

Antimicrobial resistance, stewardship and updated veterinary guidelines

Dr. Pierre Charlebois, DVM, DACVECC
April 26th, 2026



Disclaimer

- I am ***not*** an infectious disease specialist, nor a microbiologist!
- I am going to discuss this from a practicing clinician with an interest in:
 - *Antibiotic stewardship*
 - *Decreasing cost of care and polypharmacy*
 - *Improving patient care*
- Antimicrobial resistance (AMR) will be meaning antibacterial resistance for this lecture

Topics

- Antimicrobial resistance (AMR)
 - One health concern
 - Review of resistance, emerging resistance patterns
- Antimicrobial stewardship
 - Human perspective
 - Veterinary perspective
- Recent/new veterinary guidelines
 - Surgical antimicrobial prophylaxis
 - Aspiration pneumonia/pneumonitis
 - Canine acute diarrhea



World Health Organization

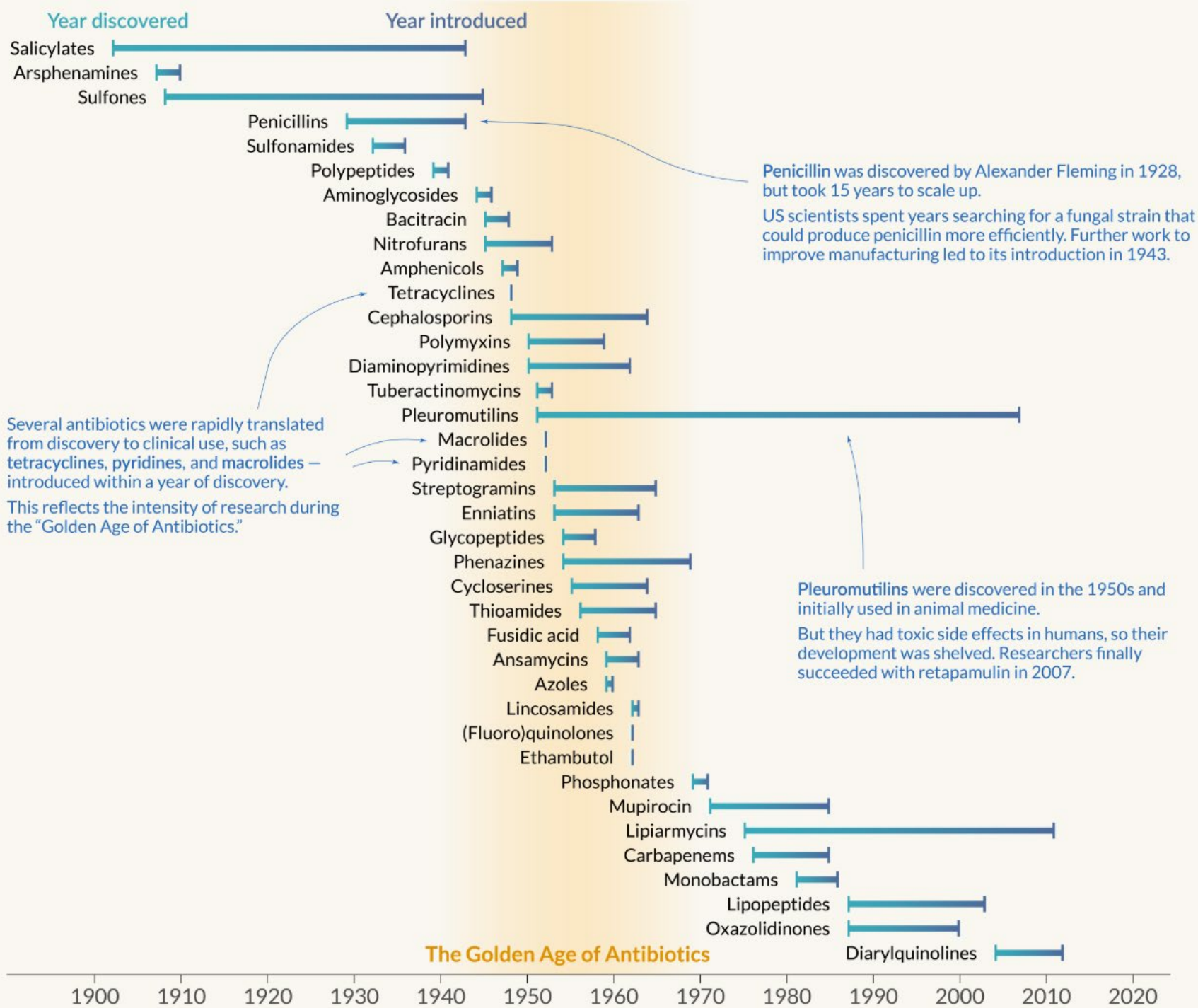


- Antimicrobial resistance is in the **top 10 major public health threat facing humanity**
- Evidence suggests that resistant bacteria can be transferred between humans, **food animals and companion animals**
- ~ 4.7 million annual death related to AMR, predicted ~10 million by 2050

Antimicrobials resistance



- Pre-dates discovery of antibiotics – resistance can be found in 30,000 years old permafrost bacterial samples!
- Discovered penicillin in 1928
- ~20 classes until 1960,
- Few new Abx class found in the last ~30 years...



[nature](#) > [articles](#) > article

Article | Published: 26 March 2025

A broad-spectrum lasso peptide antibiotic targeting the bacterial ribosome

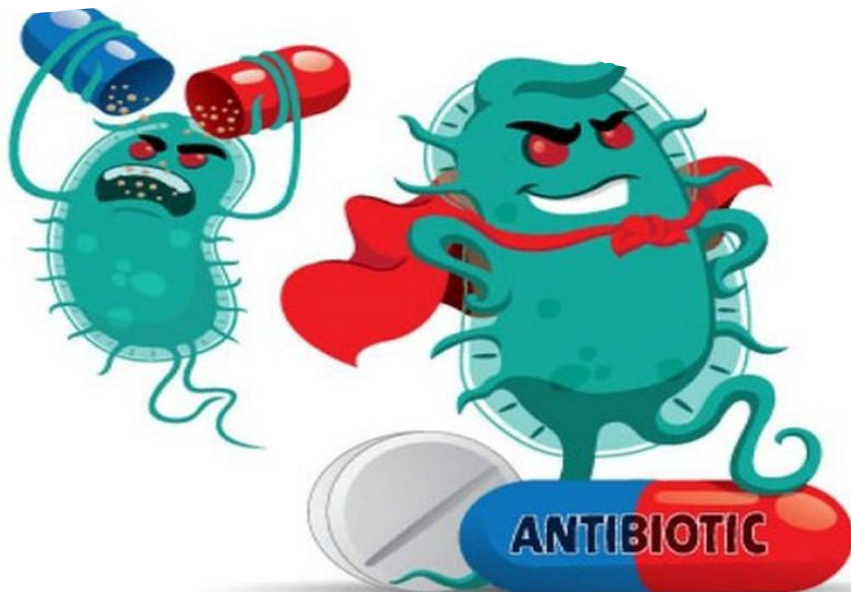
[Manoj Jangra](#), [Dmitrii Y. Travin](#), [Elena V. Aleksandrova](#), [Manpreet Kaur](#), [Lena Darwish](#), [Kalinka Koteva](#), [Dorota Klepacki](#), [Wenliang Wang](#), [Maya Tiffany](#), [Akosiererem Sokaribo](#), [Xuefei Chen](#), [Zixin Deng](#), [Meifeng Tao](#), [Brian K. Coombes](#), [Nora Vázquez-Laslop](#), [Yury S. Polikanov](#) , [Alexander S. Mankin](#)  & [Gerard D. Wright](#) 

Nature **640**, 1022–1030 (2025) | [Cite this article](#)

