, and public health. The initial survey link was distributed to participants by NSW Department of Primary Industries (NSW DPI) on the authors' behalf, as NSW DPI is the lead agency in NSW for the management of ABLV and is in contact with a broad cross section of stakeholders. To expand the reach of the survey further, a snowballing sampling approach was undertaken whereby participants were asked to distribute the survey onwards to other eligible stakeholders.

### Survey procedure

A bespoke survey was developed to identify the scope of audiences, approaches, messages, and methods used by stakeholders to communicate the risks of handling bats. The survey was developed by the research team following a stakeholder workshop held in Sydney attended by a mix of different stakeholders. The survey was conducted via an on-line questionnaire (SurveyMonkey®, California, USA) and ran from 1 to 31 July 2018. Response choices were either multiple choice (single and multiple selection) or free textbox. The questionnaire comprised 11 questions divided into three main sections (Appendix S1). The first section of the survey focused on the demographics of the

respondents including their occupational field and their current location. The second section of the survey focused on the respondents' target audiences, methods of communication, and communication messages. The goal was to gather the messages being delivered, identify the approaches respondents used to communicate with their target audiences, and to identify who their main audiences were. The third section of the survey focused on respondents' perceptions of the effectiveness of their communication messages and methods, gauge the scope and diversity of their messages, and identify any gaps they perceived in their current messages and methods. They were asked to rate the effectiveness of their communication methods on a scale, ranging from 1 being 'not at all' effective to 4 being 'extremely' effective. The draft survey was successfully piloted on three research team members' colleagues working in Primary Industries, social research, and veterinary studies to check for inconsistencies in understanding, use of terminology, and general face validity.

### Data analysis

Participants' occupational field was used as a pragmatic way to group respondents – delineating the various roles and responsibilities, skills, and activities, and by extension, segmenting the various likely audiences they would be communicating with and the messaging they might be using. Respondents were allocated to five main groups depending on their occupational fields and roles: (1) government, (2) wildlife, which included wildlife rehabilitators, wildlife rescuers and those involved in bat conservation (such as NSW Wildlife Information Rescue and Education Service [WIRES] and Wildlife Health Australia), (3) academia and research, (4) public health, and (5) animal health specialist, which included individuals that work in veterinary professions such as veterinary nurses, and veterinarians. Respondents that did not provide this information were excluded from the analysis. Primarily a descriptive analysis approach was taken, with frequencies and the mean ratings analysed for questions that required respondents to provide a rating. All results were rounded to one decimal place.

To assess the risk communication used by stakeholders, respondents were asked to provide the top three messages they used when communicating to their audiences. The intention of the message analysis was to look broadly across Australian stakeholders to gain an indication of the diversity of their risk messaging, and in doing so provide an assessment of the commonality of the content as well as potentially highlighting any gaps. This question generated open text data that were coded using a summative content analysis approach.<sup>21,22</sup>

The data provided by respondents was suited to this method of analysis because it was in the form of short text strings, rather than narrative content, requiring minimal interpretation or inference of meaning, for example, 'don't touch bats'. This observation about the data is unsurprising, given that these messages are intended to have clear and unambiguous meaning for target audiences and, typically, have to be carefully crafted.

To extract additional value from the analysis of the qualitative data, a second analysis was undertaken to categorise the nature of the content of the messages, specifically whether the stakeholder

**Table 1.** Demographics (stakeholder occupational field and state) of online survey respondents, who communicate to audiences regarding Australian bat lyssavirus and bat handling risks in Australia

Occupational field	<i>n</i> = 134
Academia/research	8 (6.0%)
Government	38 (28.5%)
Public health	16 (11.9%)
Animal health specialist	13 (9.7%)
Wildlife	59 (44.0%)
State	<i>n</i> = 133
New South Wales	91 (68.4%)
Northern Territory	3 (2.3%)
Queensland	25 (18.8%)
South Australia	7 (5.3%)
Victoria	6 (4.5%)
Western Australia	1 (0.8%)

*n*, number of respondents.

transmitting the message was providing information, instruction, or a mixture of both. This second stage analysis was post hoc and driven by researcher observations from the data in the initial content analysis. Again, assessment of the nature of the content in this way required minimal interpretation and could be readily assessed using keywords as part of content analysis. For example, messages that contained instructions had specific action phrases 'do not', 'if then' statements, and directive verbs 'report', 'educate', and 'call'.

