# Antimicrobial Resistance: Emerging Clinical Threats and Evolving Expectations for Care

**Amanda Beaudoin, DVM, PhD, DACVPM**
Director of One Health Antibiotic Stewardship | Minnesota Department of Health
Adjunct Assistant Professor | University of Minnesota College of Veterinary Medicine

August 2019

DEPARTMENT OF HEALTH

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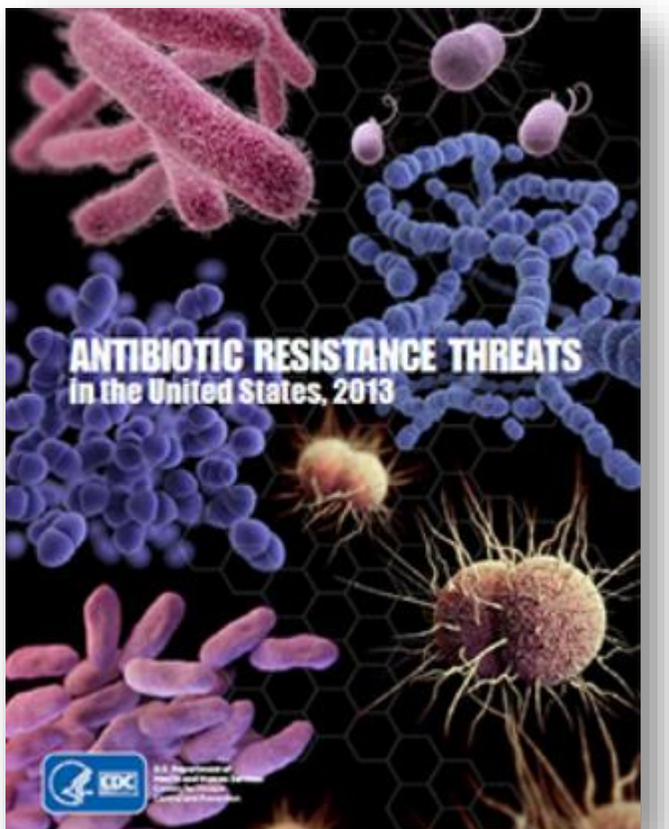
# Objectives

- Acknowledge the importance of antimicrobial resistance when considering infection prevention and occupational health

- Recognize the content contained in the Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel and other resources for Infection Prevention and Control

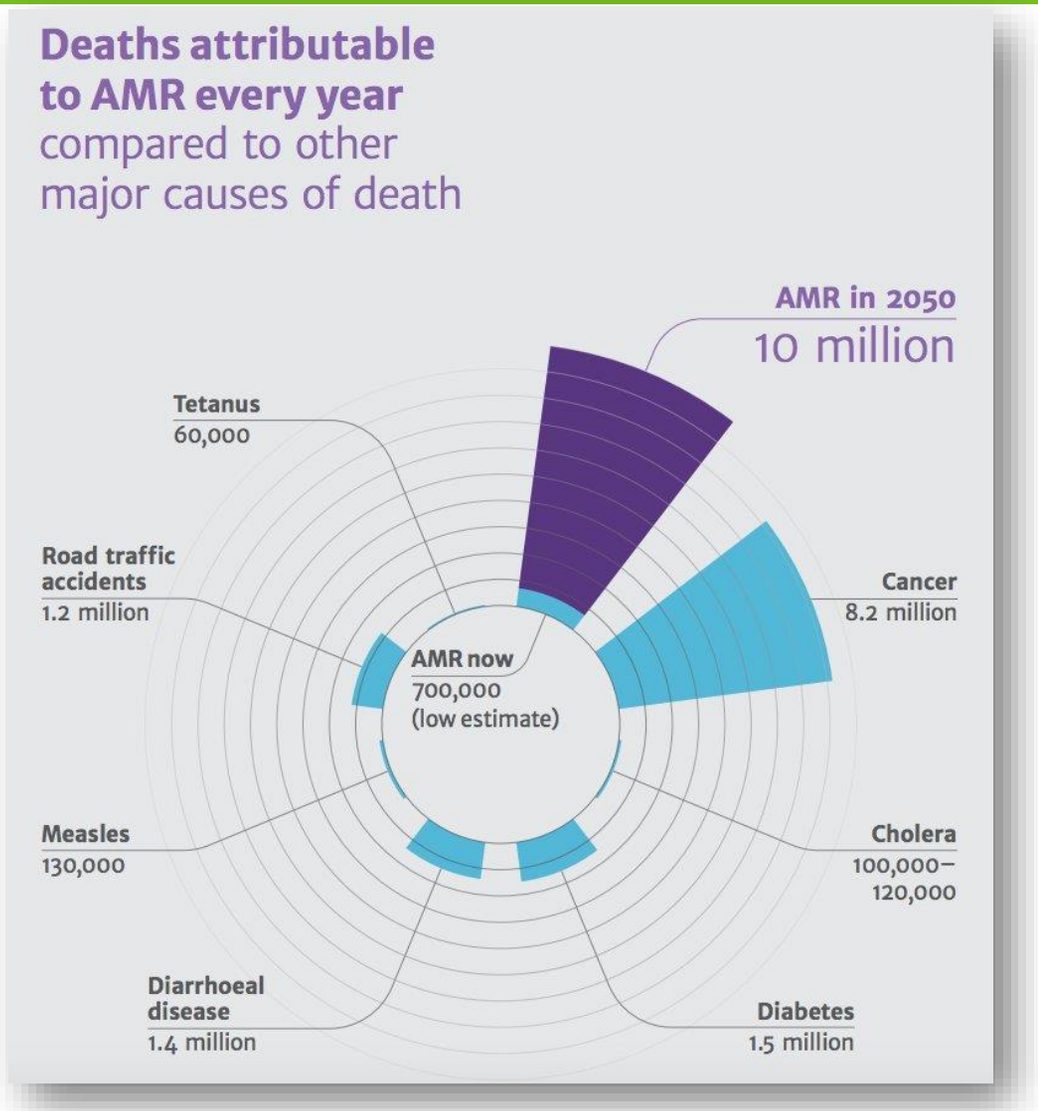
# CDC Antibiotic-Resistance Threats, 2013

- >2 million people are sickened each year with antibiotic-resistant infections
  - 23,000 die as direct result
- $20 billion in excess direct health costs estimated
- Urgent and serious resistant bacterial threats include:
  - *Clostridium difficile (C. difficile)*
  - Carbapenem-resistant Enterobacteriaceae (CRE)
  - *Campylobacter,* non-typhoidal Salmonella, *Salmonella* Typhi, *Shigella*
  - *S. pneumoniae*, tuberculosis, *Neisseria gonorrhoeae*
  - Extended spectrum β-lactamase producing Enterobacteriaceae
  - Methicillin-resistant *S. aureus* (MRSA)
  - Multidrug-resistant *Acinetobacter, Pseudomonas aeruginosa*
  - Vancomycin-resistant *Enterococcus* (VRE)