Antimicrobial resistance

Mechanisms

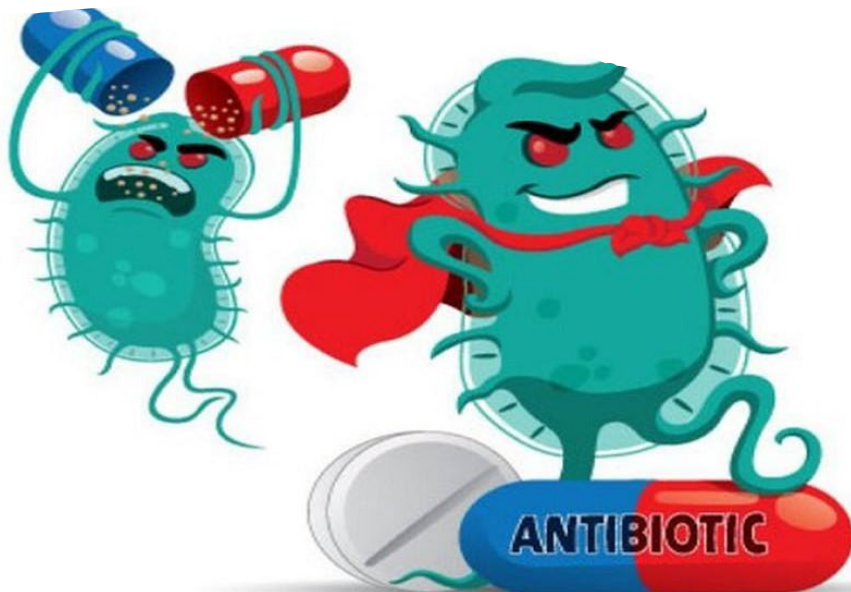
- **Natural/intrinsic**
 - *Mycoplasma* naturally resistant to *B-lactams*
 - *Aerobic bacteria* resistance to *metronidazole*
 - *Anaerobic bacteria* resistance to *aminoglycosides*



Antimicrobial resistance

Mechanisms

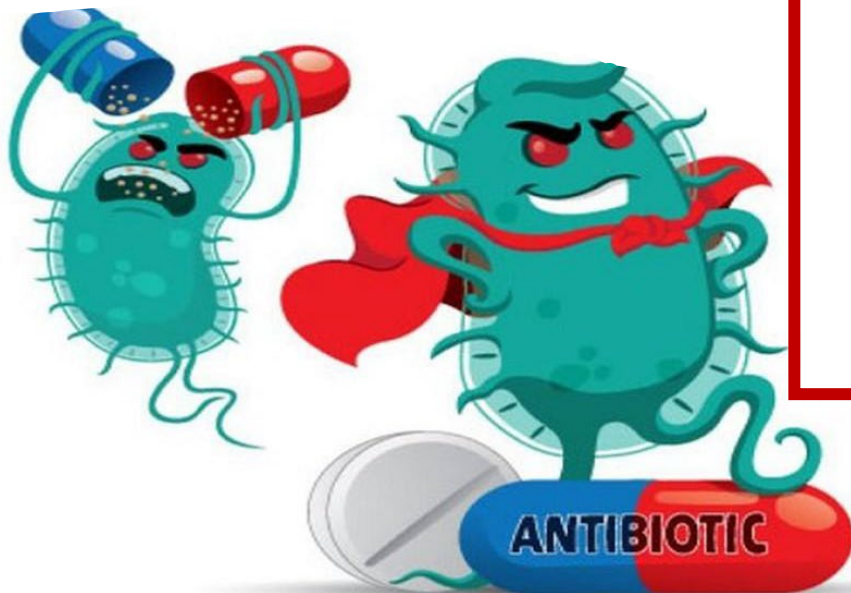
- **Natural/intrinsic**
- **Adaptive**
 - *Transient & reversible resistance induced by stressors, especially sublethal drug concentration*



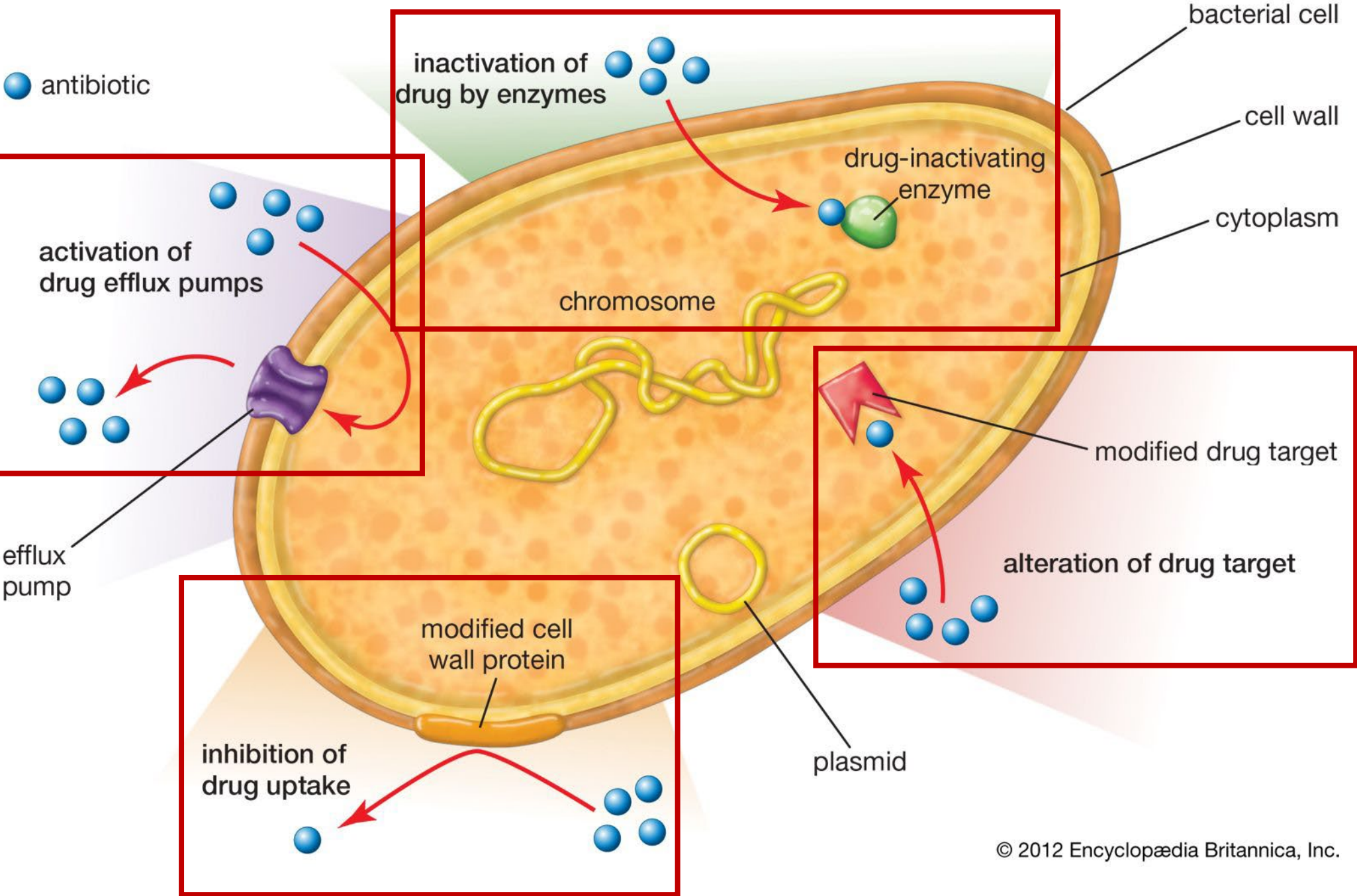
Antimicrobial resistance

Mechanisms

- **Natural/intrinsic**
- **Adaptive**
- **Acquired (horizontal gene transfer vs mutation/vertical inheritance)**
 - *Drug inactivation/modification (e.g. *B lactamases*)*
 - *Efflux pumps*
 - *Inhibition of drug uptake*
 - *Modification of target site*



Examples of mechanisms of antibiotic resistance



Terminology

- **Multi-drug-resistant (MDR) bacteria**
 - *Resistant to 3 or more classes*
- **Extensive drug-resistant (XDR) bacteria**
 - *Resistant to all but 1-2 classes*
- **Pan-resistant bacteria**
 - *Resistant to ALL classes of antimicrobial*