After an initial read through of the message data, a word cloud was used to visualise the most frequently reported words in the stakeholder messages, and this helped to inform the message 'themes' and 'sub-themes' (labels) that were used to cluster and categorise the data in the content analysis. Most individual messages could be

coded into one theme but, where required, messages were coded into more than one theme. For the second stage content analysis on the nature of the message content, each message was only allocated into a single code. The qualitative analysis was conducted by authors MRT and BPL.

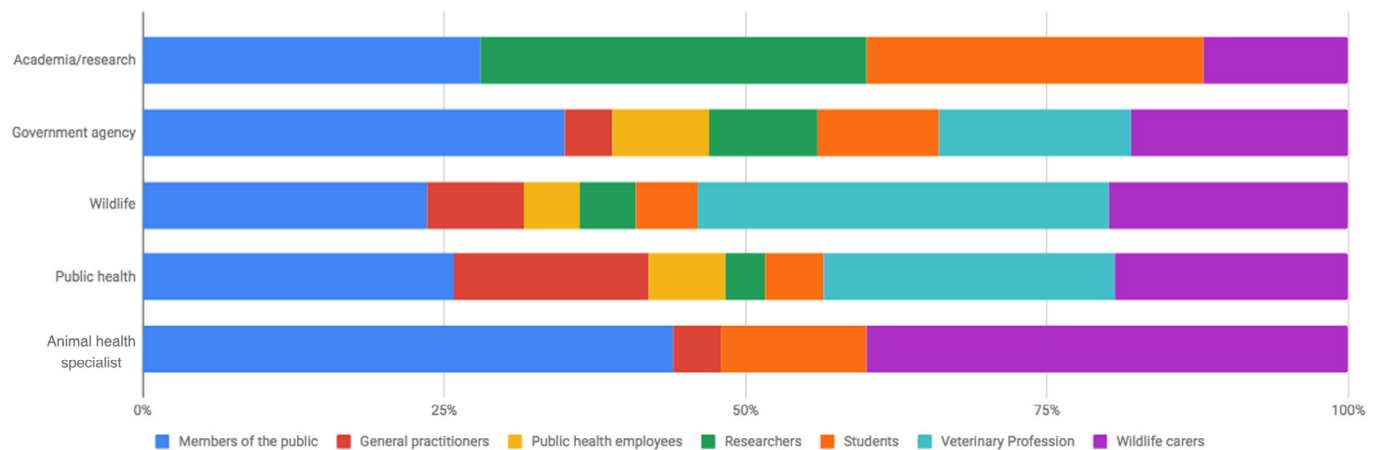
## Results

### Overall responses

A total of 137 responses were received. Three responses were excluded due to respondents not indicating their occupational fields and roles, resulting in 134 responses being analysed and reported. Five stakeholder groups were used in the following analyses based on these occupational fields and roles. In total, eight respondents were in academia and research (6.0%), 38 worked in government (28.4%), 16 in public health (11.9%), 13 were veterinary health specialists (9.7%), and 59 worked with wildlife (44%) (Table 1). A total of 133 responses indicated which state they were located in, with the greatest representation being from respondents based in New South Wales (68.4%) and Queensland (18.8%) (Table 1).

### Target audiences

There were some similarities in target audiences among the five groups (Figure 1). All stakeholder groups identified wildlife rehabilitators, students (both school-aged and higher education students) and the general public as target audiences. Members of the public were identified as the main target audience by the following stakeholder groups: government (*n* = 35, 32.7%), public health (*n* = 16, 25.8%), animal health specialist (*n* = 11, 27.5%), and wildlife (*n* = 56, 23%), whereas academia/research stakeholders' main audience was researchers (*n* = 8, 27.6%). Government, public health, and wildlife stakeholder groups reported that all seven audience categories included in the survey were part of their target audience. (Figure 1).



**Figure 1.** Percentage breakdown of target audiences that stakeholders communicate with regarding Australian bat lyssavirus and bat handling risks (total responses = 482; total academia/research responses = 29; total government responses = 107; total wildlife responses = 244; total public health responses = 62; total animal health specialists responses = 40).