http://www.cdc.gov/drugresistance/threat-report-2013/

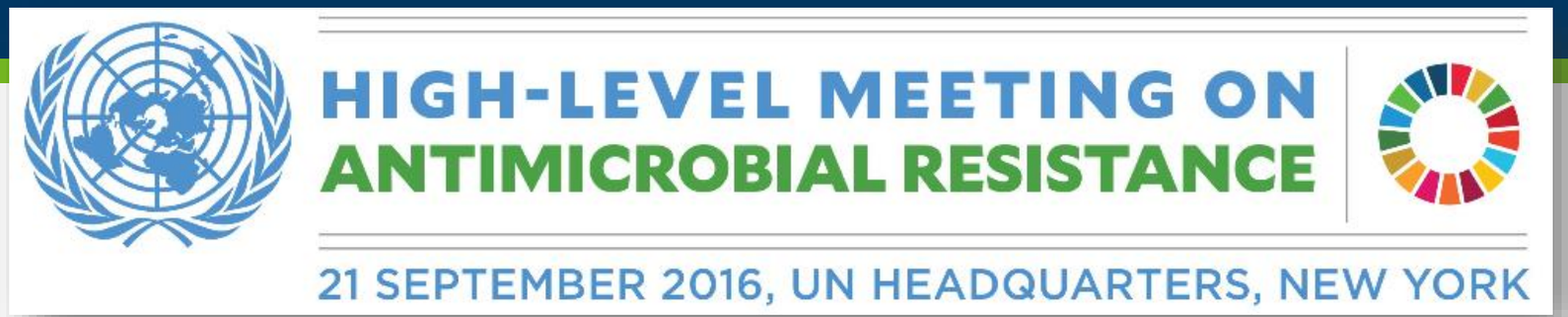
# Scope of the Problem in Healthcare

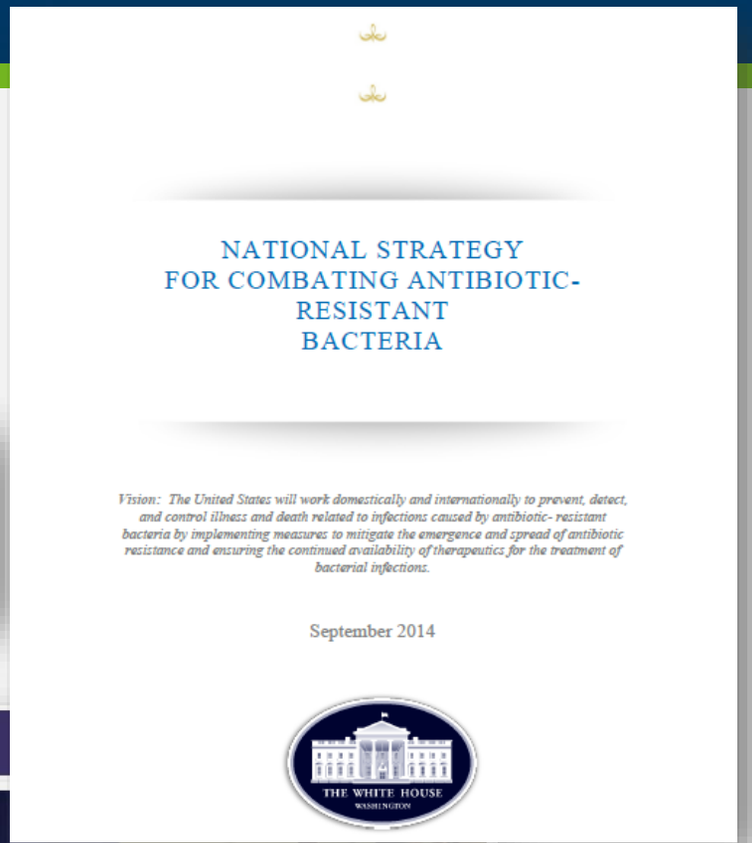


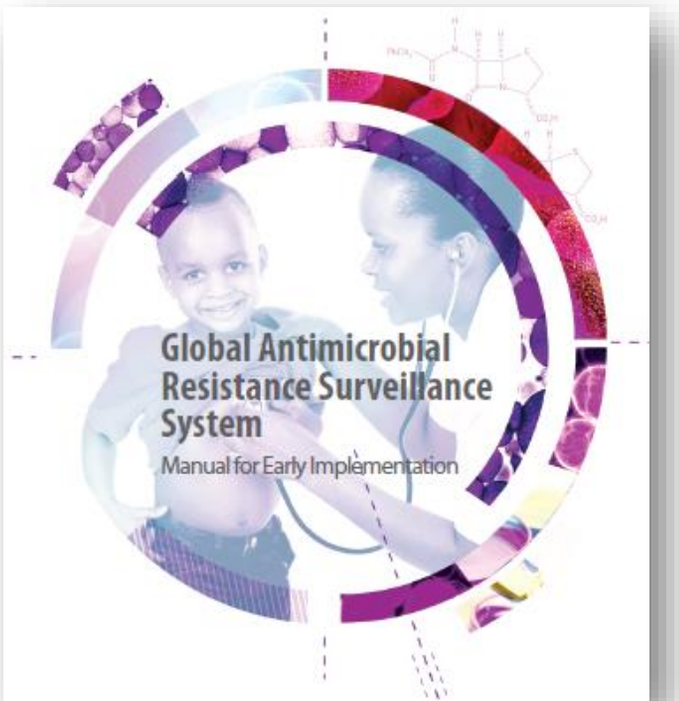

**Untreatable microbial infections**
are on track to
surpass cancer as the
**leading cause of death worldwide by 2050.**

Healthcare Infection Society UK

# Global Commitment





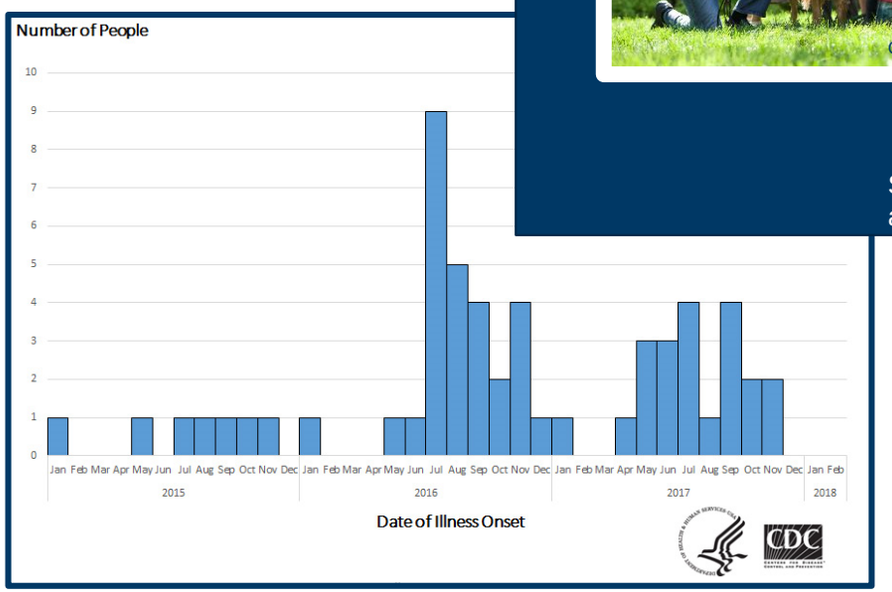
# Why Do We Care about AMR in Veterinary Medicine?

- Clinically relevant resistance
- Bacterial culture and sensitivity often not conducted
  - Antibiotics not always well-targeted
- Animals receive medically important antimicrobials
  - (e.g., cephalosporins, fluoroquinolones)
- Potential spread of antimicrobial resistance
  - Direct and close contact with humans
  - Pet-to-pet transmission
  - Foodborne infections of humans

Couples in households with dogs have more similar microbiomes than those living alone because of additional shared microbial sources.


Having a dog in the household adds bacterial diversity to adult skin.

Song et al. Cohabiting family members share microbiota with one another and dogs. *eLife* 2013




# HAI and AMR in Human Healthcare

- Any day, 3.2% of hospitalized patients have a healthcare-associated infection (HAI)
- Common infection sites:
  - Lungs, site of surgery, bloodstream, urinary tract, gastrointestinal tract
- Risk factors:
  - Medical devices, recumbency, surgery, immune compromise, substandard infection prevention and control (IPC)
- Billions in healthcare dollars annually, plus indirect costs to society (e.g., lost work time)
- HAI are commonly caused by multi-drug resistant organisms (MDRO) in high-risk medical environments
- In healthcare, HAI is a care quality and patient safety issue
  - NHSN reporting
  - Quality measures
  - Performance tied to reimbursement from Centers for Medicaid and Medicare Services

Centers for Disease Control and Prevention. Healthcare-Associated Infections. Available at https://www.cdc.gov/hai/index.html.
Magill et al. Multistate Point-Prevalence Survey of Health Care–Associated Infections. N Engl J Med 2014;370:1198-208.

# HAI and AMR in Veterinary Medicine

- ≤5.2 infections /100 dog admission days, 3.7/100 cat admission days
  - Up to 16% of small animal ICU patients
- 81% of teaching hospitals report ≥1 HAI outbreak
- Impact not well described
  - Similar infection sites, unique risks and prevention challenges to healthcare
- Frequent contamination with enteric, other bacterial organisms
  - IV catheters can be contaminated with *Staphylococcus* spp, *Enterobacter* spp, *E. coli*., *Pseudomonas* spp., *Klebsiella* spp., *Candida glabrata*
- Successful pathogens are often :
  - Opportunistic organisms of animals or people
  - Environmentally stable
  - Multidrug resistant

Ruple-Crzniak. Using syndromic surveillance to estimate baseline rates for healthcare-associated infections in critical care units of small animal referral hospitals. *JVIM* 2013;27:1392–1399
Benedict. Characteristics of biosecurity and infection control programs at veterinary teaching hospitals. *JAVMA* 2008; 233(5):767–73.
Seguela. Bacterial and fungal colonisation of peripheral intravenous catheters in dogs and cats.. *J Small Anim Pract*. 2011 Oct;52(10):531-5
Stull. Hospital-Associated Infections in Small Animal Practice. *Vet Clin Small Anim* 2015;45:217–233

# Pathogens of Concern in Small Animal Medicine

**Box 1**
**Pathogens of concern in a small animal clinic**

- Adenovirus (canine)
- *Bordetella bronchiseptica*
- Calicivirus (feline)
- *Chlamydophila* (feline)
- Distemper virus (canine)
- Herpes virus (feline)
- Influenza viruses (canine, novel)
- *Microsporum canis*
- Parainfluenza virus (canine)
- Parvoviruses (canine, feline)
- Respiratory coronavirus (canine)
- Multidrug-resistant organisms
  - *Acinetobacter* spp
  - *Escherichia coli*
  - *Enterococcus* spp
  - *Salmonella* spp
  - *Staphylococcus* spp
  - *Pseudomonas* spp

Stull and Weese. Hospital-Associated Infections in Small Animal Practice. *Vet Clin Small Anim* 2015;45:217–233

**Isolation of resistant organisms from UMN Veterinary Medical Center**

| Source | # of E. coli Isolates | Pansensitive[1] n (%) | MDR[2] n (%) |
|---|---|---|---|
| **Community Practice** | 102 | 70 (69%) | **4 (4%)** |
| **ICU** | 113 | 42 (37%) | **42 (37%)** |

1 Sensitive to all antimicrobials on panel; 2 MDR; Chi-square = 37.9; $p<0.01$
Unpublished data, courtesy of Prof. Jeff Bender

# AMR Challenges in Small Animals

- **Extended spectrum beta-lactamase (ESBL, e.g., CTX-M, TEM, SHV):** penicillins, extended-spectrum cephalosporins, monobactams
- **AmpC beta-lactamases:** penicillins, cephalosporins, cephamycins, beta-lactamase inhibitors
- **Carbapenemases (e.g., NDM, KPC):** carbapenems, penicillins, cephalosporins
- **Enterobacteriaceae** (e.g., *E. coli, Enterobacter*), ***Salmonella, Acinetobacter***
- Risk factors: raw meat consumption, antibiotic exposure
- Concerns for spread are high
  - Resistance genes often exist on mobile genetic elements
  - Evidence that humans and animals share these genes
  - Associated with HAI and outbreaks in veterinary settings
  - Identification and containment of infections and carriers is essential

**Meropenem-Resistant *E. coli***

- Recovered from 2 dogs, one person in Finnish household
- Dogs had chronic otitis externa, exposure to numerous antibiotics

Beaudoin A, Norton LE. "Antibiotic Resistance and Stewardship." Wallace-Maxcy-Roseanau-Last Public Health and Preventive Medicine. 16th Ed. MacGraw Hill Medical. Expected Pub2019
Schmidt VM. Antimicrobial resistance risk factors and characterization of faecal E. coli isolated from healthy Labrador retrievers in the United Kingdom. *Prev Vet Med* 2015;119:31-40.
Schmidt VM. Routine antibiotic therapy in dogs increases the detection of antimicrobial-resistant faecal Escherichia coli. *J Antimicrob Chemo* 2018:73(12):3305-3316.
Grönthal et al. Sharing more than friendship – transmission of NDM-5 ST167 and CTX-M-9 ST69 Escherichia coli between dogs and humans in a family, Finland, 2015. Euro Surveill. 2018;23(27).

# More AMR Challenges in Small Animals

- ***Pseudomonas aeruginosa* (PA)**
  - Considerable inherent resistance, capable of biofilm production
  - Fluoroquinolone use can drive resistance development
  - In France 19.4% otitis-causing PA resistant to enrofloxacin and gentamicin
- **Methicillin-resistant *Staphylococcus***
  - *S. pseudointermedius* (MRSP)
  - *S. aureus* (MRSA)
  - Inherent resistance to beta-lactams, commonly to other antibiotics
  - Infection is common, can be transmitted among people and animals
  - Clinical management of MRSP difficult in dogs
  - MRSA greater problem in cats
- Enterococci demonstrate inherent and acquired resistance, but often commensal finding

***S. pseudointermedius*:**

Common opportunistic pathogen for which spread of resistance will have considerable implications

Weese S. Recent Developments in Antimicrobial Resistance. Proceedings ACVIM 2019
Bourely C. Antimicrobial resistance patterns of bacteria isolated from dogs with otitis. *Epidemiology and Infection* 2019;147(e-121):1-10.

# AMR Challenges in Large Animal Patients

- ***Salmonella***
  - Concern for patient and zoonotic infection when present in veterinary settings
  - Risk of subclinical shedding
- **MRSA**
  - Challenge for individual infections (e.g., post-surgical) and outbreaks in equine veterinary settings
  - Hand hygiene important in prevention of nasal colonization of veterinary personnel
- **ESBL**
  - Reported transmission of ESBL-producing *E. coli* in equine clinic
  - Of 341 patients screened on admission to German teaching hospital, 10.7% feces and 3.4% of nasal swabs positive for ESBL *E. coli* organisms, including CTX-M, SHV-12
- IPC challenges exist in large animal clinical settings

Summarized in: Walther B et al. Multidrug-resistant opportunistic pathogens challenging veterinary infection control. Vet Microbiol. 2017 Feb;200:71-78.
Walther B, et al. Extended-spectrum beta-lactamase (ESBL)- producing Escherichia coli and Acinetobacter baumannii among horses entering a veterinary teaching hospital. PLoS ONE 13(1): e0191873

# Combatting AMR

**1 PREVENTING INFECTIONS, PREVENTING THE SPREAD OF RESISTANCE**

Avoiding infections in the first place reduces the amount of antibiotics that have to be used and reduces the likelihood that resistance will develop during therapy. There are many ways that drug-resistant infections can be prevented: immunization, safe food preparation, handwashing, and using antibiotics as directed and only when necessary. In addition, preventing infections also prevents the spread of resistant bacteria.