Antibiotic resistance

Emerging resistance genes

Gram (-) → *B-lactamases*

AmpC – AmpC beta-lactamases

ESBL - Extended-spectrum beta lactamases

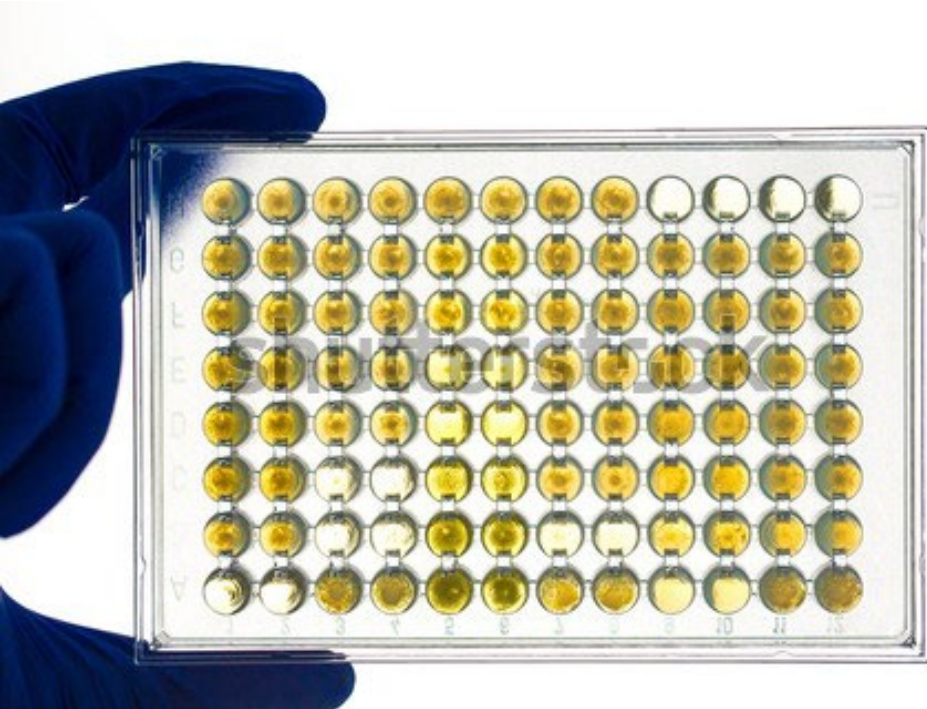
CRE - Carbapenem-resistant enterobacteriales

Gram (+) → *Modified target site*

MRSP - Methicillin resistant Staph.

Pseudointermedius

VRE – Vancomycin- resistant enterococci



Antibiotic resistance genes

- Cell wall synthesis inhibitors
 - B-lactams
 - Penicillin
 - Cephalosporins (5 generations)
 - Carbapenems (meropenem, imipenem)
 - Glycopeptide (Vancomycin)
- Nucleic acid synthesis inhibitors
 - 30s (Aminoglycosides, tetracyclines)
 - 50s (Macrolides, chloramphenicol, clindamycin, linezolid)
- DNA gyrase and topoisomerase IV inhibitor
 - Fluoroquinolones
- Metabolic pathway inhibitors
 - Folate synthesis inhibitor (Sulfonamides, TMS)

AmpC

ESBL

CRE

MRSP

VRE

Antibiotic resistance genes

- Cell wall synthesis inhibitors
 - B-lactams
 - *Penicillin*
 - *Cephalosporins (1st, 2nd, 3rd generation)*
 - Carbapenems (meropenem, imipenem)
 - Glycopeptide (Vancomycin)
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****not inhibited by B-lactamase inhibitor
(clavulanate / sulbactam)**

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AmpC

ESBL

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MRSP

VRE

****often carries other resistance genes**

Antibiotic resistance genes

- Cell wall synthesis inhibitors
 - B-lactams
 - Penicillin
 - Cephalosporins (5 generations)
 - Carbapenems (meropenem, imipenem)
 - *Glycopeptide (Vancomycin)*
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 - Folate synthesis inhibitor (Sulfonamides, TMS)

AmpC

ESBL

CRE

MRSP

VRE

Source: CYSTOCENTESIS

Culture Results: Status: FINAL

Isolate 1: **Staphylococcus pseudintermedius** - 10,000 - 50,000 CFU per ml

	Isolate 1	MIC
Cefpodoxime	R	4
Cefovecin	R	>1
Imipenem / Carbapenem	R	<=4
Oxacillin / Methicillin	R	>2
Trimethoprim/Sulfamethoxazole	R	>40
Marbofloxacin	R	>2
Gentamicin	I	8
Cephalexin	R	<=2
Minocycline	R	>1
Doxycycline	R	>0.25
Amikacin	S	<=2
Clindamycin	R	>2
Ciprofloxacin	R*	>2
Enrofloxacin	R	>2
Amoxicillin-Clavulanic Acid	R	>0.5
Amoxicillin	R	>1
Nitrofurantoin	S	<=32
Penicillin	R	>2
Chloramphenicol	R	>4

UTI



Microbiology

7/30/25

3:37 AM



Source:

WOUND

Culture Results:

Status: FINAL

Isolate 1: Staphylococcus pseudintermedius - 1+

Multi Drug Resistant MRSP

	Isolate 1	MIC
Penicillin	R	≥ 0.5
Oxacillin / Methicillin	R	≥ 4
Cefovecin	R	≥ 8
Amikacin	S	≤ 2
Gentamicin	R	≥ 16
Enrofloxacin	R	≥ 4
Marbofloxacin	R	≥ 4
Erythromycin	R	≥ 8
Clindamycin	R	
Doxycycline	R	8
Mupirocin	S	≤ 1
Chloramphenicol	R	≥ 64
Florfenicol	S	≤ 4
Rifampin	S	≤ 0.03
Trimethoprim/Sulfamethoxazole	R	≥ 320
Amoxicillin	R	> 0.25
Amoxicillin-Clavulanic Acid	R	> 0.25
Imipenem / Carbapenem	R	
Cephalexin	R	> 2
Cefpodoxime	R	≥ 8
Ciprofloxacin	R	
Azithromycin	R	
Minocycline	R	



Antibiotic stewardship

How can we be better?

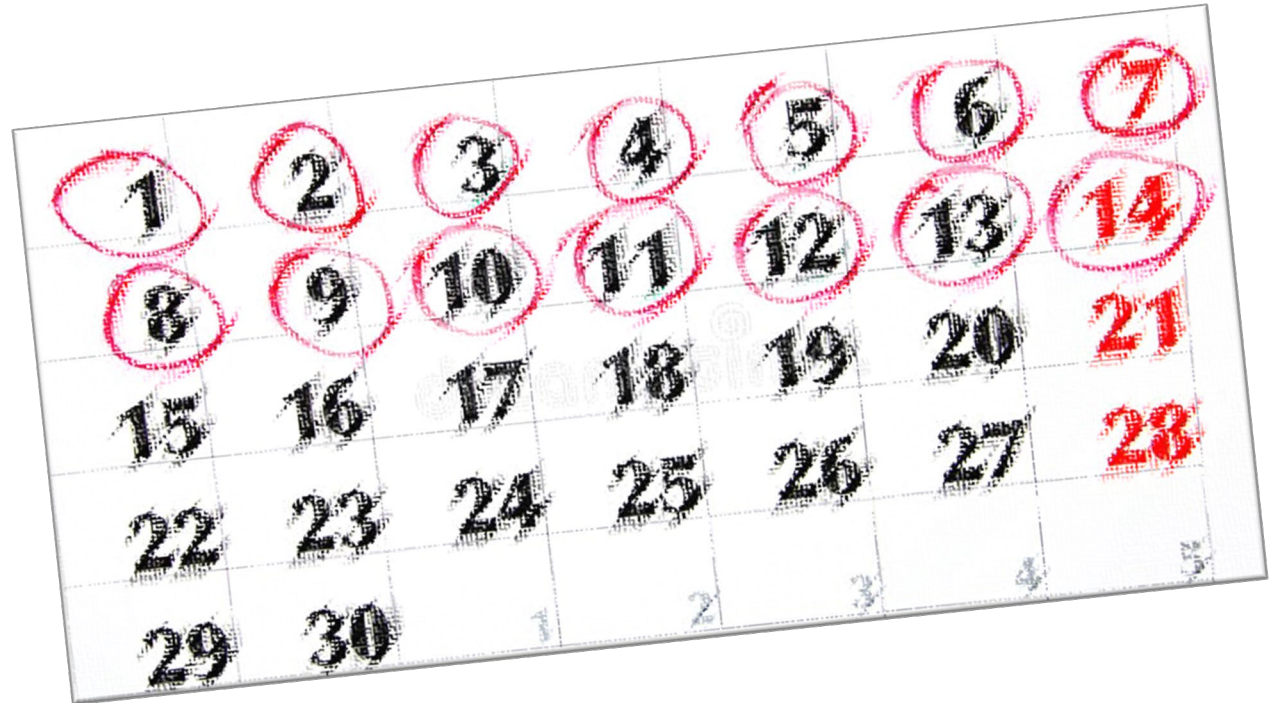
What is the optimal duration of antibiotics?

Somewhere between

“long enough to reduce bacterial load”

and

“short enough to minimal selective pressure”





[...] durations of antibiotic therapy for most bacterial infections are based on the fact that the week has 7 days in it, resulting in traditional 7- to 14-day antibiotic courses. And the modern week has 7 days in it because the Roman Emperor Constantine the Great said so in 321 CE . Had Constantine chosen a 4-day week, providers would likely routinely prescribe 4- to 8-day courses of therapy.