**Table 2.** Self-reported communication methods used by stakeholders to communicate with their audiences about Australian Bat Lyssavirus and bat handling risks

Groups	Email newsletter	One-on-one discussions	Presentation/lectures	Print newspaper	Printed information	Radio	Social media	Television	Website
Academia/research ( <i>n</i> = 54)	5 (9.3%)	21 (38.9%)	5 (9.3%)	2 (3.7%)	5 (9.3%)	1 (1.9%)	5 (9.3%)	0 (0.0%)	10 (18.5%)
Government ( <i>n</i> = 281)	17 (6.0%)	143 (50.8%)	19 (6.8%)	6 (2.1%)	44 (15.7%)	1 (0.4%)	17 (6.0%)	2 (0.7%)	32 (11.4%)
Public health ( <i>n</i> = 122)	13 (10.7%)	63 (51.6%)	6 (4.9%)	0 (0.0%)	20 (16.4%)	0 (0.0%)	3 (2.5%)	0 (0.0%)	17 (13.9%)
Animal health specialist ( <i>n</i> = 50)	4 (8.0%)	17 (34.0%)	6 (12.0%)	1 (2.0%)	6 (12.0%)	0 (0.0%)	1 (2.0%)	0 (0.0%)	15 (30.0%)
Wildlife ( <i>n</i> = 396)	21 (5.3%)	176 (44.4%)	38 (9.6%)	17 (4.3%)	49 (12.4%)	11 (2.8%)	39 (9.8%)	4 (1.0%)	41 (10.4%)
Overall average ( <i>n</i> = 903)	60 (6.6%)	420 (46.5%)	74 (8.2%)	26 (2.9%)	124 (13.7%)	13 (1.4%)	65 (7.2%)	6 (0.7%)	115 (12.7%)

*n*, number of responses.

### Communication methods

Stakeholders were asked to identify the communication methods used for each of their target audience groups. These included email newsletters, one-on-one discussions, presentations/lectures, print newspapers, printed information, radio, social media, television, and websites. Collectively, for all audience types, one-on-one discussions was reported most frequently by stakeholder groups (46.5%), and this was the method used more when communicating with members of the public or veterinary profession (Table 2). Printed information was the second most common method used across all stakeholder groups (13.7%) followed by websites/online (12.7%). Television, radio, and print newspaper were the methods used least frequently overall (0.7%, 1.4%, and 2.9% respectively).

Of the different communication methods, government and public health stakeholders used one-on-one discussions with their target audiences proportionately more than other stakeholder groups (50.8% and 51.6%, respectively) (Table 2). Printed information is the second most used communication method among the five groups (13.7%) and it is also the second most commonly used communication method by government (15.7%), public health (16.4%), and the wildlife groups (12.4%). Television is the least used method for all five groups (0.7%).

The frequency of communication between stakeholders and their audiences varied (Table 3), however on average, stakeholders communicated with their audiences most commonly on a monthly basis (23.6% of all communication was delivered monthly). The

government and the animal health specialist stakeholders sent communications least frequently of all the groups with 51.2% and 56.6% of all communications, respectively, being sent six-monthly or annually. By comparison, just under half of all wildlife stakeholder communications were sent monthly or weekly (48.5%).

Stakeholder ratings of the perceived effectiveness of different methods varied (Table 4). Overall, one-on-one discussions were rated as the most effective (mean = 3.1) and print newspaper as least effective (mean = 1.7). Within stakeholder groups, all groups except academia/research rated one-on-one discussion as the most effective, whereas the latter group rated presentations/lectures as most effective.

When asked if they would consider changing their communication methods, about two thirds of the total respondents (*n* = 84, 62.7%) stated they would (Table 5). Academia/research stakeholders were most willing to consider changing their communication methods. Optional comments were provided by respondents indicating the methods they would consider utilising in future, with websites and social media being identified most frequently.

### Messages

Respondents were asked to provide details of the three main messages they deliver to their audiences (in no particular order). Some were reported by respondents as specific messages, and some were reported as a summary of the content. A total of 259 messages were provided by stakeholders. A word cloud was

**Table 3.** Frequency of communication reported by stakeholders that communicate with their audiences about Australian bat lyssavirus and bat handling risks

Groups	Once a week/ weekly basis	Once a month/ monthly basis	Once every 3 months	Once every 6 months	Once a year
Academia/research ( <i>n</i> = 19)	3 (15.8%)	5 (26.3%)	6 (31.6%)	4 (21.1%)	1 (5.3%)
Government ( <i>n</i> = 104)	9 (8.7%)	18 (17.3%)	23 (22.1%)	28 (26.9%)	26 (25.0%)
Public health ( <i>n</i> = 61)	10 (16.4%)	18 (29.5%)	14 (23.0%)	12 (19.7%)	7 (11.5%)
Animal health specialist ( <i>n</i> = 53)	2 (3.8%)	14 (26.4%)	7 (13.2%)	15 (28.3%)	15 (28.3%)
Wildlife ( <i>n</i> = 229)	56 (24.5%)	55 (24.0%)	39 (17.0%)	32 (14.0%)	47 (20.5%)
Overall average ( <i>n</i> = 466)	80 (17.1%)	110 (23.6%)	89 (19.0%)	91 (19.5%)	96 (20.6%)

*n*, number of responses.

