

How Do We Define 'Appropriate Antimicrobial Use' In One Health? A Global Delphi Survey

Authors: *Ri Scarborough,^{1,2} Courtney Ierano,¹⁻³ Kirsten Bailey,^{1,2} Glenn Browning,^{1,2} Karin Thursky,¹⁻³ Ruby Biezen,^{1,2} Brian Hur,^{2,4} Brendan McMullan,^{5,6} Leslie Dowson,¹⁻³ Allegra Schermuly,⁷ Leanne Teoh,^{1,2} Laura Hardefeldt^{1,2}

1. The University of Melbourne, Parkville, Australia
 2. National Centre for Antimicrobial Stewardship, Melbourne, Australia
 3. The Royal Melbourne Hospital, Parkville, Australia
 4. University of Washington, Seattle, USA
 5. University of New South Wales, Kensington, Australia
 6. Sydney Children's Hospital, Australia
 7. Monash University, Clayton, Australia
- *Correspondence to
ri.scarborough@unimelb.edu.au

Disclosure: Funding for this project was provided by the Australian Government via the Medical Research Future Fund (MRFF), Grant ID MRF2028452; Hur received no salary from this grant. Schermuly has received internal funding from the Monash School of Social Sciences to cover her registration at the ASA 2025 and TASA 2025 conferences to present different data from the same broad study as this manuscript, with payment to the author. McMullan has received an Australian Government Grant: NHMRC Investigator Grant, Grant ID 2008632, with payment to the institution; an honorarium for providing a paediatric infectious diseases lecture in the ALJESAL courses in 2024–2025, with payment to the author (later donated in full to the Sydney Children's Hospitals Foundation); was a member of the DSMB for the PATRIC trial (unpaid); and is the Chair of the Australian and New Zealand Paediatric Infectious Diseases Network and Secretary of the World Society for Pediatric Infectious Diseases, both unpaid. Teoh has received a grant from the National Health and Medical Research Council (Investigator Grant 2016647); royalties for Drugs4dent in accordance with the University of Melbourne IP Policy (Drugs4dent is licensed to MIMS Australia); payment or honoraria for lectures, presentations, speakers bureaus, manuscript writing, or educational events from the Australian Dental Association, Australian Dental Association Victorian Branch, Australian Dental Association New South Wales, New Zealand Dental Association, and Royal Australasian College of Dental Surgeons; support for attending meetings and/or travel from the University of Melbourne; participated on the MIMS Clinical Advisory Board; and held a leadership or fiduciary role in the FDI World Dental Federation Preventing AMR and Infections Task Team.

The other authors have declared no conflicts of interest.

Acknowledgements: The authors would like to thank the antimicrobial stewardship experts from 44 countries who provided responses to the Delphi survey.

Keywords: Antimicrobial stewardship (AMS), antimicrobial use (AMU), One Health.

Citation: EMJ Microbiol Infect Dis. 2026;7[1]:44-47. <https://doi.org/10.33590/emjmicrobiolinfectedis/OQSY1576>

BACKGROUND AND AIMS

Many early antimicrobial stewardship (AMS) initiatives focused on reducing antimicrobial use (AMU). However, reducing AMU may cause harm. To avoid unintended consequences, the focus is now moving to increasing appropriateness of AMU. At the same time, there has been a shift from a single-context approach towards a unified, One Health AMS approach. However, the lack of an agreed definition of appropriate AMU between stakeholders representing animal, human, and environmental health remains a barrier to coordinated, One Health AMS implementation.

METHODS

The authors conducted a literature review and held four focus groups with diverse stakeholders to develop a list of proposed statements that could describe appropriate (systemic) AMU across all One Health contexts.¹ The authors included these in a four-round, online Delphi survey circulated to AMS experts globally, whom the authors identified from their publications, professional networks, project partner organisations, and snowballing. Each statement was rated on a seven-point Likert scale (0–6); a score of four or more was considered agreement. Participants could also provide written feedback on each statement. Statements were included in the consensus only when they reached 80%

agreement. Those with <60% agreement in any round were considered rejected, and statements with 60–80% agreement were presented again in the subsequent round, until round three, with changes based on participant feedback. In the fourth round, the authors asked the feasibility of measuring each consensus item in the context with which the participant was most familiar.

RESULTS

The authors invited 391 AMS experts to participate, and 243 from 44 countries (62%) provided a response to at least one survey round. Twenty-two percent were from low- and middle-income countries, and 63% were in a position to influence their national AMR strategy. Sixty-three percent represented human health, 26% represented animal health, and 11% environmental health or ‘other’. In round one, 43 of 76 proposed statements (Table 1) reached 80% consensus, with a further eight statements reaching consensus over subsequent rounds. Consensus statements covered a wide range of topics, including who should receive systemic antimicrobials; when, why, and how these should be initiated;

and whether it should be for a therapeutic or preventative indication. The selection of drug, route, dosing, and duration were the other main topics; in general, participants agreed that relevant guidelines should be followed, where these are available. In the absence of guidelines, participants agreed that the narrowest spectrum or lowest importance drug should be used, by the safest effective route, and for the shortest duration to control the infection (or risk of infection, in the case of preventative use). The median proportion of respondents who felt that, in their context, it would be feasible to measure concordance with each statement was 62%, with feasibility almost always rated higher for human health contexts than animal health contexts. Statements that were rejected in the first round included: using antimicrobials for the purpose of growth promotion in livestock and using preventative antimicrobials for the purpose of avoiding economic loss.