Dr. Spellberg, CMO, Los Angeles General Medical Center.

Antimicrobial stewardship

Optimal use of antibiotics

- No such thing as “long enough to avoid resistance”
- Each dose is a pressure that will select for resistance
- Important to review often our Abx use in order to:
 - → limit development of AMR
 - → Improve patient outcomes

Antimicrobial stewardship

Optimal use of antibiotics

Remember that resistance \neq equal pathogenicity!

AMR is a higher risk for neonates, elderly, immune compromised (cancer, diabetics, etc)

- Associated with higher morbidity, mortality, cost of care

Human perspective

1. Shorter treatment duration:

- Reduces pressure for resistance, improves compliance, reduce cost and reduce adverse effects
- In ICU – prescribed Abx with a timeline



Shorter Is Better

Diagnosis	Short (d)	Long (d)	Result	#RCT
CAP	3-5	5-14	Equal	14
Atypical CAP	1	3	Equal	1
Possible PNA in ICU	3	14-21	Equal	1*
VAP	5-8	10-15	Equal	3
Empyema	14-21	21-42	Equal	2
Cystic Fibrosis Exacerbation	10-14	14-21	Equal	1
cUTI/Pyelonephritis	5 or 7	10 or 14	Equal	13
Intra-abd Infection	4	8-10	Equal	3
Complex Appendicitis	1-2	5-6	Equal	2
Bacteremia (non <i>S. aureus</i>)	7	14	Equal	4**
Cellulitis/Wound/Abscess	5-6	10	Equal	4†
Osteomyelitis	42	84	Equal	2
Osteo Removed Implant	28	42	Equal	1
Debrided Diabetic Osteo	10-21	42-90	Equal	2‡
Septic Arthritis	14	28	Equal	1
Bacterial Meningitis (peds)	4-7	7-14	Equal	6
AECB & Sinusitis	≤5	≥7	Equal	>25
Variceal Bleeding	2-3	5-7	Equal	2
Neutropenic Fever	AFx72h/3 d	+ANC>500/9 d	Equal	2
Post Op Prophylaxis	0-1	1-5	Equal	57 [¶]
Erythema Migrans (Lyme)	7-10	14-20	Equal	3
Mediterranean Spotted Fever	1	5-10	Equal	4 [¶]
<i>P. vivax</i> Malaria	1 or 7	14	Equal	2 [¶]
Strongyloides GI Infection	1	4	Equal	1
Albendazole→Neurocysticercosis	7	14-28	Equal	3 ^θ
Early Syphilis	1 IM	3 IM in 3 wks	Equal	2

Total: 26 Conditions

159 RCTs



Dr. Spellberg, CMO, Los Angeles General Medical Center.

Human perspective



1. Shorter treatment duration:

- Reduces pressure for resistance, improves compliance, reduce cost and reduce adverse effects
- In ICU – prescribed Abx with a timeline

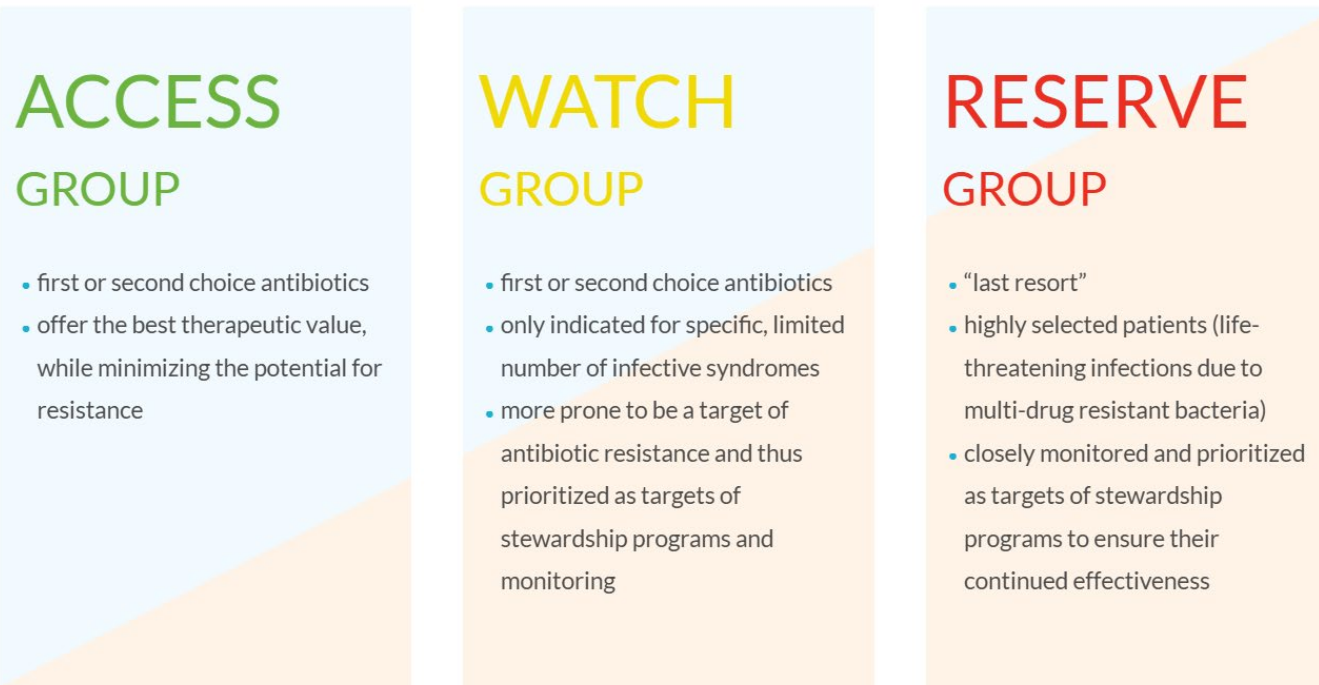
2. Right drug, dose and route

- Under dosing increases resistance pressure due to sub lethal concentration
- Overdose increases risk of toxicity
- Initial CRI of some drugs provides better treatment outcome

World Health Organization



AWaRe – benefit, harm, risk of resistance



Amoxicillin / clav
Unasyn
Cefalexin/
cephazolin
Clindamycin
Doxycycline
Metronidazole

ACCESS GROUP

- first or second choice antibiotics
- offer the best therapeutic value, while minimizing the potential for resistance

WATCH GROUP

- first or second choice antibiotics
- only indicated for specific, limited number of infective syndromes
- more prone to be a target of antibiotic resistance and thus prioritized as targets of stewardship programs and monitoring

3rd gen cephalo
Fluoroquinolones
Meropenem
Vancomycin

RESERVE GROUP

- “last resort”
- highly selected patients (life-threatening infections due to multi-drug resistant bacteria)
- closely monitored and prioritized as targets of stewardship programs to ensure their continued effectiveness

Linezolid
Tigecycline

Human perspective



1. Shorter treatment duration:

- Reduces pressure for resistance, improves compliance, reduce cost and reduce adverse effects
- In ICU – prescribed Abx with a timeline

2. Right drug, dose, duration and route

- Under dosing increases resistance pressure due to sub lethal concentration
- Overdose increases risk of toxicity
- Initial CRI of some drugs provides better treatment outcome

3. Clinical reasoning

- Avoid pitfalls – “don’t rock the boat”, “quick and safe drugs”, “satisfy patient”
- In hospital – daily review of drugs for de-escalation

Antibiotic use


Human

- Ontario, Canada 2016 – 5.6 million outpatient Rx, 10,616 clinicians
 - Median duration was 7-8 days
 - >30% were more than 8 days
- Estimated that ~30-50% of Abx prescribed may not be necessary
 - → No indications, not following guidelines, excessive duration, inappropriate dosing

Antibiotic use

Veterinary

- Prescribing practices in small animal ECC (2020)
 - Cornell university (2017 data)
 - 45% had no evidence of infection
 - 34% UTI treated appropriately (55% did not submit a culture)
 - 7% pneumonia appropriate (93% did not submit a culture)
- Free urine C&S improved prescription practices in Australia (JVIM 2026)
 - Lower rate of empirical antibiotics
 - Shorter duration and lower tier antibiotic selection



Updates on veterinary antimicrobial guidelines

*Surgical antimicrobial prophylaxis
(SAP)*

Pneumonia

Canine acute diarrhea



Surgical antimicrobial prophylaxis






*~15% of all antibiotic use in
animals*

Surgical antimicrobial prophylaxis (2025)