**2 TRACKING**

CDC gathers data on antibiotic-resistant infections, causes of infections and whether there are particular reasons (risk factors) that caused some people to get a resistant infection. With that information, experts can develop specific strategies to prevent those infections and prevent the resistant bacteria from spreading.

**3 IMPROVING ANTIBIOTIC PRESCRIBING/STEWARDSHIP**

Perhaps the single most important action needed to greatly slow down the development and spread of antibiotic-resistant infections is to change the way antibiotics are used. Up to half of antibiotic use in humans and much of antibiotic use in animals is unnecessary and inappropriate and makes everyone less safe. Stopping even some of the inappropriate and unnecessary use of antibiotics in people and animals would help greatly in slowing down the spread of resistant bacteria. This commitment to always use antibiotics appropriately and safely—only when they are needed to treat disease, and to choose the right antibiotics and to administer them in the right way in every case—is known as antibiotic stewardship.

**4 DEVELOPING NEW DRUGS AND DIAGNOSTIC TESTS**

Because antibiotic resistance occurs as part of a natural process in which bacteria evolve, it can be slowed but not stopped. Therefore, we will always need new antibiotics to keep up with resistant bacteria as well as new diagnostic tests to track the development of resistance.

According to Centers for Disease Control and Prevention, *four core actions* can help fight resistance.

1. **Prevent infections**
2. Track infections
3. Improve antibiotic prescribing (stewardship)
4. Develop new drugs and diagnostics

http://www.cdc.gov/drugresistance/about.html

# Importance of IPC

- Resistant infections not necessarily more virulent, but:
  - Difficult to treat
  - Prevention is worth a pound of cure
- Up to 70% of human HAI are preventable
  - Likely similar in veterinary medicine
- HAI impact client cost and satisfaction
- Effective IPC reduces individual infections, overall clinic risk profile
- Every animal examined or admitted could introduce organisms that cause infection of self, other patients, or staff
- Standard precautions are essential


Umscheid. Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs. *ICHE* 2011 Feb;32(2):101-14.

# Increased Emphasis on IPC

- IPC is essential to quality veterinary care
  - Spread of AMR holds all veterinary professionals increasingly accountable
  - Higher awareness of HAI among public
- Prevention of HAI can be targeted to high-risk scenarios, like surgical site infection
  - *S. pseudointermedius* is very common cause
  - High rates of resistance to additional antimicrobials
  - SSI prevention has become essential
- Veterinarians can pose a risk to their patients
  - More likely to be colonized with MRSA than general public
  - Moving among patients and patient care areas
  - Hand washing is essential

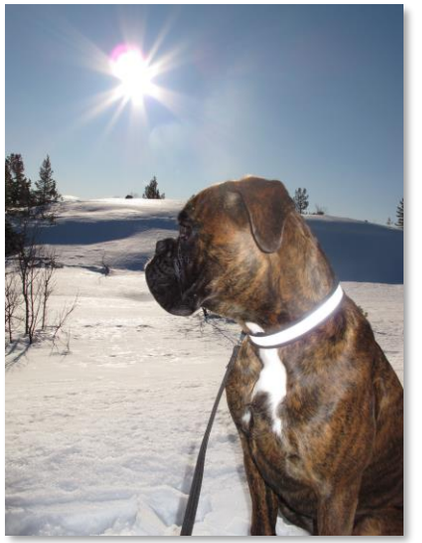


Hanselman BA, Kruth SA, Rousseau J, et al. Methicillin-resistant Staphylococcus aureus colonization in veterinary personnel. *Emerg Infect Dis* 2006;12(12):1933–8.

# Case 1: Mr. Bob

| | S aureus, M | |
|---|---|---|
| Drug | Result | Interp. |
| Clindamycin | >4 | Resistant |
| Doxycycline | <=0.12 | Susceptible |
| Enrofloxacin | >4 | Resistant |
| Erythromycin | >4 | Resistant |
| Gentamicin | <=4 | Susceptible |
| Marbofloxacin | >4 | Resistant |
| Penicillin | - | Resistant |
| Rifampin | <=1 | Susceptible |
| Tetracycline | <=0.25 | Susceptible |
| Trimethoprim/sulfamet | <=2 | Susceptible |
| Oxacillin | >2 | Resistant |
| Vancomycin | | |
| Amoxicillin/Clavulanat | - | Resistant |
| Ampicillin | - | Resistant |
| Cefazolin | - | Resistant |
| Cefovecin | - | Resistant |
| Cefpodoxime | - | Resistant |
| Cephalothin | - | Resistant |
| Chloramphenicol | <=8 | Susceptible |

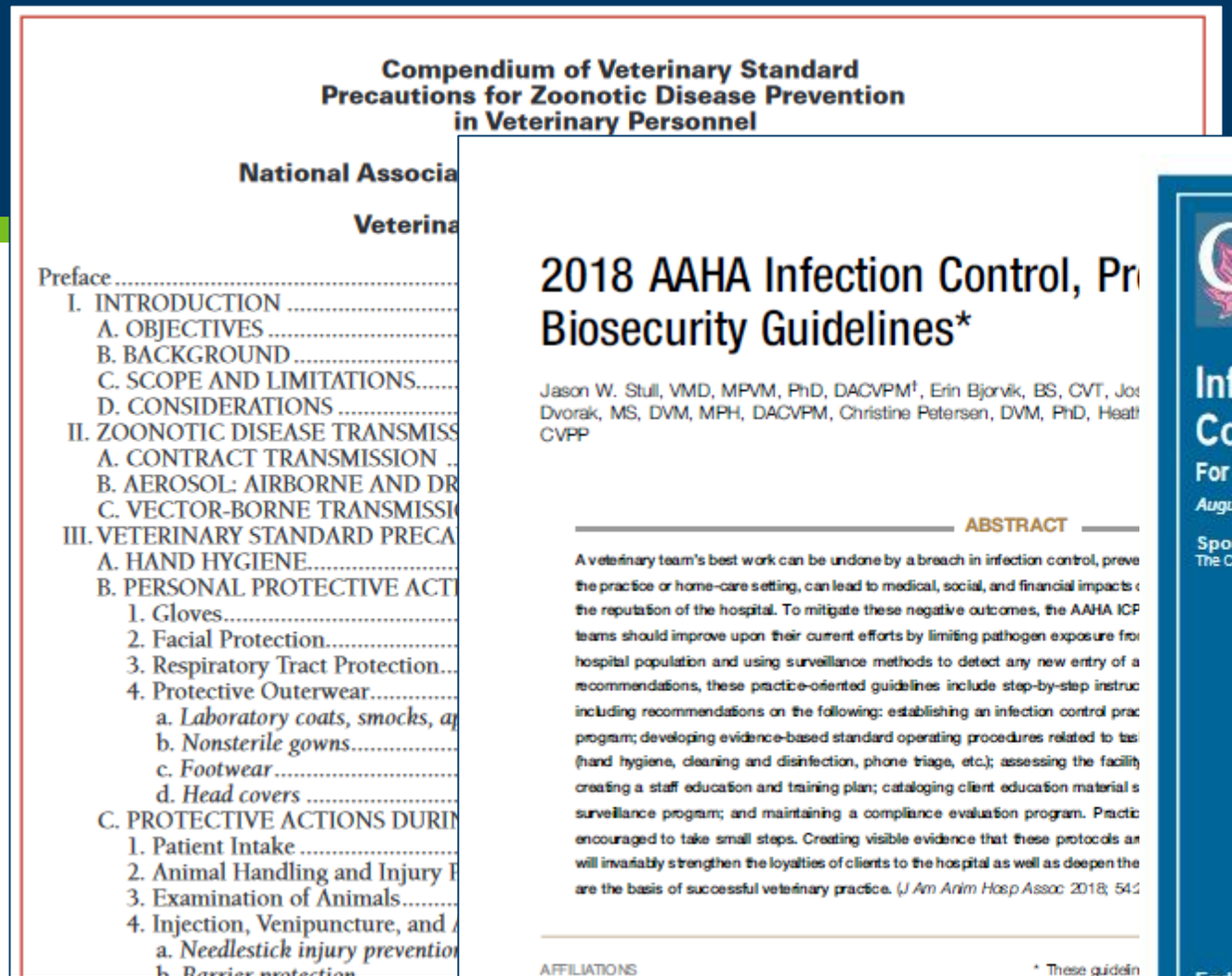
- 6 yo, MN Boxer
- TPLO for CCL rupture with implants
- Sent home on 3rd generation cephalosporin
  - Consistent with clinic protocol
- Developed draining tract at surgical site



**Room to Improve**

- Antibiotics are not substitute for good IPC
- Broad-spectrum antibiotic prescribed with no clear indication
- No clear guidelines exist for post-TPLO antibiotic use

# Important Resources



**Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel**

**National Associa**

**Veterina**

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4. Injection, Venipuncture, and
a. *Needlestick injury preventio*
b. *Barrier protection*

National Association of State Public Health Veterinarians



**2018 AAHA Infection Control, Pr Biosecurity Guidelines***

Jason W. Stull, VMD, MPVM, PhD, DACVPM†, Erin Bjorvik, BS, CVT, Jos Dvorak, MS, DVM, MPH, DACVPM, Christine Petersen, DVM, PhD, Heath CVPP

**ABSTRACT**

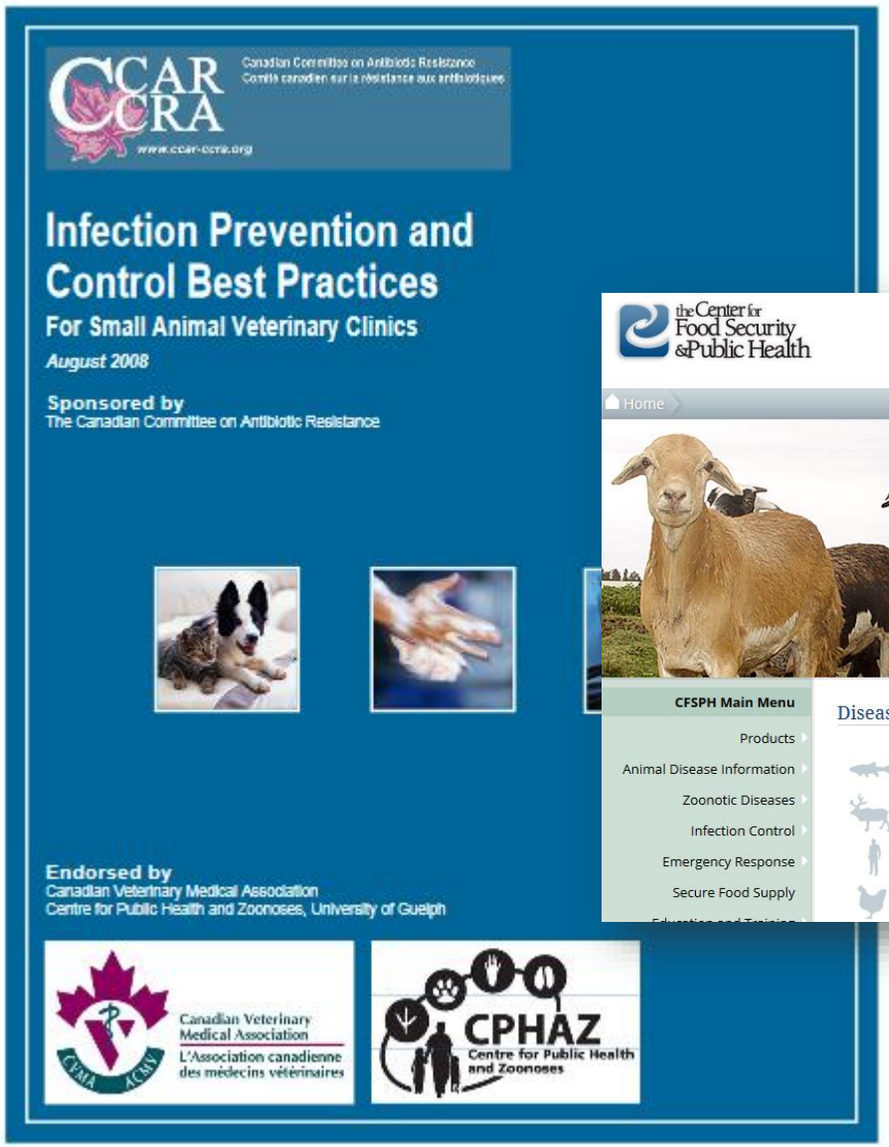
A veterinary team's best work can be undone by a breach in infection control, preve the practice or home-care setting, can lead to medical, social, and financial impacts the reputation of the hospital. To mitigate these negative outcomes, the AAHA ICP teams should improve upon their current efforts by limiting pathogen exposure fro hospital population and using surveillance methods to detect any new entry of a recommendations, these practice-oriented guidelines include step-by-step instruc including recommendations on the following: establishing an infection control prac program; developing evidence-based standard operating procedures related to tas (hand hygiene, cleaning and disinfection, phone triage, etc.); assessing the facilit creating a staff education and training plan; cataloging client education material s surveillance program; and maintaining a compliance evaluation program. Practic encouraged to take small steps. Creating visible evidence that these protocols ar will invariably strengthen the loyalties of clients to the hospital as well as deepen the are the basis of successful veterinary practice. (*J Am Anim Hosp Assoc* 2018; 54:

AFFILIATIONS

From the Department of Veterinary Preventive Medicine, College of Veterinary Medicine, Ohio State University, Columbus, Ohio, and Department of Health Management, Atlantic Veterinary College, the University of Prince Edward Island, Charlottetown, Prince Edward Island, Canada (J.W.S.); Veterinary Specialty Center, Buffalo Grove, Illinois (E.B.); Mesa Veterinary Hospital, Golden, Colorado (J.B.); Center for Food Security and Public Health, College of Veterinary Medicine, Iowa State University, Ames, Iowa (G.D.); Department of Epidemiology and Center for Emerging Infectious Diseases, College of Public Health, University of Iowa, Iowa City, Iowa (C.P.); and Oradell Animal Hospital, Paramus, New Jersey (H.L.T.).

* These guidelin by AAHA. This d standard of care construed as d procedure. Varia of the individual vidual practice s dations has be recommendation sensus of expert of these recomm ians must base

American Animal Hospital Association



CCAR CRA
Canadian Committee on Antibiotic Resistance
Comité canadien sur la résistance aux antibiotiques
www.ccar-crea.org

**Infection Prevention and Control Best Practices**
**For Small Animal Veterinary Clinics**
*August 2008*

**Sponsored by**
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ISU Center for Food Security and Public Health

# Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel

**Minimum infection prevention practices that apply to all patient care, regardless of suspected or confirmed infection status of the patient, in any setting where care is delivered**

- **Hand hygiene**
- **Personal protective equipment (PPE)**
  - Gloves, face protection, respiratory protection, protective outerwear
- **Protective actions during veterinary procedures**
  - Intake, handling, examination, injection safety, dentistry, resuscitation, obstetrics, necropsy, specimen handling, wound care
- **Environmental infection control**
  - Cleaning and disinfection, isolation of animals, linen handling, spill response, medical waste, rodent and vector control, dedicated staff eating and break space



Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. JAVMA 2015;247(11):1252-1277.

# Protection of Veterinary Workers

- Zoonotic diseases are recognized occupational hazards for veterinary personnel
- Occupational Health and Safety Administration (OSHA) has specific standards that apply to workplace hazards (e.g., PPE standard)
- OSHA general duty clause covers measures without specific standards (29 U.S.C § 654 Sec. 5)
- Infection prevention only one aspect of employee safety and health
  - Biological and infectious hazards
  - Physical hazards
  - Chemical hazards
  - Ergonomics
  - Workplace stress and violence



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# Transmission-Based Precautions

## Contact Precautions

*Agents spread by direct/indirect contact with patient/patient's environment*

- Single patient room
- Cohorting at ≥3 feet apart
- Gown, gloves for all interactions that might involve contact with patient/potentially contaminated patient areas
- Don PPE on room entry, discard before exiting

## Droplet Precautions

*Agents spread by respiratory/mucous membrane contact with respiratory secretions*

- No air handling, ventilation
- Single patient room
- Cohorting, separation curtain
- Mask for close patient contact
- Patients transported out of room should wear mask, follow respiratory/cough etiquette

## Airborne Precautions

*Agents that remain infectious over long distances when suspended in the air*

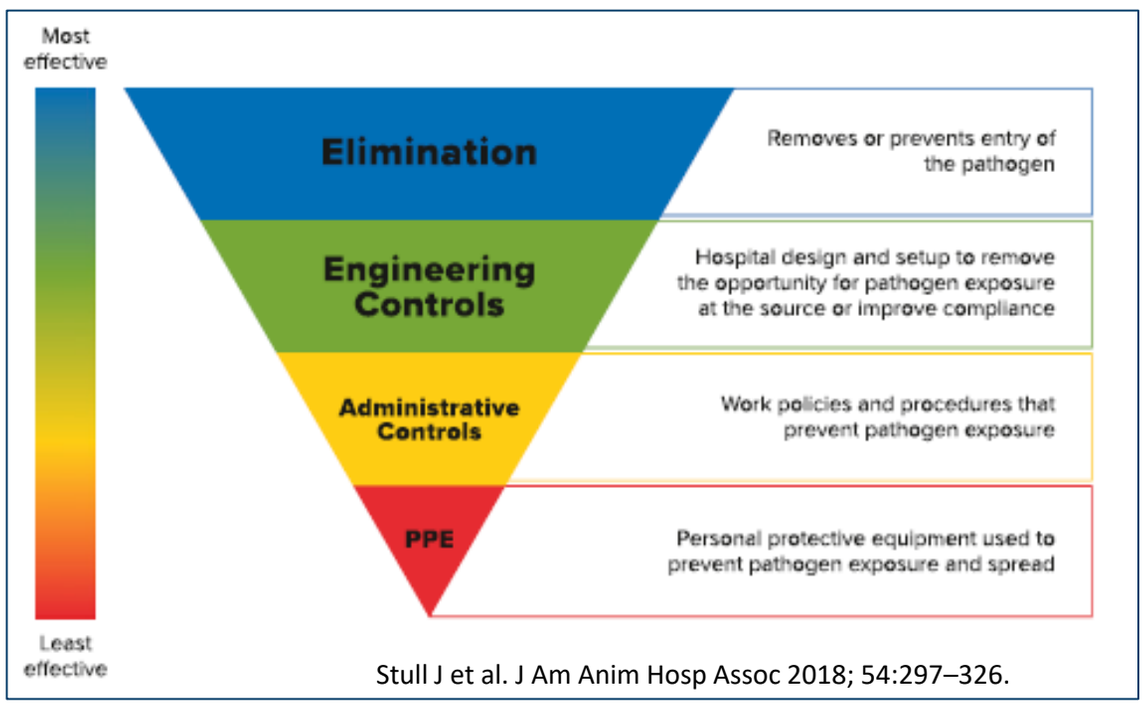
- Airborne infection isolation room or private room
- Mask or respirator, depending on disease

https://www.cdc.gov/infectioncontrol/guidelines/isolation/precautions.html#IIIb

# Infection Prevention and Control Program Essentials

## Goals: Reduce HAI and protect veterinary staff and clients

- Hand hygiene and PPE
- Environmental infection control
- Patient management
- Education, training, leadership
- Surveillance
- MDRO containment
- Antimicrobial stewardship



Stull J et al. J Am Anim Hosp Assoc 2018; 54:297–326.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# Hand Hygiene (HH)

- Most important aspect of infection prevention
- Hand washing with soap and water, use of alcohol-based hand sanitizer
- Routine HH removes or kills transient microorganisms on skin
  - Present on most superficial layers of skin
  - Acquired through contact with animals, people, environment
  - Most likely to be transferred among patients
- Surgical scrubbing removes or kills resident microorganisms on skin
  - Present in deeper layers of skin
  - Not susceptible to mechanical removal
  - Addition of antiseptic agent
- Important to use procedures that maintain skin integrity

CDC/ Kimberly Smith, Christine Ford

Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA* 2015;247(11):1252-1277.
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# When to Conduct HH

- Hand washing must be conducted when debris is visible
  - Hand sanitizer ineffective when organic material present
  - If no running water available, use wet hand wipe to remove debris, followed by sanitizer
- Hand sanitizer not effective against bacterial spores (e.g., *Clostridium*), *Cryptosporidium*, nonenveloped viruses (e.g., parvovirus)
- Conduct HH:
  - Immediately before and after patient contact, especially invasive procedures
  - Before and after contact with items in the patient's environment
  - After exposure to bodily fluids (e.g., discharge, specimen handling)
  - Before putting on gloves AND after glove removal
  - After using restroom
  - Before eating

Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA* 2015;247(11):1252-1277.
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# Personal Protective Equipment

- PPE includes:
  - Gloves
  - Protective outerwear (e.g., lab coat, gown)
  - Face protection (e.g., face shield),
  - Respiratory protection (e.g., N95 respirator)
- PPE reduces risk of clothing contamination, exposure of skin and mucous membranes to pathogens, and reduces transmission of pathogens among patients
- Daily laundering, at minimum of lab coats, scrubs, and when exposed to infectious patient
  - Clothing can serve as fomite for microorganism transmission
- Disposable items cannot be reused
- Should not be worn outside of work environment


CDC/ Awadh Mohammed Ba Saleh, Yemen

Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA* 2015;247(11):1252-1277.
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# Gloves

- Barrier that can be removed when soiled but not substitute for hand hygiene
  - Before and after glove use
- Routine use when contact with patient with known or suspected infection, feces, body fluids, vomitus, exudate, non-intact skin
- Use during dental, obstetric procedures, cleaning of animal areas, and necropsy
- Sterile gloves should be used to prevent transmission of microorganisms to patient or clinical equipment (e.g., surgery, examination of “clean” wounds, sterile equipment)
- Changed between animals and between dirty and clean procedures

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# Protective Clothing

- Limits transmission of pathogens between person and patient
- Laboratory coats, coveralls, gowns (reusable cloth, disposable), coveralls
  - Regular clothing must be completely covered
  - Permeable or impermeable, based on situation
- Use when:
  - Risk of clothing contamination with large number of organisms (e.g., procedures with splashing risk, patients with diarrhea/respiratory disease)
  - Any risk of clothing contamination with highly virulent, resistant, or transmissible organisms (e.g., multidrug resistant organism, parvovirus, influenza) from patient or patient's environment
- Nonsterile gowns used during patient care to prevent transfer of pathogens from one patient to others
  - Disposable gowns should not be reused
  - Perform hand hygiene after removing gown, before leaving patient environment

Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA* 2015;247(11):1252-1277.
Stull J et al. 2018 AAHA Infection Control, Prevention, and Biosecurity Guidelines. *J Am Anim Hosp Assoc* 2018; 54:297–326.