**Table 4.** Stakeholders' perceptions about the effectiveness of the communication methods they use with their audiences regarding Australian bat lyssavirus and bat handling risks

	Academia/research	Government	Public health	Animal health specialist	Wildlife	Average
Email newsletter	2.3	2.0	2.7	2.0	2.2	<b>2.2</b>
One-on-one discussions	2.6	3.2	3.4	2.9	3.4	<b>3.1</b>
Presentations/lectures	3.3	2.8	3.1	2.1	2.9	<b>2.8</b>
Print newspaper	1.5	1.7	2.2	1.3	1.9	<b>1.7</b>
Printed information	2.0	2.4	2.7	2.7	2.7	<b>2.5</b>
Radio	2.0	1.8	2.4	1.5	2.1	<b>2.0</b>
Social media	2.3	2.4	2.4	1.7	2.4	<b>2.2</b>
Television	2.5	1.8	2.9	1.5	2.0	<b>2.1</b>
Website	2.5	2.0	2.4	2.4	2.4	<b>2.3</b>

Scale: 1 = not at all; 2 = somewhat; 3 = very; 4 = extremely.

created (Figure 2) showing that the words 'bats', 'touch', 'handle', 'risk', and 'vaccinated' were the most frequently used and these words were used to guide the content analysis and subsequent theme naming convention. Although most individual messages could be coded into one theme, some were coded into more than one theme and a total of 316 coding entries were recorded from the 259 messages. Table 6 summarises this analysis and includes examples of some of these messages, as reported by respondents.

Stakeholder messages were coded into six themes: Handling bats (31.3%,  $n = 99$ ), Risk awareness (19.3%,  $n = 61$ ), Mitigation of risk (23.7%,  $n = 75$ ), Value of bats (17.7%,  $n = 56$ ), ABLV specific messages (4.4%,  $n = 14$ ), and Other/non-specific (3.5%,  $n = 11$ ). Over half the messages reported by this sample of stakeholders could be characterised as relating to (not) handling bats and mitigation of risk. The former were mostly simple, direct messages about not handling, or generally avoiding contact with bats. This straightforward message formed part of just under a quarter of all messaging reported by stakeholders (23.4%,  $n = 62$ ). Where additional messaging was provided it was typically to draw attention to the need for those who handle bats to have handling experience and/or to be rabies vaccinated. Risk mitigation messaging included directions

about what to do if bitten or scratched, and advice about reporting sick or injured bats to wildlife rehabilitators or similar. Additional messages included information about how to handle bats safely, using personal protective equipment (PPE) and avoiding being bitten.

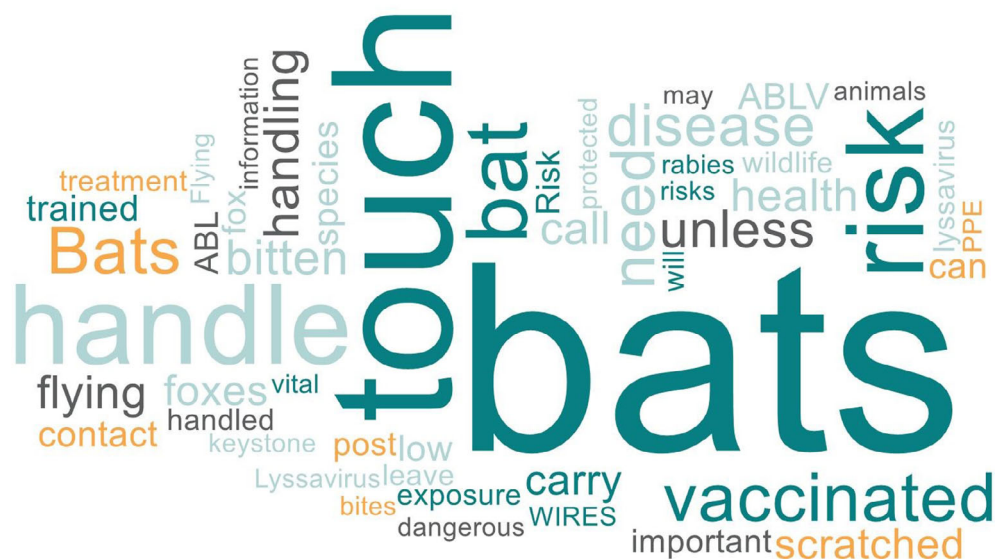
The next most frequently used messages related to risk awareness and the value of bats. Risk awareness messaging included general information regarding the risk that bats pose. Some messaging included a more balanced consideration of risk, typically stating that the risk of Lyssavirus was generally low and that not all bats carried the virus. One consistent risk awareness message was that if you do not handle bats there is no risk – 'no touch, no risk'. Messaging categorised as placing value on bats outlined their importance to the ecosystem, that they were threatened or vulnerable, and generally advocated for compassion and concern for their welfare, as well as reassuring audiences about the low risk posed to them by bats in general.