European Network for Optimization of Veterinary Antimicrobial Therapy (ENOVAT) 2025 guidelines for surgical antimicrobial prophylaxis in dogs and cats

AUTHORS:

F. ALLERTON  *.1, T. M. SØRENSEN^{††}, K. SCAHILL^{†S¶}, J. E. RUPEREZ^{**}, F. SWINBOURNE^{††}, D. R. VERWILGHEN  ††,
M. C. NOLFF^{SS}, F. FOROUTAN^{¶¶}, S. J. BAINES^{*}, A. VILEN^{***}, L. PELLIGAND  †††††SSS, E. M. BROENS^{SSS¶¶¶},
P. L. TOUTAIN^{†††††****}, M. L. BRENNAN^{†††}, T. MOONEY^{††††}, S. CLARKE^{SSSS}, J. E. MILES[†], J. L. GRANICK  ¶¶¶¶,
Y. WINSBORG[†], L. R. JESSEN^{†SSS}, J. S. WEESE  † AND ON BEHALF OF THE EUROPEAN NETWORK FOR OPTIMIZATION OF
VETERINARY ANTIMICROBIAL THERAPY (ENOVAT) GUIDELINES AND THE ESCMID STUDY GROUP FOR VETERINARY
MICROBIOLOGY (ESGVM)

Surgical antimicrobial prophylaxis - SAP

- Members, including:
 - Surgery (10), internal medicine (5), pharmacology (2), infectious disease specialist (1), microbiologist (1), epidemiology (1).
- Evidence based guidelines that
 - Compare benefits and harm based on scoping review of all current veterinary literature (systematic review, meta-analysis), and;
 - Human SAP guidelines to fill gaps as low level evidence

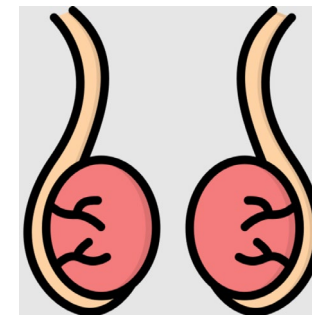


Surgical antimicrobial prophylaxis - SAP

- Describes ***clean, clean-contaminated & contaminated*** procedures
 - Did NOT include dirty procedures in these guidelines (ocular, dental, wounds, etc)
- Recommendations for ***peri & post-operative*** use
 - Peri-operative (2h before, up to 24h)
 - Post operative (beyond 24h)
- Used “**threshold**” to make recommendations
 - 5-25% reduction in risk, as believed to be worth it by practitioners

SAP – Clean

Spay/neuter



Recommendation 1 – Peri-operative antimicrobial use in neutering

In dogs and cats undergoing neutering, we recommend **against the use of peri-operative surgical antimicrobial prophylaxis**
Strong recommendation, low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 2 – Post-operative antimicrobial use in neutering

In dogs and cats undergoing neutering, we recommend **against the use of post-operative surgical antimicrobial prophylaxis**
Strong recommendation, low-certainty evidence. Level of agreement 100% (17/17)

- Low baseline risk of SSI (around 0 – 1.7% without SAP) (*excluding laparoscopic (28.6%)*)
- SAP currently used in 30-40% of neuters in UK/Australia (2017)
- Absolute risk reduction was ~ 11-27 SSI / 1000 patients

SAP – Other clean procedures

Splenectomy, dermal mass, gastropexy



Recommendation 3 – Peri-operative antimicrobial use in other clean procedures

In dogs and cats undergoing clean soft tissue surgical procedures other than neutering (e.g. splenectomy, dermal mass removal, exploratory laparotomy, gastropexy), we recommend **against the use of peri-operative surgical antimicrobial prophylaxis**

Strong recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 4 – Post-operative antimicrobial use in other clean procedures

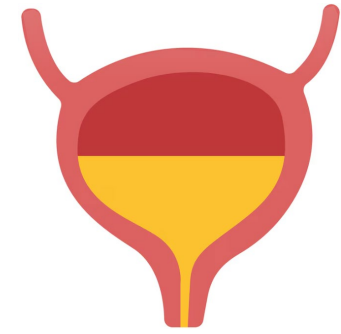
In dogs and cats undergoing clean soft tissue surgical procedures other than neutering (e.g. splenectomy, dermal mass removal, exploratory laparotomy, gastropexy), we recommend **against the use of post-operative surgical antimicrobial prophylaxis**

Strong recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

- 25% UK vets used SAP for 1cm dermal mass (2012)
- Very low evidence due to lack of studies
- Generally low SSI risk, like neuters/spays

SAP – Clean-contaminated

Urologic procedures



Recommendation 5 – Peri-operative antimicrobial use in clean-contaminated urologic procedures

In dogs and cats undergoing clean-contaminated urological surgical procedures, we suggest not to use peri-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 6 – Post-operative antimicrobial use in clean-contaminated urologic procedures

In dogs and cats undergoing clean-contaminated urological surgical procedures, we recommend against the use of post-operative surgical antimicrobial prophylaxis

Strong recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

- Generally low risk of SSI
- **Conditional:** Can use if suspect UTI

SAP – Clean-contaminated

GI procedures – enterotomy, R&A without sepsis



Recommendation 7 – Peri-operative antimicrobial use in clean-contaminated gastrointestinal procedures

In dogs and cats undergoing clean-contaminated gastrointestinal surgical procedures, we suggest administration of peri-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 94% (16/17)

Recommendation 8 – Post-operative antimicrobial use in clean-contaminated gastrointestinal procedures

In dogs and cats undergoing clean-contaminated gastrointestinal surgical procedures, we recommend against the use of post-operative surgical antimicrobial prophylaxis

Strong recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

- **Conditional:** Against peri-op Abx for gastrotomy alone
 - Lower bacterial burden with normal gastric pH
 - More amenable to surgical technique to reduce risk of contamination

SAP – Contaminated

Soft tissue

Recommendation 11 – Peri-operative antimicrobial use in contaminated procedures

In dogs and cats undergoing contaminated soft tissue surgical procedures, we **suggest administration of peri-operative surgical antimicrobial prophylaxis**
Conditional recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

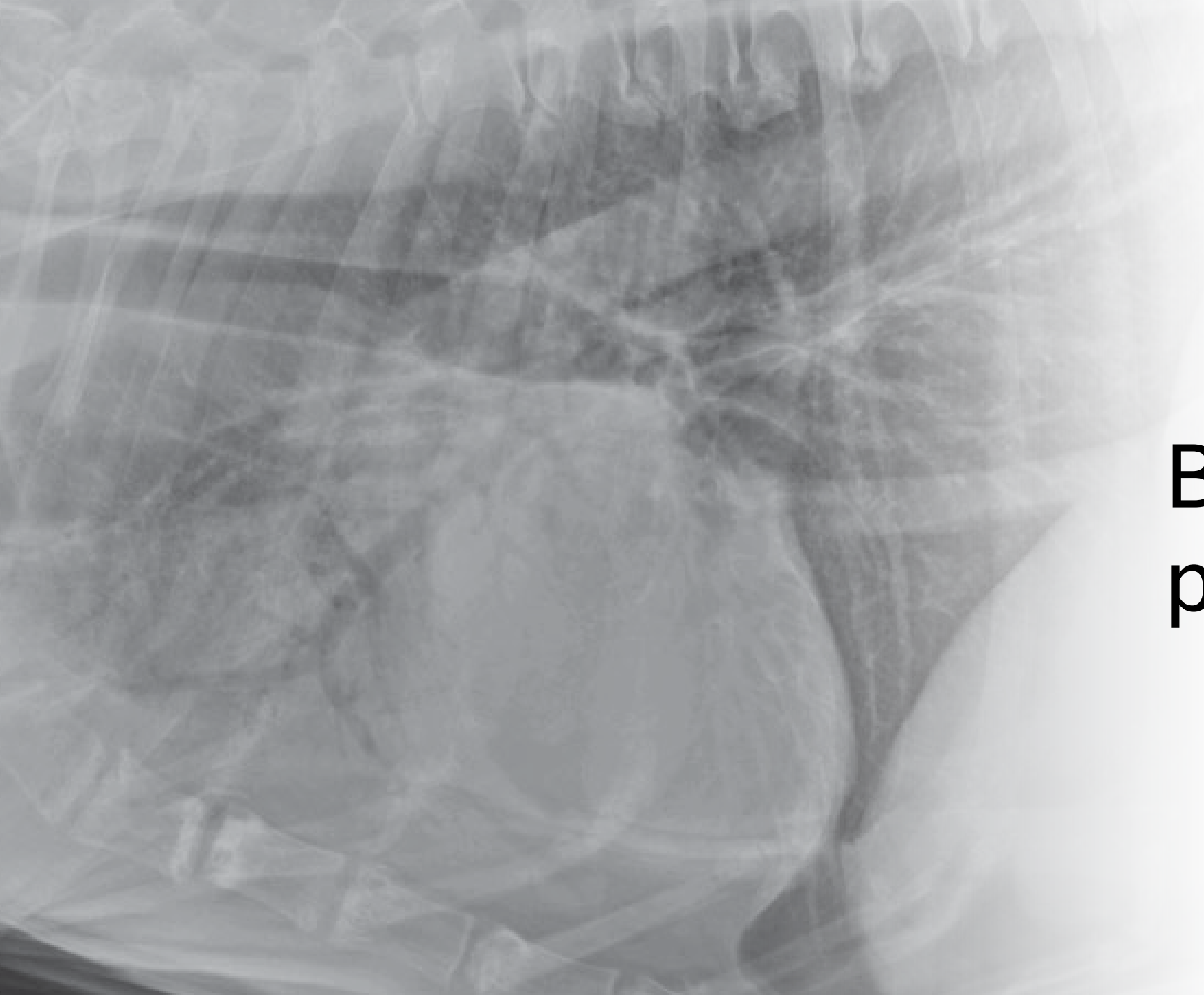
Recommendation 12 – Post-operative antimicrobial use in contaminated procedures