# Face, Foot, and Respiratory Protection

- Face protection includes surgical masks and eye protection, or face shield
  - Used when splash or droplet transmission risk
    - Dental procedures
    - Wound lavage, abscess lancing
    - Potentially zoonotic respiratory disease with productive coughing or sneezing
    - Necropsy
  - Facial hair, eye glasses taken into consideration during selection
- Foot protection: single-use disposable covers or easily cleaned and disinfected slip-on shoes/boots
- Respiratory protection (e.g., N95)
  - Protects airways of workers exposed to small airborne contaminants
    - Requires compliance with OSHA's respiratory tract protection standard (29 CFR 1910.134)

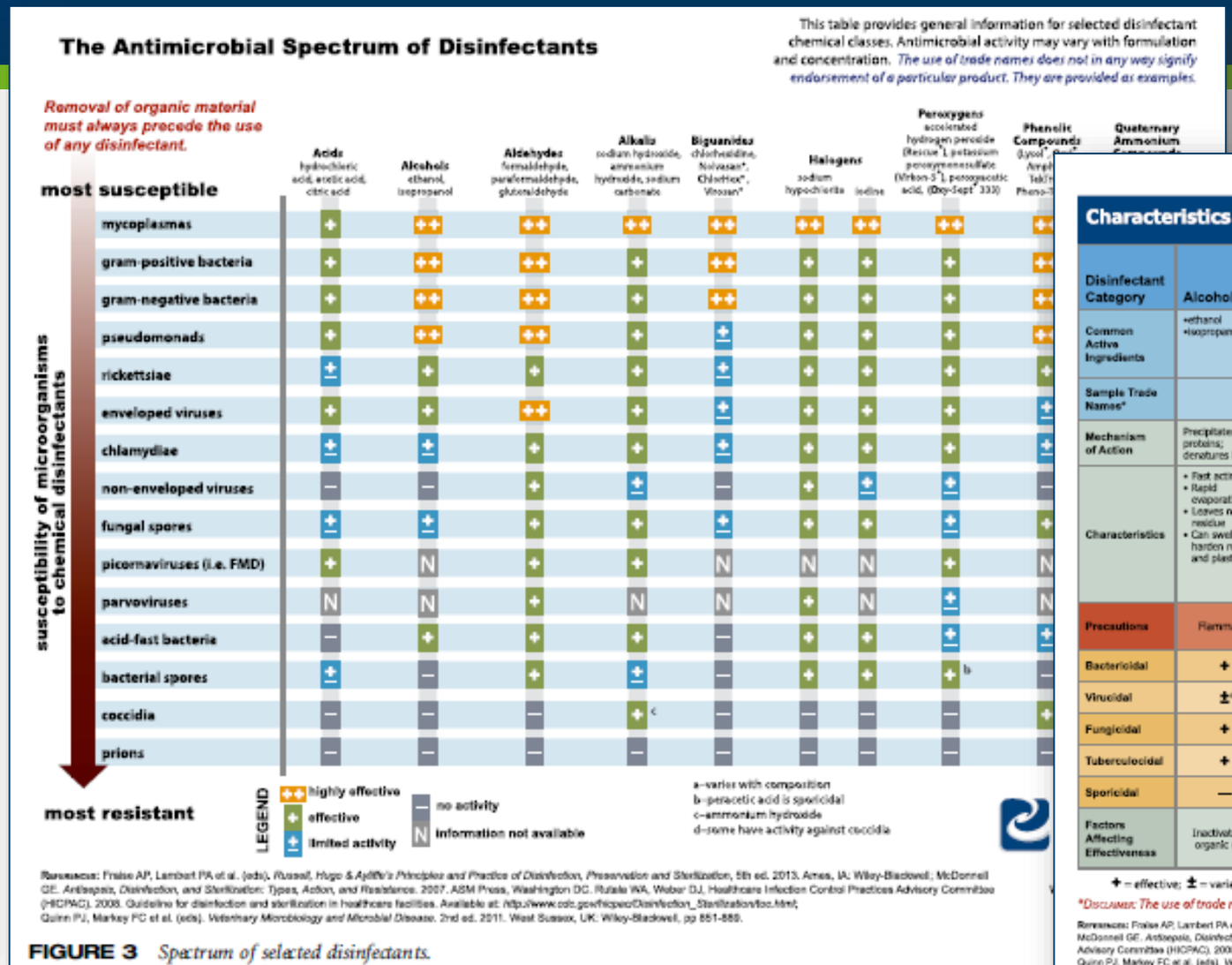
Williams C et al. Compendium of Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA* 2015;247(11):1252-1277.
Stull J et al. 2018 AAHA Infection Control, Prevention, and Biosecurity Guidelines. *J Am Anim Hosp Assoc* 2018; 54:297–326.

# Environmental Infection Control

- Cleaning and disinfection is important step in HAI prevention, control of outbreaks
  - Environmental contamination in healthcare facilities associated with HAI
  - Reduction of contamination support outbreak control, reduction of HAI
- Basics components:
  - Surface or item cleaned to be free of visible organic material
  - EPA-registered disinfectant, applied at manufacturer's dilution, contact time
  - Selection based on surface, activity spectrum, susceptibility to organic matter
  - HH conducted afterward
- Regular cleaning and disinfection between uses, when visibly soiled
  - Increased cleaning for high-touch surfaces, areas holding animal(s) with transmissible pathogen of concern

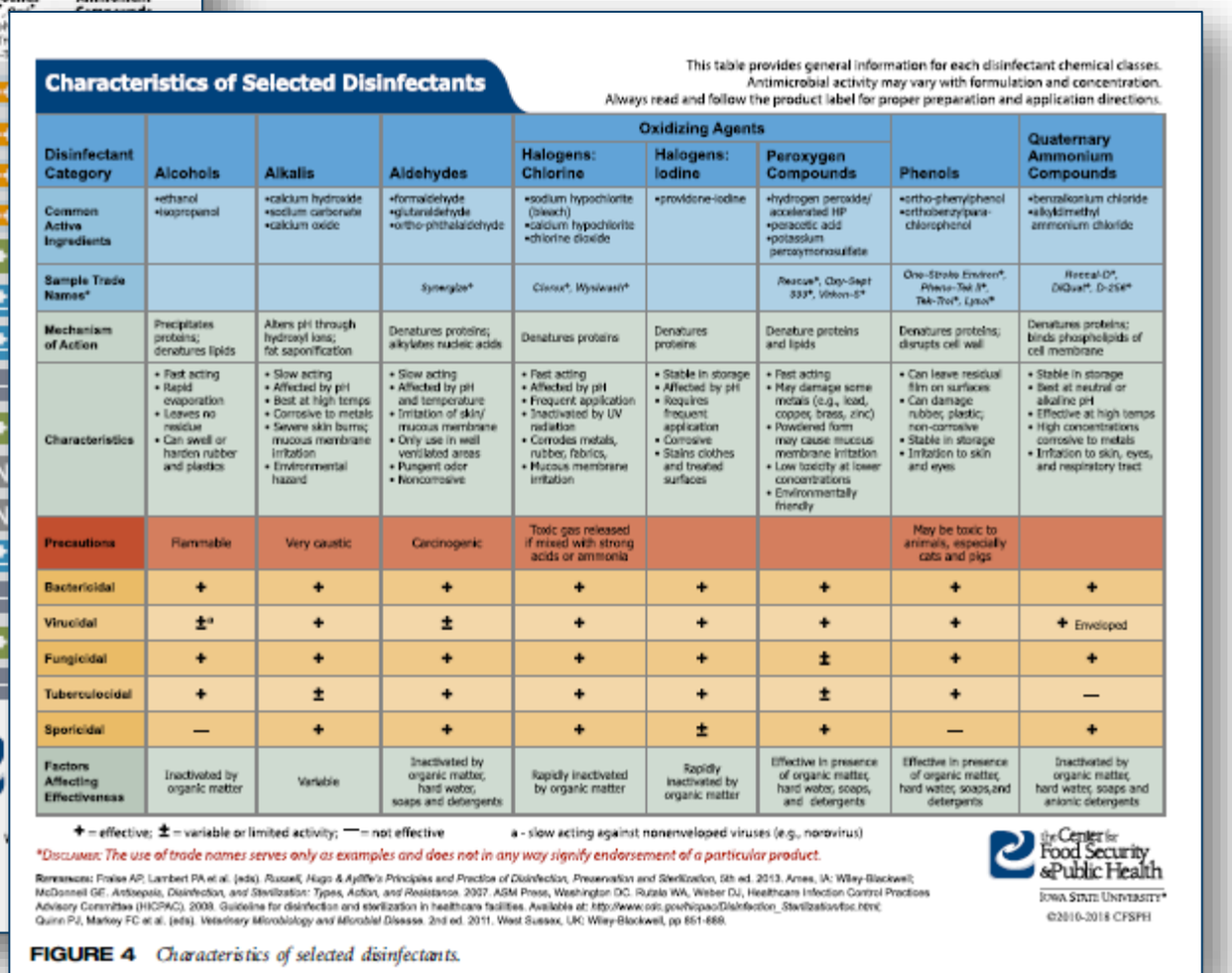
Donskey CJ. Does improving surface cleaning and disinfection reduce healthcare-associated infections? Am J Infect Control 2013;41(Suppl 5):S12–9
Stull and Weese. Hospital-Associated Infections in Small Animal Practice. Vet Clin Small Anim 2015;45:217–233

# Environmental Infection Control




References: Fraise AP, Lambert PA et al. (eds). Russell, Hugo & Ayliffe's Principles and Practice of Disinfection, Preservation and Sterilization, 5th ed. 2013. Ames, IA: Wiley-Blackwell; McDonnell GE. Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance. 2007. ASM Press, Washington DC. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee (HICPAC). 2008. Guideline for disinfection and sterilization in healthcare facilities. Available at: http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html; Quinn PJ, Markey FC et al. (eds). Veterinary Microbiology and Microbial Disease. 2nd ed. 2011. West Sussex, UK: Wiley-Blackwell, pp 851-889.