In terms of less frequently reported themes and sub-themes in messaging, a relatively small proportion of the messages (4.4%) were categorised as containing ABLV-specific information concerning the virus and its consequences for people who become infected, and

**Table 5.** Stakeholders' opinions about changing communication methods/messages they use to communicate with audiences regarding Australian bat lyssavirus and bat handling risks and gaps/difficulties identified by the respondents regarding delivering their messages

Stakeholder group	Consider hanging communication method, $n = 134$		Gaps/difficulties identified in delivering messages, $n = 133$		Consider changing messages, $n = 133$	
	No	Yes	No	Yes	No	Yes
Academia/research	1 (12.5%)	7 (87.5%)	2 (25.0%)	6 (75.0%)	4 (50.0%)	4 (50.0%)
Government	13 (34.2%)	25 (65.8%)	15 (40.5%)	22 (59.5%)	16 (42.1%)	22 (57.9%)
Public health	6 (37.5%)	10 (62.5%)	3 (18.8%)	13 (81.2%)	2 (13.3%)	13 (86.7%)
Animal health specialist	4 (30.8%)	9 (69.2%)	4 (30.8%)	9 (69.2%)	7 (53.8%)	6 (46.2%)
Wildlife	26 (44.0%)	33 (56.0%)	20 (33.9%)	39 (66.1%)	30 (50.8%)	29 (49.2%)
Total	50 (37.3%)	84 (62.7%)	44 (33.1%)	89 (66.9%)	59 (44.4%)	74 (55.6%)

$n$ , number of respondents.



**Figure 2.** Word cloud providing a weighted visualisation of the 50 most frequently used words in the three main messages delivered to target audiences about Australian bat lyssavirus and bat handling risks as reported by stakeholders. More frequently used words have larger font sizes.

**Table 6.** Thematic analysis of the top three messages used by stakeholders

Message themes	Sub-themes	N	Example messages/message sentiments
Handling bats	Do not handle bats/avoid contact with bats	62	Do not handle bats, even if dead. Do not attempt to handle any bat.
	Only those who are trained should handle bats	14	Do not handle bats unless you are trained to do so.
	Only those who are vaccinated should handle bats	23	Only vaccinated, experienced handlers should touch bats
Risk awareness	General risk awareness – bats pose a risk/general risks/other risks, for example, Hendra virus	19	Bats in Australian pose a significant risk. Bats in Australia can carry rabies-like disease.
	Balanced consideration of risk – ABLV risk is generally low, not all bats have the virus, things that are/are not a risk, for example, urine, faeces.	29	Not all bats carry lyssavirus. Flying fox faeces and urine are not carriers of ABLV.
	There's no risk if you do not handle/touch bats, bats are not aggressive/will not attack you	13	The risks of contracting ABLV are not present if physical contact does not occur. No touch, no risk.
Mitigation of risk	Safe behaviours – how to handle/manage bats safely, how to avoid being bitten, the need to use PPE/take precautions	15	For microbats, use gloves to handle. Vaccinate. Washing hands after handling bats.
	Reporting – who to call/what to do if you find a bat/advice to report	24	If you find a sick bat, report it to WIREs, do not touch it. Call a vaccinated and licensed carer who can help.
	What to do if bitten or scratched	32	Report bites and scratches. If bitten, go to hospital or GP immediately.
	Need to protect pets/children and keep them away from bats	4	Educate your children to not touch bats (dead or alive).
Value of bats	Significance – importance of bats for the environment, threatened/vulnerable species	34	Bats are protected and are special, do not hurt them. Bats are very important to our ecosystem.
	Compassion for bats – care for their welfare, reducing fear, advocating for kindness towards them, reassurance about (low) risk	22	Bats are not disease carrying vermin, they are extremely clean and healthy critical species. Do not panic about a bat.
ABLV specific	General awareness that bats can carry ABLV	4	Both mega and micro bats can carry the virus.
	Specific information about ABLV – how dangerous it is, consequences of it for people	10	Risk of ABLV and post exposure treatment. ABLV is a devastating fatal illness in humans.
Other	Non-specific comment – unable to code	11	Awareness. Protection. Public health units have more information than GPs.