CONCLUSION

The 51 consensus items from this global survey form a new foundation for further One Health discussion around appropriate AMU and unified measures of appropriate use.

Table 1: The 51 consensus statements regarding important features of appropriate AMU, with the survey question: when considering whether a systemic use of antimicrobials was appropriate, how important is the following?

Category	Consensus statement
Recipient of therapeutic antimicrobials	There was adequate evidence that the person/animal had an infection.
	Suffering and/or complications from the infection would likely be lessened with antimicrobials.
	An equivalent (or better) health outcome was not achievable without systemic antimicrobial treatment.
Preventative AMU	There was potential for significant suffering without preventative antimicrobial use.
	There was potential for significant mortality without preventative antimicrobial use.
	All practicable management options to control infection (e.g., moving animals/people away from risk) had already been implemented.
	Consideration was given to the risks of preventative antimicrobial use, including AMR.

Table 1: The 51 consensus statements regarding important features of appropriate AMU, with the survey question: when considering whether a systemic use of antimicrobials was appropriate, how important is the following? (Continued).

Livestock-specific considerations	The drug was not prohibited in the animal species in which it was used.
	The drug choice and regimen ensured the animal product(s) complied with local and relevant export antimicrobial residue limits.
Initiation of AMU	Person/animal/herd was under the care of a clinician (for livestock, a veterinarian had visited the farm at least once in the last year).
	Person/animal/herd was examined by a clinician during the current episode.
	Disease severity justified starting antimicrobials, rather than a 'watch and wait' strategy.
	Where sepsis was suspected, treatment was initiated as soon as possible.
	For surgical prophylaxis, timing of antimicrobial administration was concordant with current guidelines.
	Where recommended in current guidelines, a sample was collected for culture and susceptibility testing.
	The reason or indication for antimicrobial use was documented in medical record.
	Patient or carer was meaningfully involved in the decision to use antimicrobials (emergencies excepted).
	Patient or carer was given instructions (appropriate to their health literacy) on taking or administering the antimicrobials correctly, including when to stop.
	Patient or carer was informed about potential adverse effects.
	A date for review or cessation of antimicrobial treatment was set.
	Drug
Empiric drug selection accounted for local epidemiology (e.g., antibiogram data) where available.	
Where feasible, point-of-care testing was used to refine the empiric antimicrobial selection.	
Where culture and susceptibility results were available, the results were used to guide drug choice.	
Patient had no known allergy or other contraindications to the drug.	
Drug penetrates the target tissue(s) adequately and remains active at the target tissue.	
Where multiple drugs would be suitable, consideration was given to minimising adverse effects.	
Where multiple drugs would be suitable, consideration was given to minimising antimicrobial resistance risk.	
Where multiple drugs would be suitable, a drug with the narrowest spectrum or lowest importance rating was selected.	
Where current guidelines recommended multi-agent therapy, a recommended combination was used.	
For patients with compliance challenges receiving oral medication, consideration was given to palatability of available formulations.	
Cost of drug was bearable for the bill payer(s). Payer can be the patient, animal owner, insurer, government, or other.	

Table 1: The 51 consensus statements regarding important features of appropriate AMU, with the survey question: when considering whether a systemic use of antimicrobials was appropriate, how important is the following? (Continued).

Route	Route allowed drug to reach the site of infection at a concentration that will be effective.
	Safest effective route for the patient at that time point.
	Route concordant with current guidelines, where these were available.
	Route as physically comfortable as possible for the patient (assuming there were multiple safe and effective routes).
	Route convenient for the patient if self-administering (assuming there were multiple safe and effective routes).
	Route convenient and safe for the carer if patient not administering (assuming there were multiple safe and effective routes for the patient).
Dosing	Where guidelines were available, dosing regimen was concordant with current guidelines for the known or presumptive diagnosis.
	Consideration was given to the actual or adjusted body weight of the patient.
	Dosing regimen was adjusted for other relevant patient factors, e.g., renal insufficiency.
	Dosing regimen was adjusted based on antimicrobial susceptibility results where dose-dependent susceptibility was present.
	Dosing regimen accounted for the site of infection.
Duration	Where guidelines were available, duration was concordant with current guidelines for the known or presumptive diagnosis.
	Duration was only as long as required to ensure control of the infection (or for prophylaxis, only as long as required to manage infection risk).
	Where appropriate, duration was adapted according to improvement in clinical signs/symptoms and/or infection-specific biomarkers.
Off-label use	There was no registered antimicrobial for the species (or age group) and indication.
	There was sufficient evidence that the extra-label use was safe and effective for that clinical situation.
	The patient had a known, relative contraindication to the registered antimicrobial(s).
	There was sufficient evidence that the product information (label) regimen is subtherapeutic (in livestock, provided that the withholding period is appropriately adjusted).
Reasons to deviate from appropriate use principles	Recommended drug not available (e.g., supply chain issue).

AMR: antimicrobial resistance; AMU: antimicrobial use.

Reference

1. Scarborough R et al. How do we define 'appropriate antimicrobial use' in One Health? A global Delphi survey. Abstract 01387. ESCMID Global, 17-21 April, 2026.