Antimicrobial resistance: How is it a One Health problem?

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A cross-cutting and systemic approach to health based on the fact that human and animal health are interdependent and linked to the health of the ecosystems in which they co-exist



Food and Agriculture Organization of the United Nations





World Health Organization



Food and Agriculture Organization of the United Nations





UN () environment programme

Source: Adapted from Jones et al. (2013) as used in <u>www.unep.org/resources/report/</u> preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and









Companion animals and AMR



Companion animals and MRSA

Microb Drug Resist. 2018 Mar;24(2):203-212. doi: 10.1089/mdr.2017.0032. Epub 2017 Jun 9.

Molecular Characterization of Methicillin-Resistant Staphylococcus aureus Isolated from Australian Animals and Veterinarians.

<u>Worthing KA</u>¹, <u>Abraham S</u>², <u>Pang S</u>^{2,3}, <u>Coombs GW</u>^{2,3}, <u>Saputra S</u>^{4,5}, <u>Jordan D</u>⁶, <u>Wong HS</u>⁴, <u>Abraham RJ</u>^{2,4}, <u>Trott DJ</u>⁴, <u>Norris JM</u>¹.

Author information

Abstract

7.

This study aimed to determine the frequency and molecular epidemiology of methicillin-resistant Staphylococcus aureus (MRSA) from Australian animals and whether animal-derived MRSA was similar to that from Australian veterinarians. A total of 1,080 clinical coagulase positive Staphylococcus isolates from Australian animals were collected during 2013. Sixteen (4%) of 360 S. aureus isolates were MRSA. Most MRSA came from companion animals, while none came from livestock. MRSA isolates were characterized using whole genome sequencing. ST22-IV (EMRSA-15) was the most common clone in dogs and cats. Clone. complex (CC) 8 was most common in horses. Most ST22-IV isolates were resistant to ciprofloxacin. Animal-derived MRSA genomes were interrogated for

Very low level of MRSA causing disease in animals (1.5 or 4.0 %)

MRSA from dogs, horses, cats and one kangaroo while none came from livestock

Companion animal veterinarians and AMR

Non-typhoidal Salmonella and AMR in TZ and Kenya

Non-typhoidal Salmonella and AMR in Vietnam

Coliforms and AMR in Kenya

- Urban Zoo project Nairobi
 - 99 households
 - 321 human samples
 - 633 animal samples
- AMR prevalence
 - Highest in human samples
 - Lowest in ruminant samples

Fig. 3. Distribution of multi-drug resistance patterns among *Escherichia coli* isolates obtained from humans (n = 321), poultry (n = 345), pigs (n = 51), bovines (n = 64), goats (n = 132) and rabbits (n = 41) in Nairobi, Kenya.

The role of animals as source of AMR

- NTS, TZ: "Human and poultry isolates bore more AMR"
- NTS, VN: "Animal NTS explains the full extent of AMR in human NTS infections"
- Coliforms, KE: "no evidence to suggest that keeping livestock, when treated as a single risk factor, contributed significantly to the burden of AMR in humans"
- Coliforms, TZ: "When cultural and ecological conditions favour bacterial transmission, there is a high likelihood that people will harbour AMR bacteria irrespective of antimicrobial use practices"
- Different countries/hosts/authors \rightarrow evidence/interpretations/implications
- How is that "One" Health?

How do we measure AMR?

How do we measure AMR?

Evelyn Simak/Texel ewe and twin lambs/CC BY-SA 2.0

https://www.nadis.org.uk/

How do we measure AMR?

Noyes et al. Sci Rep. 2016;6:24645. doi: 10.1038/srep24645.

Holt et al. PNAS 2015;112(27):E3574-81. doi: 10.1073/pnas.1501049112.

A sheep in wolf's clothing?

Staphylococcus aureus: EUCAST versus sheep

Silva et al. PLoS One. 2020;15(9):e0238708. doi: 10.1371/journal.pone.0238708.

Staphylococcus aureus: EUCAST versus sheep

Bespoke ruminant ECOFFs?

Class/compound	EUCAST clinical breakpoint	EUCAST ECOFF	CO _{wT} from NRI
Cephalosporin			
Cefoxitine (2 nd gen)	0.8%	0.8%	0.8%
Ceftiofur (3 rd gen)	0%	Not defined	0%
Cefotaxime (3 rd gen)	0%	3.1%	1.5%
Ceftazidime (3 rd gen)	0.8%	14.6%	0.8%
Tetracyclines			
Oxytetracycline	11.5%	Not defined	13.1%
Tetracycline	11.5%	Not defined	16.6%
Carbapenems			
Imipenem	0%	15.4%	0%

* EUCAST = European Committee on Antimicrobial Susceptibility Testing; ** ECOFF = ecological cut-off value;

****NRI = Normalised Resistance Interpretation; Kronval & Smith, APMIS. 2016;124(12):1023-1030. doi:

		Class/compound	EUCAST clinical breakpoint		EUCAST ECOFF	CO _{wt} from NRI
		Cephalosporin				
		Cefoxitine (2 nd gen)		0.8%	0.8%	0.8%
ſ	C			0%	Not defined	0%
l	Sneep are not a prof			0%	3.1%	1.5%
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		Ceftazidime (3 rd gen)		- 0.8%	14.6%	0.8%
		Tetracyclines				
	$\bigcap$	Cl		11.5%	Not defined	13.1%
		Sneep are <b>not</b> a pro		11.5%	Not defined	16.6%
		Carbapenems				
		lmipenem		0%	15.4%	0%

* EUCAST = European Committee on Antimicrobial Susceptibility Testing; ** ECOFF = ecological cut-off value;

***NRI = Normalised Resistance Interpretation; Kronval & Smith, APMIS. 2016;124(12):1023-1030. doi:

The University of Sydney

	Class/compound	EUCAST clinical breakpoint		EUCAST ECOFF		CO _{wt} from NRI	
	Cephalosporin				_		
	Cefoxitine (2 nd gen)	Sheep	are a i	oroblem	0.8%		0.8%
C					defined		0%
	neep are <b>not</b> a prot		0%		3.1%		1.5%
	Ceftazidime (3 rd gen)				14.6%		0.8%
	Tetracyclines						
$\bigcap$			11.5%	No	ot defined	-	3.1%
	Sheep are <b>not</b> a pro	blem	11.5%	No	ot defined	-	6.6%
	Carbapenems	Sheen are	a pro	blem 15.4%			
	Imipenem						0%

* EUCAST = European Committee on Antimicrobial Susceptibility Testing; ** ECOFF = ecological cut-off value;

****NRI = Normalised Resistance Interpretation; Kronval & Smith, APMIS. 2016;124(12):1023-1030. doi:

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![](_page_26_Figure_1.jpeg)

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****NRI = Normalised Resistance Interpretation; Kronval & Smith, APMIS. 2016;124(12):1023-1030. doi:

# Key points

- AMR is found in humans, animals and the environment
- Who gets it from whom, and how it is a One Health problem, is open to interpretation
- The role of monogastric species or life stages may differ from ruminants' role
- Aquaculture and companion animal species are not adequately captured in current One Health understandings/activities
- What you put in is what comes out
- The process from "in" to "out" can be conducted in many ways
- What comes out can be interpreted in many ways

![](_page_27_Picture_8.jpeg)