In dogs and cats undergoing contaminated soft tissue surgical procedures, we **suggest that post-operative surgical antimicrobial prophylaxis should be used for 3 to 5 days with daily review and adaptation/de-escalation in line with culture and susceptibility test results**
Conditional recommendation, very low-certainty evidence. Level of agreement 88% (15/17)

Daily review: BAR? Eating? non painful? incision clean?

Unknown optimal duration but **3-5 days likely more than adequate**

- *Note, humans recommend 48h only*



Bacterial pneumonia

Bacterial pneumonia – Human side

Community acquired pneumonia (CAP)



American thoracic society and infectious disease society guidelines for community acquired pneumonia (2019):

- Duration guided by clinical status
- 5 days for immunocompetent patients
 - If no resolution, consider resistance, empyema, lung abscess, etc

Side note: recommend against recheck radiographs

- *Limited evidence of clinical usefulness*
- *In past, used to detect lung malignancies hidden by pneumonia, which were mostly in smokers or ex-smokers*

Bacterial pneumonia – Human side

Community acquired pneumonia (CAP)

Meta-Analysis > JAMA Pediatr. 2022 Dec 1;176(12):1199-1207.

doi: 10.1001/jamapediatrics.2022.4123.

Short-Course vs Long-Course Antibiotic Therapy for Children With Nonsevere Community-Acquired Pneumonia: A Systematic Review and Meta-analysis

Qinyuan Li^{1 2 3 4}, Qi Zhou⁵, Ivan D Florez^{6 7 8}, Joseph L Mathew⁹, Lianhan Shang¹⁰,
Guangli Zhang^{1 2 3 4}, Xiaoyin Tian^{1 2 3 4}, Zhou Fu^{1 2 3 4}, Enmei Liu^{1 2 3 4},
Zhengxiu Luo^{1 2 3 4}, Yaolong Chen^{5 11 12 13 14}

- *9 RCT, 11,143 patients aged 2 to 59 months*
- *Non severe CAP*

3–5 days of treatment is non inferior to 10 days

- *Similar treatment failure rate*
- *Decreased gastro-intestinal side effects*

Bacterial pneumonia – Veterinary side

Aspiration pneumonia/bronchopneumonia

- Traditionally 3-6 weeks, 1-2 weeks past normal CXR
 - No evidence to support this
 - Recheck radiograph?





Bacterial pneumonia – Veterinary side

Aspiration pneumonia/bronchopneumonia

- ISCAID respiratory guidelines (2017)
 - No treatment, or amoxicillin, ampicillin
 - Cephazolin + enrofloxacin ***if septic***
 - 10-14 day duration, re-evaluate and assess based on clinical, hematology, radiographs
- Vet Clin Small Animal – Pneumonia (2020)
 - Re-evaluation 10-14 days
 - Recheck CXR “useful to document resolution before or within 1week of discontinuation
 - No justification/evidence for benefit

Antimicrobial discontinuation in dogs with acute aspiration pneumonia based on clinical improvement and normalization of C-reactive protein concentration

Nina Fernandes Rodrigues  | Léna Giraud | Géraldine Bolen | Aline Fastrès  |
Cécile Clercx | Kris Gommeren | Frédéric Billen

- Week 1,3 & 5 → CRP, CXR, POCUS, examination
- 70% discontinued Abx at 1 week, 30% at 3 weeks



→ CXR and LUS helpful for diagnosis, but not for de-escalation

Pneumonia in dogs and cats (2026)

JAVMA



Shorter versus longer durations of antibiotic treatment for pneumonia in dogs and cats: a systematic review and meta-analysis

Fiona Emdin, DVM^{1-3*} ; Abby Emdin, PhD⁴; Sean W. X. Ong, MD^{2,5,6}; Valerie Leung, BScPharm, MBA^{1,7}; Kevin L. Schwartz, MD^{1,4,8}; Bradley J. Langford, PharmD, MPH^{1,9}; Kevin A. Brown, PhD^{1,4}; J. Scott Weese, DVM, PhD^{10,11} ; Susan Massarella, MLIS¹; Nick Daneman, MD^{1,2,5}

Study outcome

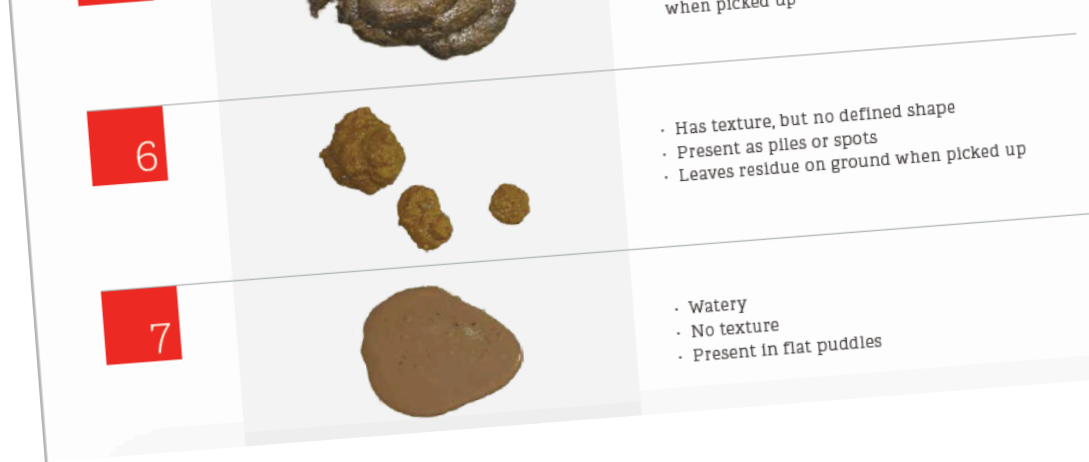
- *No clinical difference between shorter (10-14d) and longer (21-28d) of antibiotics for pneumonia in dogs, but studies were limited*
- *No studies in cats*

Canine acute diarrhea

CAD



Canine acute diarrhea



- 50-65% are prescribed antimicrobials, despite evidence for lack of efficacy
 - *Metronidazole and amoxi/clav*

Metronidazole 2025

ORIGINAL ARTICLE

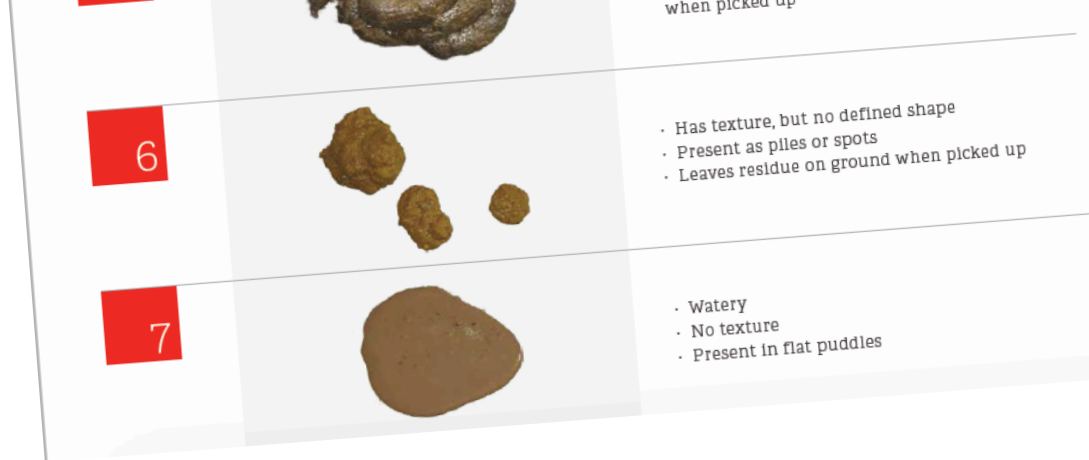
Understanding the rationale for metronidazole use in dogs and cats