**FIGURE 3** *Spectrum of selected disinfectants.*




| Disinfectant Category | Alcohols | Alkalis | Aldehydes | Oxidizing Agents: Halogens: Chlorine | Oxidizing Agents: Halogens: Iodine | Oxidizing Agents: Peroxygen Compounds | Phenols | Quaternary Ammonium Compounds |
|---|---|---|---|---|---|---|---|---|
| Common Active Ingredients | •ethanol<br>•isopropanol | •calcium hydroxide<br>•sodium carbonate<br>•calcium oxide | •formaldehyde<br>•glutaraldehyde<br>•ortho-phthalaldehyde | •sodium hypochlorite (bleach)<br>•calcium hypochlorite<br>•chlorine dioxide | •providone-iodine | •hydrogen peroxide/ accelerated HP<br>•peracetic acid<br>•potassium peroxymonosulfate | •ortho-phenylphenol<br>•orthobenzyl-para-chlorophenol | •benzalkonium chloride<br>•alkyldimethyl ammonium chloride |
| Sample Trade Names* | | | Synergize® | Clorox®, Wyswash!® | | Rescue®, Oxy-Sept 333®, Virkon-S® | One-Stroke Environ®, Phenu-Tek II®, Tek-Trol®, Lysol® | Roccal-D®, DiQuat®, D-256® |
| Mechanism of Action | Precipitates proteins; denatures lipids | Alters pH through hydroxyl ions; fat saponification | Denatures proteins; alkylates nucleic acids | Denatures proteins | Denatures proteins | Denature proteins and lipids | Denatures proteins; disrupts cell wall | Denatures proteins; binds phospholipids of cell membrane |
| Characteristics | • Fast acting<br>• Rapid evaporation<br>• Leaves no residue<br>• Can swell or harden rubber and plastics | • Slow acting<br>• Affected by pH<br>• Best at high temps<br>• Corrosive to metals<br>• Severe skin burns; mucous membrane irritation<br>• Environmental hazard | • Slow acting<br>• Affected by pH and temperature<br>• Irritation of skin/ mucous membrane<br>• Only use in well ventilated areas<br>• Pungent odor<br>• Noncorrosive | • Fast acting<br>• Affected by pH<br>• Frequent application<br>• Inactivated by UV radiation<br>• Corrodes metals, rubber, fabrics,<br>• Mucous membrane irritation | • Stable in storage<br>• Affected by pH<br>• Requires frequent application<br>• Corrosive<br>• Stains clothes and treated surfaces | • Fast acting<br>• May damage some metals (e.g., lead, copper, brass, zinc)<br>• Powdered form may cause mucous membrane irritation<br>• Low toxicity at lower concentrations<br>• Environmentally friendly | • Can leave residual film on surfaces<br>• Can damage rubber, plastic, non-corrosive<br>• Stable in storage<br>• Irritation to skin and eyes | • Stable in storage<br>• Best at neutral or alkaline pH<br>• Effective at high temps<br>• High concentrations corrosive to metals<br>• Irritation to skin, eyes, and respiratory tract |
| Precautions | Flammable | Very caustic | Carcinogenic | Toxic gas released if mixed with strong acids or ammonia | | | May be toxic to animals, especially cats and pigs | |
| Bactericidal | + | + | + | + | + | + | + | + |
| Virucidal | ±[a] | + | ± | + | + | + | + | + Enveloped |
| Fungicidal | + | + | + | + | + | ± | + | + |
| Tuberculocidal | + | ± | + | + | + | ± | + | — |
| Sporicidal | — | + | + | + | ± | + | — | + |
| Factors Affecting Effectiveness | Inactivated by organic matter | Variable | Inactivated by organic matter, hard water, soaps and detergents | Rapidly inactivated by organic matter | Rapidly inactivated by organic matter | Effective in presence of organic matter, hard water, soaps, and detergents | Effective in presence of organic matter, hard water, soaps,and detergents | Inactivated by organic matter, hard water, soaps and anionic detergents |

+ = effective; ± = variable or limited activity; — = not effective  a - slow acting against nonenveloped viruses (e.g., norovirus)

*Disclaimer: The use of trade names serves only as examples and does not in any way signify endorsement of a particular product.

References: Fraise AP, Lambert PA et al. (eds). Russell, Hugo & Ayliffe's Principles and Practice of Disinfection, Preservation and Sterilization, 5th ed. 2013. Ames, IA: Wiley-Blackwell; McDonnell GE. Antisepsis, Disinfection, and Sterilization: Types, Action, and Resistance. 2007. ASM Press, Washington DC. Rutala WA, Weber DJ, Healthcare Infection Control Practices Advisory Committee (HICPAC). 2008. Guideline for disinfection and sterilization in healthcare facilities. Available at: http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html; Quinn PJ, Markey FC et al. (eds). Veterinary Microbiology and Microbial Disease. 2nd ed. 2011. West Sussex, UK: Wiley-Blackwell, pp 851-889.

the Center for Food Security & Public Health
Iowa State University


**FIGURE 4** *Characteristics of selected disinfectants.*

Stull J et al. 2018 AAHA Infection Control, Prevention, and Biosecurity Guidelines. *J Am Anim Hosp Assoc* 2018; 54:297–326.
Iowa State University Center for Food Security and Public Health. Disinfection. http://www.cfsph.iastate.edu/Disinfection/index.php

# Patient Management

- "Flow" for work and animal movement when infectious disease is present
  - Avoid waiting room, common treatment areas
- Consider interventions to reduce transmission of organisms (e.g., cohorting, isolation)
  - Dedicated isolation room with own equipment, hand hygiene station, PPE, signage
- Review shared medical equipment practices during outbreaks, for patients with transmissible organism of concern
- Optimize IPC during procedures, for maintenance of medical devices
  - Placement and maintenance of peripheral catheters, indwelling urinary catheters
- Resident animals can harbor resistant bacteria and can act as fomites within a veterinary clinic
  - Limit contact between staff and resident animals
  - Prevent access of resident animals to patient care areas

Ghosh A, Kukanich K, Brown CE, et al. *Front Microbiol* 2012;3:62.
Stull and Weese. Hospital-Associated Infections in Small Animal Practice. Vet Clin Small Anim 2015;45:217–233

# Case 2: Buffy

- 8yr FS Manx feline, well-loved clinic cat
- **2012:** Presented with ≥7 year history of urinary incontinence and inappropriate urination
  - History of UTI diagnoses and treatment prior to 2012 unknown
- **October 2012–August 2016**
  - Six *Enterococcus* sp. UTI diagnoses
  - Treated with cefovecin, amoxicillin-clavulanate, or orbifloxacin each time
- **September 2016**
  - UTI: *E.coli* (10–50K/ml) and methicillin-resistant *S. pseudointermedius* (MRSP, 10–50K/ml)
  - Treatment with orbifloxacin

- **December 20, 2017**
  - MRSP, >100K/ml; nitrofurantoin, 80 mg/mL TID
- **January 24, 2018**
  - MRSP, 1–10K/ml; nitrofurantoin, 80 mg/mL TID
- **June 2018–September 2018 (4 months)**
  - Treated three times for *Enterococcus* sp. with amoxi-clav
- **Ongoing**
  - Urine specimens collected when apparent increase in leaked urine on floor

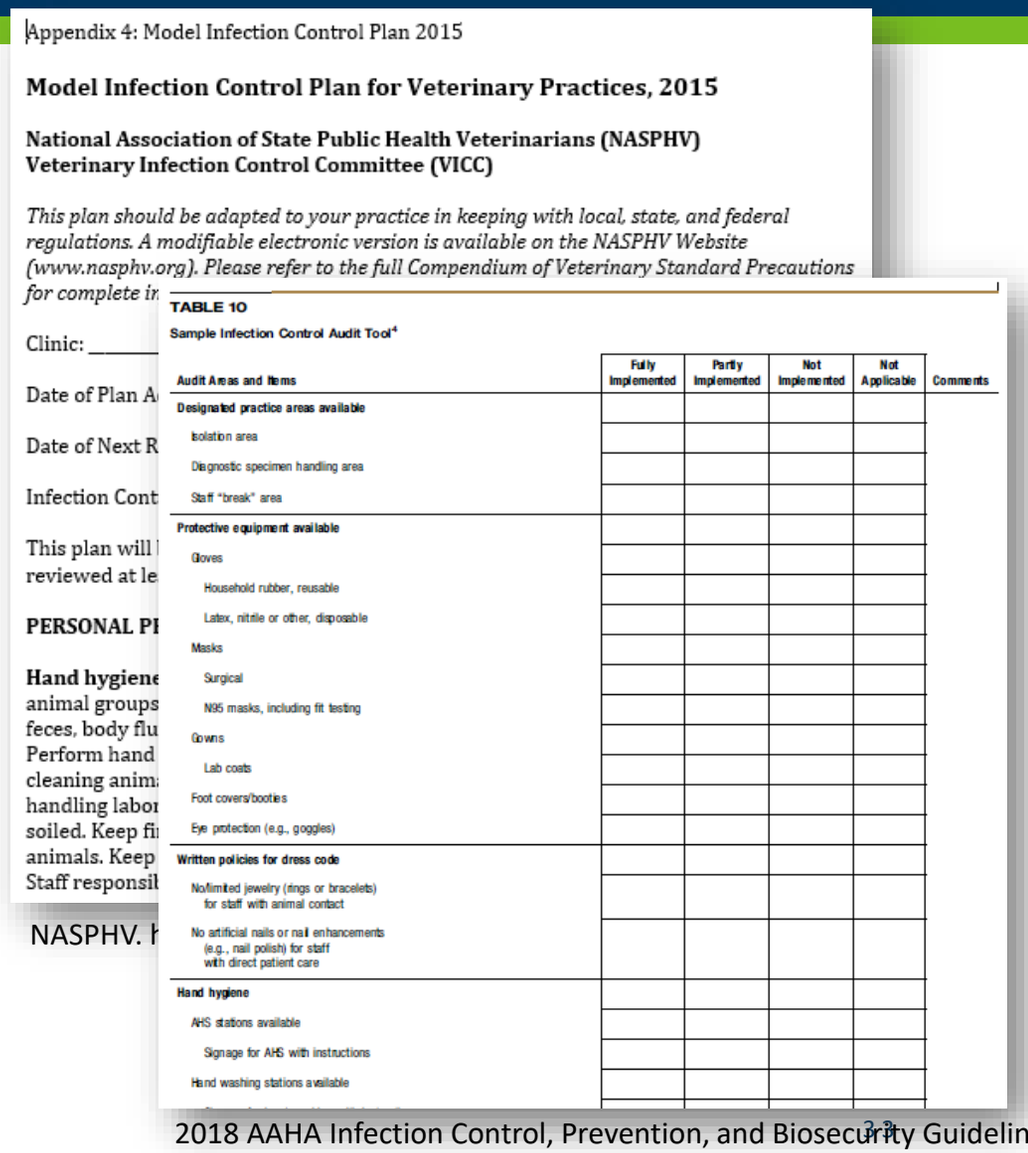
| | |
|---|---|
| PENICILLIN G | R >=0.5 |
| AMOXICILLIN | R |
| AMOX/CLAV ACID | R |
| OXACILLIN | R 2 |
| CEPHALEXIN | R |
| CEFOVECIN | R |
| CEFPODOXIME | R |
| IMIPENEM | R |
| AMIKACIN | S |
| GENTAMICIN | R >=16 |
| CIPROFLOXACIN | R |
| ENROFLOXACIN | R >=4 |
| MARBOFLOXACIN | R >=4 |
| MOXIFLOXACIN | R |
| AZITHROMYCIN | R |
| ERYTHROMYCIN | R >=8 |
| CLINDAMYCIN | S 0.5 |
| VANCOMYCIN | DNR |
| TETRACYCLINE | R >=16 |
| NITROFURANTOIN | S <=16 |
| CHLORAMPHENICOL | R >=64 |

**Room to Improve**

- Non-first-line antibiotic selection for initial uncomplicated UTI
- Repeated treatment of *Enterococcus* bacteriuria
- Ongoing potential for treatment of subclinical bacteriuria
- Clinic cat contacts patient care areas, employee space

# Leadership, Education, Training

- Administrative leadership is essential
- Clinical IPC leader
- Clinic infection control manual/policy
  - Roles, responsibilities, protocols
  - Steps to measure adherence to IPC plan
  - Communication protocol for routine work, situations of concern
  - Phone numbers for laboratory, IPC consultants, public health
- Routine education, including veterinarian and other staff
- Education plan for onboarding employees