Number of specific messages = 259. Number of coding entries = 316 as some messages related to more than one theme.

relatively few stakeholders mentioned dangers posed to children and pets, and the need to select appropriate netting to avoid entangling bats.

The messages were coded to categorise the nature of the message being delivered. The majority of messages (59.4%,  $n = 154$ ) were categorised as 'information' – that is, imparting knowledge, facts or relevant details (e.g. 'Lyssavirus is not common in flying fox populations', 'bats are vital to the health of our ecosystem'). Just over a third of messages (35.1%,  $n = 91$ ) were categorised as 'instruction' – that is, providing direction about what should be done (e.g. 'do not handle bats', 'if bitten seek medical attention immediately'). A small proportion of messages (2.3%,  $n = 6$ ) contained 'a combination of information and instruction' – that is, telling people what to do and why to do it (e.g. 'do not touch bats, as they can carry Lyssavirus', 'do not handle bats, as you may be bitten or scratched').

A total of 66.9% ( $n = 89$ ) of respondents agreed that there were gaps in the messaging or difficulties in delivering their messages (Table 5). Some of the reoccurring gaps and difficulties outlined in open text related to themes of media misinformation and hysteria, negative misconceptions and fears about bats and ABLV preventing people engaging with messaging, and lack of communication to some segments of the population, for example, culturally and linguistically diverse (CALD) communities, and tourists.

Approximately half of the academia/research ( $n = 4$ , 50%), animal health specialist ( $n = 6$ , 46.2%), and wildlife ( $n = 29$ , 49.2%) group respondents considered changing their messages whereas the proportion of respondents who would consider changing their message was much larger in the government and public health stakeholder groups (57.9%,  $n = 22$  and 86.7%,  $n = 13$ , respectively) (Table 5). In open comments, a small number of respondents ( $n = 4$ , 2.9%) stated that communication methods and messages were interlinked such that if the communication method was not effective, then the messages delivered would be ineffective as well. Five respondents stated that they would change their messages if a certain message was demonstrated to be more effective than other messages and five others stated that they would be open to changing their messages based on new information and knowledge.

## Discussion

This study provides a snapshot of the risk messaging approaches, the main risk messages, and details of the target audiences of a broad range of stakeholder groups with responsibilities for communicating about ABLV. The study identified that the general public is a target audience for all stakeholder groups, and that most stakeholder groups target multiple audiences with their messaging. One-on-one discussion is the communication method most used by all stakeholder groups, with printed information and websites being the next most used method. One-on-one discussion is also considered by most stakeholders to be the most effective communication method.

Content analysis of risk messages used by stakeholders identified common themes, with the message not to handle bats being the most prevalent, along with instructions about what to do if you were bitten or scratched and/or what to do if you found a sick bat, being the

next most frequently used messages. Communications were aimed at raising general risk awareness related to bats, and messages emphasising the value of bats was also commonly used by stakeholders, with a need for tailored messaging to different target audiences being evident. Interestingly, messaging directly mentioning ABLV were uncommon. Around two-thirds of stakeholders identified gaps and difficulties in delivering their messaging. Most expressed an openness to consider changing both their messages and their communication methods, with those working in public health being the most highly supportive of change.

Stakeholders reported that the most frequently targeted audiences were members of the public (Figure 1). This is not surprising, as Si et al. (2016) found 89% of reported potential exposures between 2009 and 2014 in Queensland were in members of the public (whether they intentionally or unintentionally encountered a bat), compared with reported potential exposures of less than 5% for those with occupational exposure to bats (e.g. veterinarians, staff in animal clinics, bat carers).<sup>23</sup> Other studies have similarly found that potential exposures are highest among the public.<sup>15,16</sup> In the NSW Zoonoses Annual Report in 2018,<sup>18</sup> 181 exposures were reported and out of the 154 responses that stated their occupation, only 10% ( $n = 16$ ) were reported to be working in high-risk occupations (such as wildlife rehabilitators and veterinarians) while the remaining were members of the public. Frequent exposures in members of the public are most likely attributed to a lack of awareness and understanding of the risks, or due to concern about bat welfare.<sup>7,23,24</sup> Clearly, messages targeted to the public should not include jargon and scientific terms as this can make information harder to understand, leading to concerns that the information provided may appear irrelevant or be misinterpreted,<sup>25</sup> and therefore, ineffective. In addition, given the evidence that exposure to risk is also motivated by a concern for animal welfare, it is also clear that risk messaging that acknowledges this concern is also likely to be more accepted.