J. NG ^{ID}*,^{†,1}, N. STEFFENSEN[‡], I. BATTERSBY[§], J. S. WEESE ^{ID}[¶], D. TIMOFTE^{**}, P. L. TOUTAIN^{††}, J. L. GRANICK^{††}, J. ELLIOTT^{††}, S. CHOI[†], T. SPARKS^{§§}, S. TAVENER^{¶¶} AND F. ALLERTON[†]

- Rationale for use (with overlap):
 - 64% for anti-inflammatory or immunomodulatory properties
 - 38% for suspect / confirmed susceptible infection
 - 26% for systemic disease
 - 26% for protozoal infection
 - 19% because previous positive outcome
 - 9% practice / owner expectations



Canine acute diarrhea



- 50-65% are prescribed antimicrobials despite evidence for lack of efficacy
 - *Metronidazole and amoxi/clav*
- Harmful effects of drugs used for CAD
 - **Adverse effects** – *hyporexia, diarrhea, vomiting, neurological signs.*
 - *Diarrhea reported in ~56% of healthy dogs given metronidazole*
 - **Dysbiosis** for weeks to years – *drug, duration, individual factors*
 - **Resistance** – *Clavamox may increase amoxicillin resistant E.coli, for at least 3 weeks*

β-Lactam and metronidazole administration are risk factors for carbapenemase-producing Enterobacterales acquisition in hospitalized dogs

Samuel Chien, DVM¹; Stephen D. Cole, VMD, MS, DACVM²; Jaclyn Dietrich, BA² ;
Laurel E. Redding, VMD, PhD, DACVPM³ ; Emmelyn Hsieh, DVM, DACVIM^{1*} 

- Every other day rectal testing for bacterial resistance
- Risk factors explored: demographic, housing, service, drugs received, surgery done, procedures done, inserted tubes

B lactams and metronidazole were only associated factor

Canine acute diarrhoea (2024)



Contents lists available at [ScienceDirect](#)

The Veterinary Journal

journal homepage: www.elsevier.com/locate/tvjl



European Network for Optimization of Veterinary Antimicrobial Therapy (ENOVAT) guidelines for antimicrobial use in canine acute diarrhoea

L.R. Jessen^{a,*}, M. Werner^b, D. Singleton^c, C. Prior^d, F. Foroutan^e, A.A. Ferran^f, C. Arenas^{g,h}, C. R. Bjørnvad^a, E. Lavyⁱ, F. Allerton^d, K. Allensbach^j, L. Guardabassi^k, S. Unterer^b, T. Bodnárová^{l,n}, U. Windahl^m, M.L. Brennanⁿ, J.S. Weese^o, K. Scahill^{p,q}, ESCMID Study Group for Veterinary Microbiology (ESGVM), European Network for Optimization of Antimicrobial Therapy (ENOVAT)

ENOVAT - Canine acute diarrhea

- Consulted pDVM and dog owners for critical outcomes

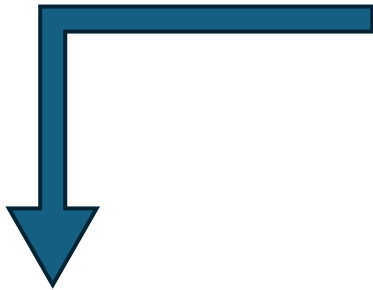
Table 1

Critical outcomes and treatment effect thresholds in dogs with acute diarrhea.

Outcome (subgroup)	Threshold for a clinically relevant effect of treatment
Duration of diarrhea	At least 1 day reduction
Duration of hospitalization (dogs with moderate and severe disease)	At least 1 day reduction
Mortality (dogs with severe disease)	3 % risk increase/decrease
Progression of disease (dogs with mild disease)	30 % risk increase/decrease
Progression of disease (dogs with moderate – severe disease)	10 % risk increase/decrease

ENOVAT - Canine acute diarrhea

Mild



Recommendation 1

In dogs with acute non-hemorrhagic diarrhoea and mild disease we recommend against treatment with antimicrobials.

Strong recommendation, high-certainty evidence.

Level of agreement 100%

Recommendation 2

In dogs with acute hemorrhagic diarrhoea and mild disease we recommend against treatment with antimicrobials.

Strong recommendation, high-certainty evidence.

Level of agreement 100%

“[...] high certainty evidence that antimicrobials do not confer a clinically relevant effect in dogs with acute diarrhoea and mild disease, whether or not blood is present in the stools

ENOVAT - Canine acute diarrhea

Moderate

Recommendation 3

In dogs with acute non-hemorrhagic diarrhoea, and moderate disease, we recommend against treatment with antimicrobials.

Strong recommendation, high-certainty evidence

Level of agreement 100 %

Recommendation 4

In dogs with acute hemorrhagic diarrhoea, and moderate disease, we recommend against treatment with antimicrobials.

Strong recommendation, high-certainty evidence

Level of agreement 100 %

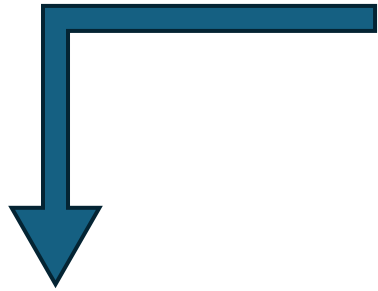
Remarks: Dogs with laboratory values indicative of severe or overwhelming inflammation, such as severe neutrophilia ($> 25 \times 10^9$), neutropenia and/or degenerative left-shift, represent an exception.



“[...] high certainty evidence that antimicrobials do not confer a clinically relevant effect in dogs with acute diarrhoea and moderate disease, whether or not blood is present in the stools

ENOVAT - Canine acute diarrhea

Severe



Recommendation 5

In dogs with acute hemorrhagic and non-hemorrhagic diarrhoea, and severe disease we suggest treatment with systemic antimicrobials.

Conditional recommendation, low-certainty evidence

Level of agreement 100%

- *May present critically ill, or failed time and fluid therapy alone*
- *Suggest IV antibiotics*
 - *Ampicillin, amoxi-clav, TMS for non critical illness,*
 - *4 quadrants for critical illness or risk of resistance (Aminopenicillins or clinda + Fluoroquinolone or aminoglycoside)*

ENOVAT - Canine acute diarrhea

Duration

Recommendation 7

The duration of antimicrobial treatment is dependent on the treatment response and the panel suggests daily assessment of animals while hospitalized. Antimicrobial therapy should not extend beyond clinical resolution. For the majority of dogs, treatment of 3–7 days is likely adequate to obtain clinical resolution.

Conditional recommendation, very low-certainty evidence

Level of agreement 100%

- *No studies of short (<7d) vs long duration*
- *No consensus on duration of Abx for bacteremic/septic dogs*
 - *In people, 5-7 days is non inferior to 10-14d and the Society of critical care medicine recommend shorter in people*

Thank you for your time...!

Any questions?