Appendix 4: Model Infection Control Plan 2015

**Model Infection Control Plan for Veterinary Practices, 2015**

**National Association of State Public Health Veterinarians (NASPHV)**
**Veterinary Infection Control Committee (VICC)**

*This plan should be adapted to your practice in keeping with local, state, and federal regulations. A modifiable electronic version is available on the NASPHV Website (www.nasphv.org). Please refer to the full Compendium of Veterinary Standard Precautions for complete in*

Clinic: _____

Date of Plan A

Date of Next R

Infection Cont

This plan will
reviewed at le

**PERSONAL PF**

**Hand hygiene**
animal groups
feces, body flu
Perform hand
cleaning anim
handling labor
soiled. Keep fi
animals. Keep
Staff responsil

NASPHV. h

**TABLE 10**

**Sample Infection Control Audit Tool[4]**

| Audit Areas and Items | Fully Implemented | Partly Implemented | Not Implemented | Not Applicable | Comments |
|---|---|---|---|---|---|
| **Designated practice areas available** | | | | | |
| Isolation area | | | | | |
| Diagnostic specimen handling area | | | | | |
| Staff "break" area | | | | | |
| **Protective equipment available** | | | | | |
| Gloves | | | | | |
| Household rubber, reusable | | | | | |
| Latex, nitrile or other, disposable | | | | | |
| Masks | | | | | |
| Surgical | | | | | |
| N95 masks, including fit testing | | | | | |
| Gowns | | | | | |
| Lab coats | | | | | |
| Foot covers/booties | | | | | |
| Eye protection (e.g., goggles) | | | | | |
| **Written policies for dress code** | | | | | |
| No/limited jewelry (rings or bracelets) for staff with animal contact | | | | | |
| No artificial nails or nail enhancements (e.g., nail polish) for staff with direct patient care | | | | | |
| **Hand hygiene** | | | | | |
| AHS stations available | | | | | |
| Signage for AHS with instructions | | | | | |
| Hand washing stations available | | | | | |

2018 AAHA Infection Control, Prevention, and Biosecurity Guidelines

# Surveillance

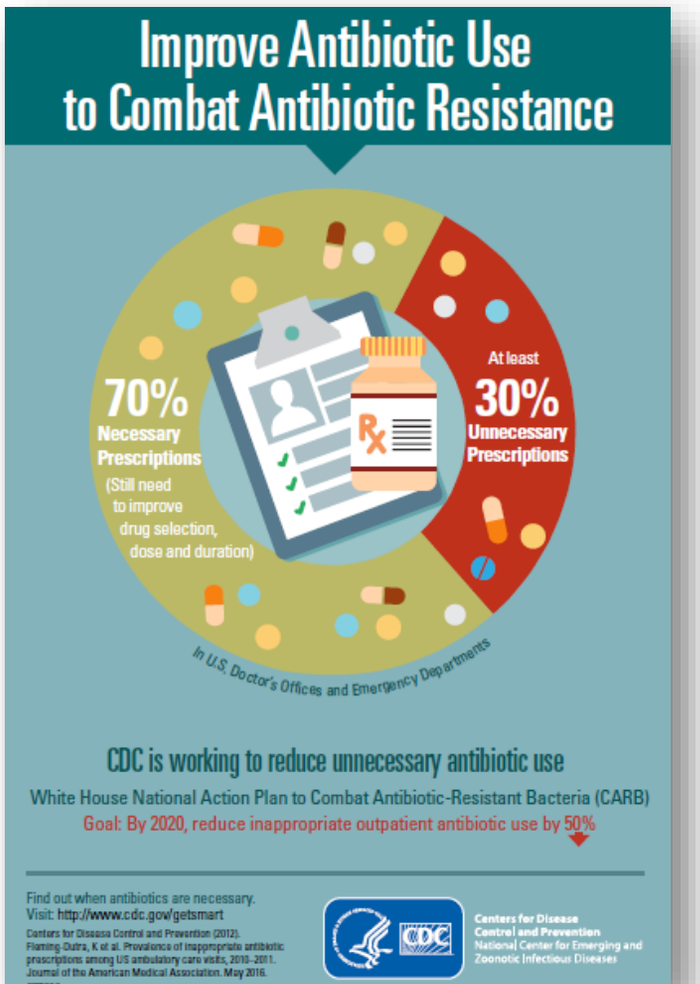
- Passive surveillance
  - Routine monitoring of surgical outcomes, culture and susceptibility testing results
  - Record information into central database, reviewed by IPC leader
  - Follow up with active surveillance as needed

- Active surveillance
  - Admission screening (e.g., MRSA, *Salmonella*)
  - Assessment of potential in-clinic transmission

- Surveillance data can be used to assess potential breaches in IPC, noncompliance
- Can also be used for education of staff or to stimulate conversation of IPC practices, challenges

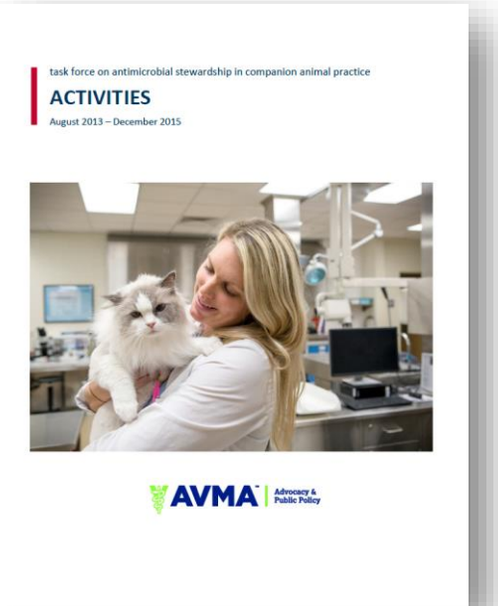
# Antimicrobial Stewardship: Improving Use While Effectively Treating Infections

- Antibiotics are essential to all aspects of health, shared resource
- High facility antibiotic use can put all patients at risk
  - Increased transmission, infection, colonization of resistant organisms for all
  - Drug interactions and adverse effects
- Stewardship goal is to optimize the “5 Ds”:
  - **Diagnosis.** Determining if an antibiotic is needed
  - **Drug.** Choosing the right antibiotic for the infection and patient
  - **Dose.** Giving the right amount of antibiotic
  - **Duration.** Giving the antibiotic for the right amount of time
  - **De-escalation.** Discontinuing or narrowing antibiotic as appropriate



# AVMA Core Principles of Companion Animal Stewardship

- **Clinic/Practice Commitment**
  - Gather a stewardship team
- **Responsibility, Authority, Drug Expertise**
  - Leadership and expertise to advance stewardship
- **Implementing Actions to Improve Antibiotic Use**
  - Use of prescribing guidelines, algorithms, protocols
- **Surveillance: tracking, monitoring and measurable outcomes**
  - Understand baseline practices and track compliance with clinic protocols
- **Resources and Education**
  - Require yearly CE for stewardship and train new staff

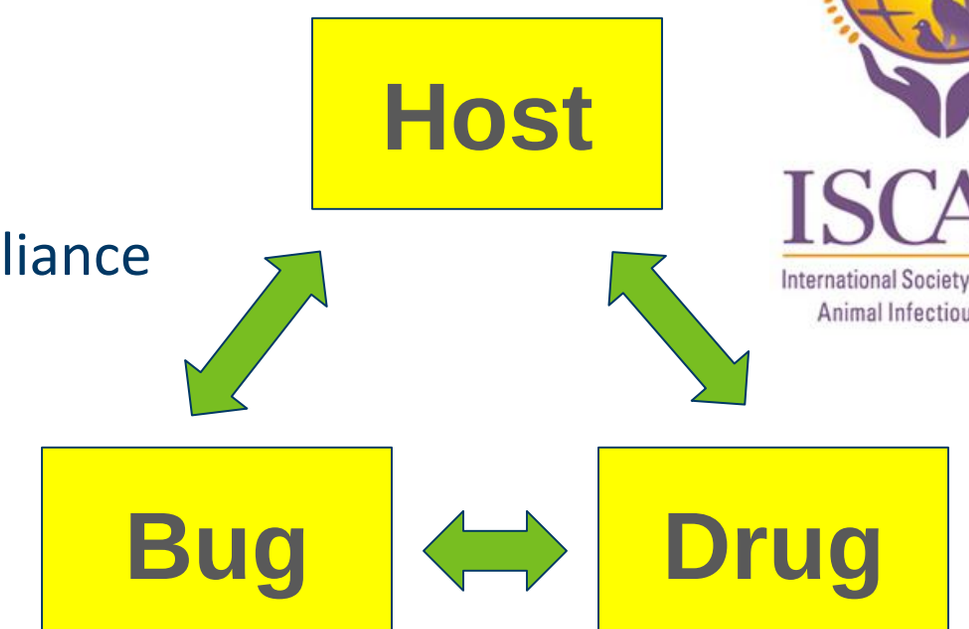


# Antibiotic Therapy “Do and Don’t”

- Consider and rule-out non-bacterial causes
- Consider other therapeutic options
- Utilize culture and sensitivity testing
- Refer to published treatment guidelines
- Monitor treatment response and client compliance
- Take a “time out” before adding, switching, or changing antibiotic treatments

Journal of Veterinary Internal Medicine
Open Access
*ACVIM Consensus Statement*
*J Vet Intern Med* 2015;29:487–498

ISCAID
International Society for Companion Animal Infectious Diseases



# Case 3: Shelly

- 14yo, FS Cocker Spaniel
- Metastatic anal sac carcinoma
  - Ureteral transposition w/stents
  - Diarrhea → metronidazole
  - UTI → ciprofloxacin, No WBC, No bacteria, No Culture
- Ureteral stents obstructed, bilateral pyelonephritis
  - UC: no growth on imipenem
  - Rx: meropenem
- Re-obstructed → MDR *E. coli* cultured
  - Bilateral SUBs placed
  - Rx: meropenem
- SUBs obstructed → MDR *E. coli* cultured
  - Humane euthanasia

| | E coli | |
|---|---|---|
| **Drug** | **Result** | **Interp.** |
| Amikacin | <=4 | Susceptible |
| Amoxicillin/Clavulanate | >8 | Resistant |
| Ampicillin | >8 | Resistant |
| Cefazolin | >32 | Resistant |
| Cefovecin | >8 | Resistant |
| Cefpodoxime | >8 | Resistant |
| Cephalexin | >16 | Resistant |
| Doxycycline | >8 | Resistant |
| Enrofloxacin | >4 | Resistant |
| Gentamicin | 2 | Susceptible |
| Marbofloxacin | >4 | Resistant |
| Orbifloxacin | >8 | Resistant |
| Piperacillin/Tazobactam | <=8 | Susceptible |
| Pradofloxacin | >2 | Resistant |
| Tetracycline | >16 | Resistant |
| Trimethoprim/sulfamethoxazole | >4 | Resistant |
| Imipenem | <=1 | Susceptible |
| Nitrofurantoin | - | Resistant |
| Meropenem | - | Susceptible |

# Case 3: Shelly and Use of Third Line Antibiotics

**Room to Improve**

- Communication among services poor
- No protocol to guide use of third line antibiotics
- IPC: some good practices, some not so good

- Third line antibiotics (e.g., vancomycin, carbapenems, linezolid) might be warranted if:
  - Documented infection: clinical, cytology, culture
  - No other reasonable options and susceptible to third line drug
  - **Realistic chance of infection elimination (e.g., eliminate underlying cause)**
  - Consultation with infectious disease or antibiotic therapy expert