Following the main general public audience, other target audiences mentioned by respondents were, typically, related more closely to the role (and expertise) of the stakeholders. For example, academia/research stakeholders were communicating more to researchers, and animal health specialists were communicating more to wildlife carers. These more closely matched technical/disciplinary relationships can enable use of more technical and nuanced language and more complex content. However, caution is required to avoid assumptions of common understanding of terminology, and message testing with target audiences is still recommended.

Along with generally low ratings for the effectiveness of communication methods, one notable finding from the study was that one-on-one discussion was reported to be the most used communication method across the five stakeholder groups (Table 2), while also being rated as the most effective method across four groups (public health, government, animal health specialist, and wildlife groups) (Table 4). One-on-one discussions can facilitate more personal interactions between the stakeholders and their respective audiences compared to other methods,<sup>26</sup> however, it is a time-consuming approach not suitable for larger audiences.<sup>27</sup>

With members of the public being the most targeted audiences reported by stakeholders, one-on-one discussion is not efficient and

can only reach a small number of people at a time. The use of one-on-one methods as a communication approach may also explain the percentage of respondents (66.9%) identifying difficulties and gaps in their communications with their audiences. With current technology, websites and social media can spread warning and prevention messages faster than other methods.<sup>25,26</sup> Such methods can be useful during emergency situations such as summer heat wave events, which can have severe impacts on bats. These methods can be used for rapidly raising awareness amongst target audiences about what to do and what not to do, with the goal of preventing members of the community encountering bats and being potentially exposed to ABLV. Pre-prepared communication plans and messages prepared prior to foreseeable events can be an effective way for stakeholders to engage with their audiences rapidly. Such approaches have been developed and used in the context of chemical, biological, radiological, and nuclear (CBRN) terrorism<sup>28</sup> and templates and tools are available for health-related crisis and emergency risk communication.<sup>29</sup> One-on-one discussions can still be used with individuals, such as those exposed to a bat scratch or bite, or in situations requiring more in-depth learning about ABLV itself. Further research could be undertaken to investigate the delivery and receipt of messaging in these fast-onset scenarios, to evaluate if these approaches could be effective in changing behaviours to decrease the exposure to bats or increase knowledge on what to do or not to do when encountering a bat.

From analysis of the priority message content that respondents provided, certain themes appear to be more relevant to some audiences. This highlights a need for stakeholders to provide appropriately worded and tailored messaging for different audiences. For example, if the message is targeted towards the general public, then the initial message content may need to focus more on the themes of 'handling bats', 'risk awareness', and 'ABLV specific' and the instruction provided may focus on 'mitigation of risk' (Table 6). This would include not touching or handling bats and provide clear information about organisations that are equipped to handle bats. Contact information for wildlife rehabilitation groups should be included in the messages, making it easy for audiences to follow the correct advice, and reinforcing the message that these organisations have trained (and vaccinated) personnel that can handle bats safely and are able to answer any concerns or questions. This also helps to address animal welfare concerns that at-risk members of the public have in these situations. If targeted audiences are veterinarians, then information provided may focus more on themes such as safely 'handling bats', especially pre-exposure vaccinations (Table 6). Reported uptake of rabies vaccination in veterinarians and veterinary students in Queensland in 2013/4 is less than 20%,<sup>30</sup> emphasising the potential risks of exposure for this occupational group. Therefore, messaging for veterinary professionals should also focus on the theme of 'mitigation of risk' (Table 6) including, but not limited to, getting post-exposure prophylaxis if scratched or bitten by a bat, PPE in handling bats, and contact details for the relevant local veterinary laboratory for bat submission (e.g. NSW DPI Laboratory for regions in NSW).<sup>31</sup>