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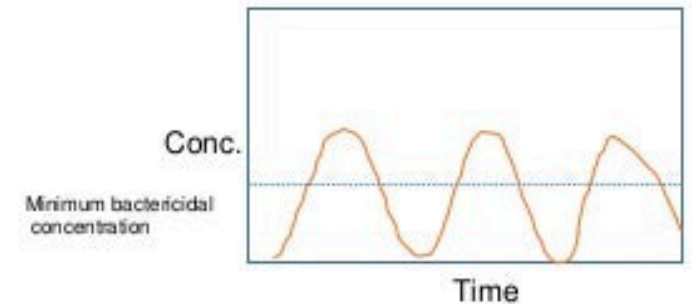
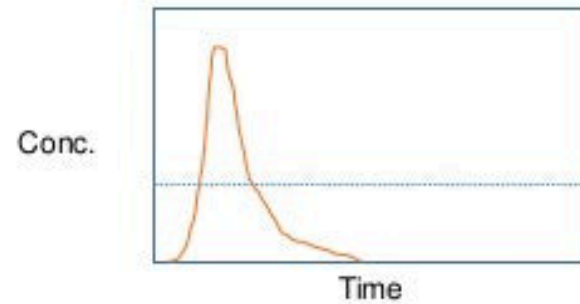
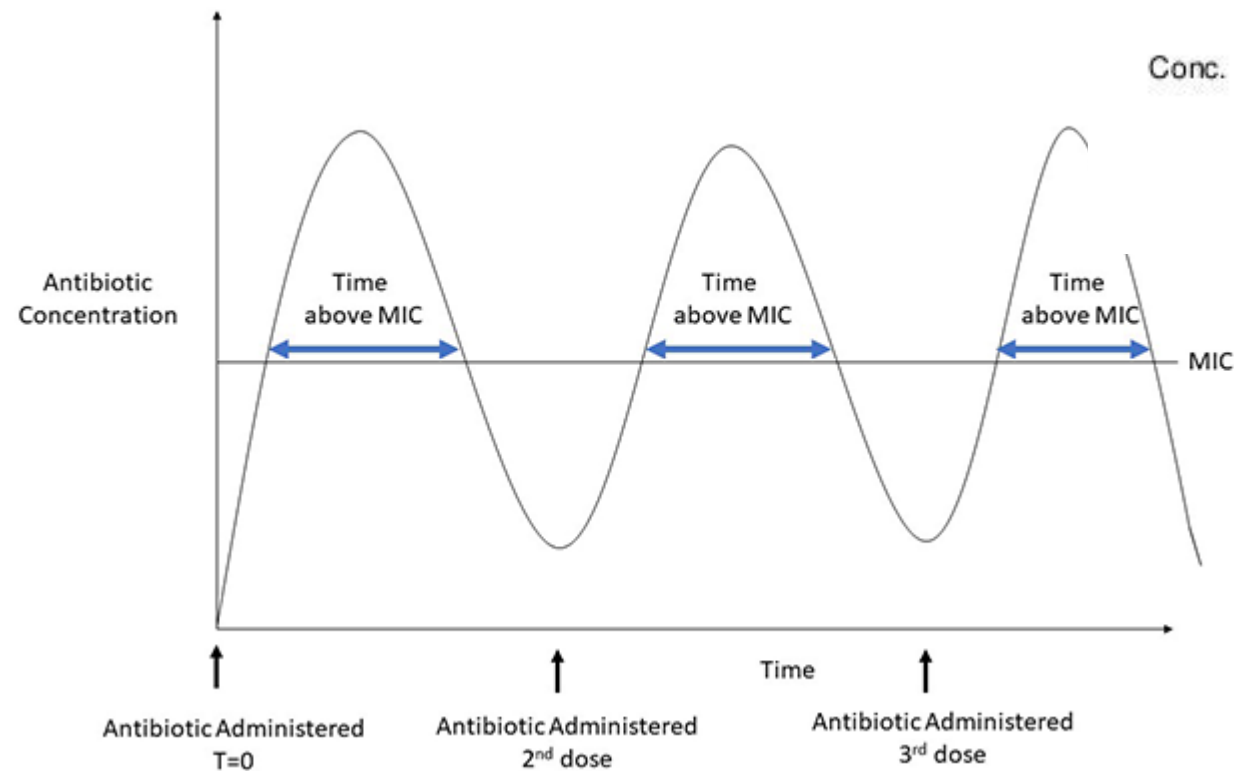
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Concentration dependent

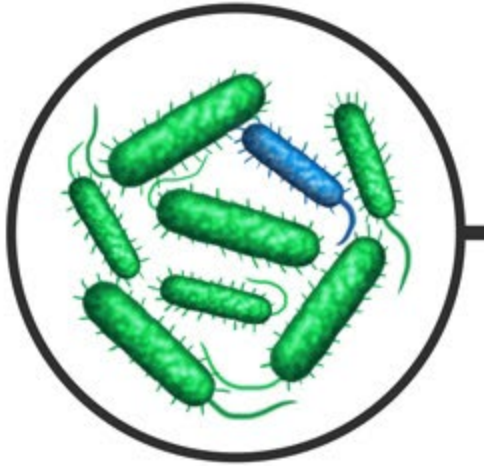
- Max kill depends on concentration achieved
- High doses as shorter infusions or lesser frequency are better
- Has post antibiotic effect

Time dependent

- Max kill depends on time achieved
- Optimal doses as longer infusions or at higher frequency
- No post antibiotic effect



Antibiotic Resistance in Bacteria



Step 1

In a population of bacteria, one bacterium mutates and becomes antibiotic resistant.

SAP – Orthopedic procedures

Non-implant vs implant

Recommendation 13 – Peri-operative antimicrobial use in non-implant orthopaedic procedures

In dogs and cats undergoing clean orthopaedic surgical procedures not involving the placement of an implant, we suggest not to use peri-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 14 – Post-operative antimicrobial use in non-implant orthopaedic procedures

In dogs and cats undergoing clean orthopaedic surgical procedures not involving the placement of an implant, we recommend against the use of post-operative surgical antimicrobial prophylaxis

Strong recommendation, low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 15 – Peri-operative antimicrobial use in implant orthopaedic procedures

In dogs and cats undergoing clean orthopaedic surgical procedures involving the placement of an implant, we suggest administration of peri-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

Recommendation 16 – Post-operative antimicrobial use in implant orthopaedic procedures

In dogs and cats undergoing clean orthopaedic surgical procedures involving the placement of an implant, we recommend against the use of post-operative surgical antimicrobial prophylaxis

Strong recommendation, moderate-certainty evidence. Level of agreement 100% (17/17)

Recommendation 17 – Peri-operative antimicrobial use in TPLO procedures

In dogs undergoing a Tibial Plateau Levelling Osteotomy (TPLO) procedure, we suggest administration of peri-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 94% (16/17)

Recommendation 18 – Post-operative antimicrobial use in TPLO procedures

In dogs undergoing a Tibial Plateau Levelling Osteotomy (TPLO) procedure, we suggest not to use post-operative surgical antimicrobial prophylaxis

Conditional recommendation, very low-certainty evidence. Level of agreement 100% (17/17)

Human perspective

- Culture is still gold standard but now have some available more rapid molecular testing:
 - MALDI-TOF, NAAT
 - Minutes to hours
- Biomarkers (CRP and PCT) are used to help differential bacterial vs viral/nonbacterial conditions
 - E.g. normal PCT in COVID19 patients differentiates bacterial co-infection



Metronidazole 2025

ORIGINAL ARTICLE

Understanding the rationale for metronidazole use in dogs and cats

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- Putative immunomodulatory / anti-inflammatory is **poorly demonstrated**
- Retrospective study + questionnaire (10,000 vets invited, 138 replies), multiple countries
 - CAD 47%





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Urinary tract infection

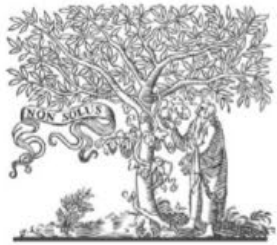
Human guidelines

2024 European Association of Urology - Guidelines on Urological Infections

- **Asymptomatic UTI**

- May have some protective effects against symptomatic infections
- Do not screen or treat in following patients:
 - *Regulated diabetics*
 - *Elderly*
 - *Renal transplants*
 - *Patients with recurrent UTI*

- **Uncomplicated cystitis:** 1-5 days (depending on drug used)



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International Society for Companion Animal Infectious Diseases (ISCAID) guidelines for the diagnosis and management of bacterial urinary tract infections in dogs and cats

J. Scott Weese^{a,*}, Joseph Blondeau^{b,c}, Dawn Boothe^d, Luca G. Guardabassi^{e,f}, Nigel Gumley^g, Mark Papich^h, Lisbeth Rem Jessenⁱ, Michael Lappin^j, Shelley Rankin^k, Jodi L. Westropp^l, Jane Sykes^l



Urinary tract infection

Subclinical bacteriuria

→ *Positive urine culture, without clinical signs*

- No recommendation to screen subclinical DM, cushings, etc
 - No evidence of progression to cystitis
 - Regardless of CFU/ml
- Treatment is not recommended even if the following apply:
 - Pyuria
 - Resistant bacteria is present

Urinary tract infection

Sporadic bacterial cystitis / simple UTI

→ *Various lower urinary signs in healthy, normal anatomy*

- 3-5 days, but 3 likely enough for most
 - 1st line: Amoxicillin/TMS
 - 2nd line: 3rd generation cephalosporin, fluoroquinolone
- Expect response within 48h, else reconsider diagnosis