An interesting finding identified in this study was that some stakeholders felt it was important to include messaging about the ecological importance of bats in the environment, with bats playing a vital ecological role, for example, in seed dispersal and pollinating plants (Table 6).<sup>9</sup> The need to impart awareness of bats' environmental and

ecological roles was identified as being crucial given that bat populations have decreased over recent years. The importance of this messaging is supported by other studies which also found that stakeholders preferred delivering messages that included the benefits of bats in the environment rather than only focusing on the risk bats carry.<sup>32,33</sup> Some stakeholders use 'fear appeals' to convey risks such as 'bats in Australia can carry rabies-like disease' or 'do not handle bats, even if dead' (Table 6), with the goal of using fear to prevent audiences from interacting with bats.<sup>32</sup> However, the creation of a negative perception of bats in target audiences may adversely impact upon bat conservation efforts<sup>26</sup> and increase misconceptions about bats<sup>32</sup> and ultimately lead to their persecution. Furthermore, Kung et al.<sup>33</sup> reported that community respondents believed the benefits of bats are understated and the media and other stakeholders are putting too much emphasis on bats as carriers of diseases. These negative perceptions are likely to have only worsened in the light of the ongoing COVID-19 pandemic with bats being suggested as the potential origin of the SARS-CoV-2 virus.<sup>34</sup> An Australian assessment was conducted to assess the risk in bats in Australia and determined that COVID-19 could potentially have catastrophic consequences on conservation and animal welfare.<sup>35</sup> Indeed, in 2020 in the midst of the COVID pandemic, some wildlife rescue and rehabilitation groups, such as the Canadian Wildlife Health Cooperative, suspended rehabilitation work and research into bat diseases such as white-nose syndrome as a result of negativity towards bats leading to more bats being susceptible to diseases and a decrease in their population total.<sup>36</sup> Lu et al.<sup>37</sup> investigated communication factors contributing to people's view on bats and rabies in relation to bat conservation and public health and found that messages mentioning the benefits of bats in the environment, rather than just focusing on the fact that bats can be a source of lyssavirus infection, enabled participants to develop more positive beliefs about bats. Further, Quinn et al.<sup>24</sup> concluded that communications to the general public needed to have 'a balance between human protection measures and bat welfare'. The authors asserted that if too much emphasis is placed on the human protection aspect, the lives of bats may potentially be endangered with people responding by trying to destroy their habitat. Conversely, if too much emphasis is placed on bat welfare, then the number of bat-human interactions would not decrease.

The fact that, although this study surveyed a broad range of key stakeholders, the majority of the stakeholders who responded to the survey were located in NSW and Queensland is a limitation of this study. While ABLV-infected bats have been identified in NSW and Queensland, they have also been found in the Northern Territory, South Australia, Victoria, and Western Australia.<sup>38-40</sup> The snowballing recruitment strategy whereby the survey was distributed through NSW DPI, may have led to an unequal distribution to different stakeholders and a recruitment bias. As such, even though the stakeholders represented most organisational sectors communicating about ABLV, the authors cannot be certain that data collected in this study fully represented the communication approaches and messaging at a national level and future studies should be directed at canvassing the perceptions of those in a wider geographical area. Finally, in considering the effectiveness of risk messaging, although



stakeholders in this study reported their views about the effectiveness of their methods, corroborating evidence direct from target audiences would assist in supporting study findings.

### Conclusion

This study identified the target audiences, communication methods, and messaging used by a broad range of Australian stakeholders to communicate the risks of Australian Bat Lyssa Virus (ABLV). Stakeholders are required to communicate to a broad range of target audiences that have varying degrees of awareness and knowledge of the potential risks posed by bats, the most effective ways to limit their exposure to ABLV, and the best actions to take for their own safety and for animal welfare. Stakeholders are, therefore, required to provide tailored risk messaging, using the most effective communication methods for a range of audiences.

Heavy reliance on one-on-one discussions with audiences, was found across all stakeholder groups. This method was believed to be an effective method for risk communication but was also acknowledged as an inefficient method. An openness to change communication approaches and messages was found across stakeholder groups, with interest in increased use of social media and online communication methods.

Gaps in messaging and difficulties in delivering messages to some groups, for example, culturally and linguistically diverse audiences, and tourists, was reported. Concerns were also raised around persistent miscommunication in the media, and misperceptions by the general public, about the degree of risk posed by bats. Stakeholders felt there was a need to balance this with messaging about the value of bats in the ecosystem, and a more realistic representation of the risks posed by bats (especially if they were not touched).

The study identified a high level of commonality in message content, which is important for consistency in risk messaging. However, there is a longer term need to evaluate the effectiveness of risk messaging by target audiences and ensure that public health reporting of exposures to bat scratches/bites, and animal health reporting, continue to be monitored. These measures should provide evidence that any changes made by stakeholders to their risk messaging and communication methods are assisting in improved public safety outcomes, and improvements in animal welfare.

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### Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site: <http://onlinelibrary.wiley.com/doi/10.1111/avj.13277/supinfo>.

### Appendix S1. Survey questions.

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