SAGE-Hindawi Access to Research
Veterinary Medicine International
Volume 2011, Article ID 263768, 9 pages
doi:10.4061/2011/263768

*Research Article*

**Antimicrobial Use Guidelines for Treatment of Urinary Tract Disease in Dogs and Cats: Antimicrobial Guidelines Working Group of the International Society for Companion Animal Infectious Diseases**

J. Scott Weese,[1] Joseph M. Blondeau,[2] Dawn Boothe,[3] Edward B. Breitschwerdt,[4] Luca Guardabassi,[5] Andrew Hillier,[6] David H. Lloyd,[7] Mark G. Papich,[4] Shelley C. Rankin,[8] John D. Turnidge,[9,10] and Jane E. Sykes[11]

[1] *Department of Pathobiology, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada N1G 2W1*
[2] *Clinical Microbiology, Royal University Hospital and University of Saskatchewan, Saskatoon, SK, Canada S7N 0W8*
[3] *College of Veterinary Medicine, Auburn University, Auburn, AL 36849, USA*
[4] *College of Veterinary Medicine, North Carolina State University, Raleigh, NC 27606, USA*
[5] *Department of Veterinary Disease Biology, Faculty of Life Sciences, University of Copenhagen, 1870 Frederiksberg C Copenhagen, Denmark*
[6] *College of Veterinary Medicine, The Ohio State University, Columbus, OH 43210, USA*
[7] *Department of Clinical Sciences, Royal Veterinary College, North Mymms, Hertfordshire AL9 7TA, UK*
[8] *School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA 19104, USA*
[9] *Division of Laboratory Medicine, Women's and Children's Hospital, North Adelaide, SA 5006, Australia*
[10] *University of Adelaide, Adelaide, SA 5000, USA*
[11] *Department of Medicine and Epidemiology, University of California, Davis, Davis, CA 95616, USA*

Correspondence should be addressed to J. Scott Weese, jsweese@uoguelph.ca

Received 16 February 2011; Accepted 31 March 2011

Academic Editor: Remo G. Lobetti

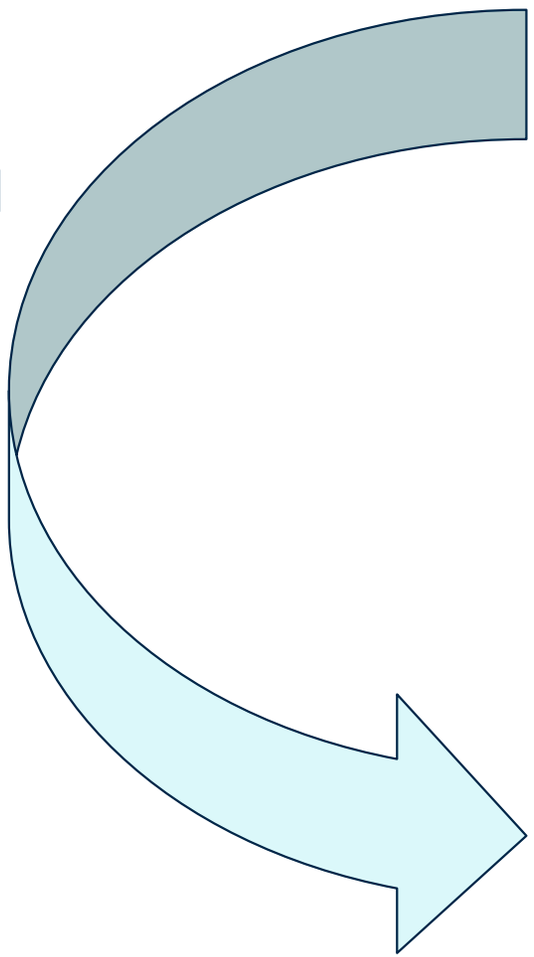


Urinary tract disease is a common reason for use (and likely misuse, improper use, and overuse) of antimicrobials in dogs and cats. There is a lack of comprehensive treatment guidelines such as those that are available for human medicine. Accordingly, guidelines for diagnosis and management of urinary tract infections were created by a Working Group of the International Society for Companion Animal Infectious Diseases. While objective data are currently limited, these guidelines provide information to assist in the diagnosis and management of upper and lower urinary tract infections in dogs and cats.

# Infection Prevention and Control Program Essentials

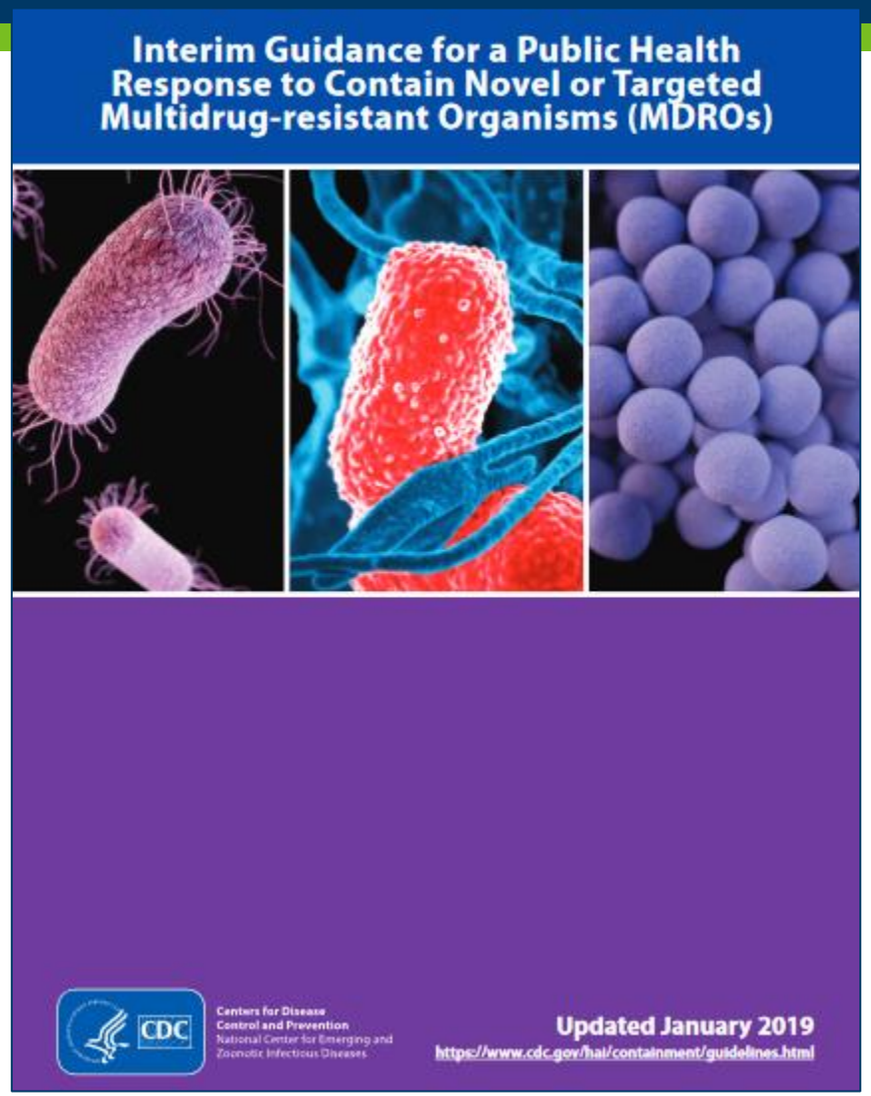
**Goals: Reduce HAI and protect veterinary staff and clients**

- **Hand hygiene and PPE**
- **Environmental infection control**
- **Patient management**
- **Education, training, leadership**
- **Surveillance**
- **MDRO containment**
- **Antimicrobial stewardship**



**MDRO Response**

# MDRO Containment

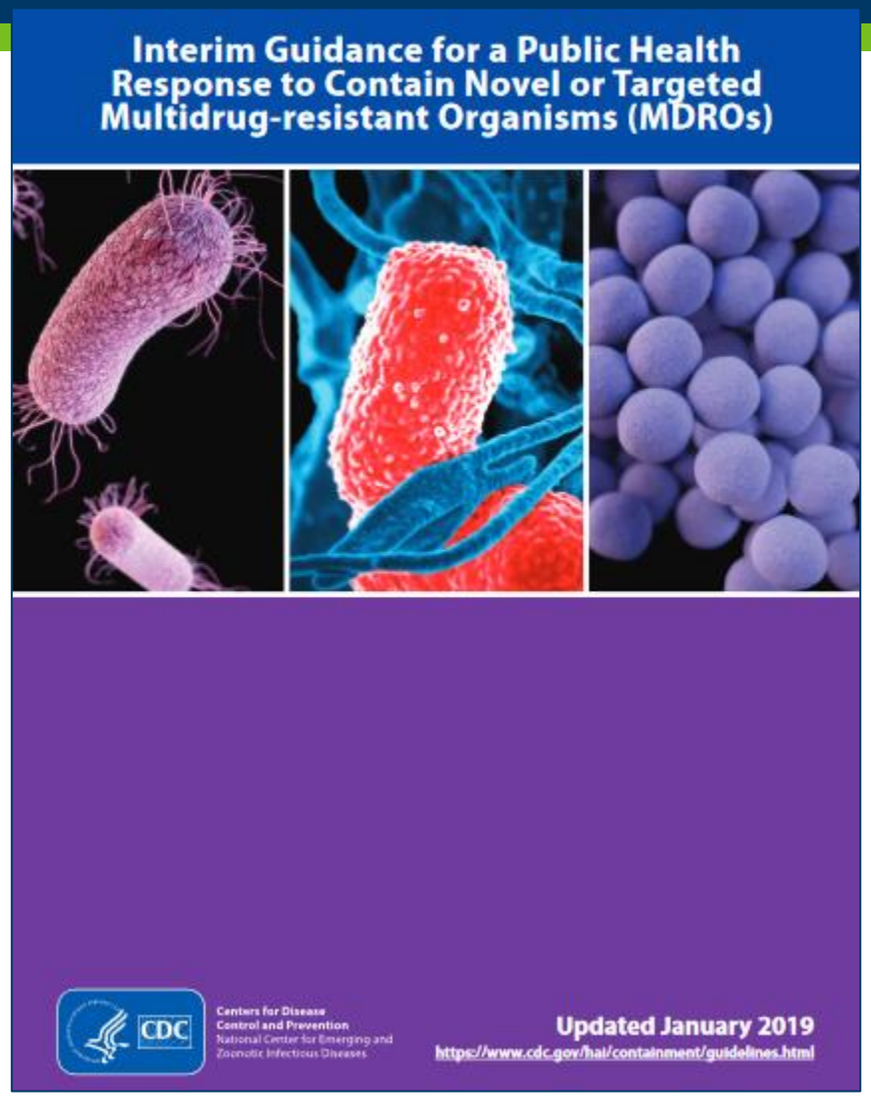



https://www.cdc.gov/hai/pdfs/containment/Health-Response-Contain-MDRO-H.pdf

**Goals of initial containment approach in healthcare settings:**

1. Identifying affected patients
2. Ensuring appropriate control measures are promptly implemented to contain further spread
3. Determining if transmission and dissemination is occurring
4. Characterizing organism or resistance mechanism to guide further response actions, patient management, future responses

# Strategies for MDRO Containment




https://www.cdc.gov/hai/pdfs/containment/Health-Response-Contain-MDRO-H.pdf

**Specific actions dependent on the identified MDRO:**

1. Initial response measures
   - Notify primary physician, patient care personnel, public health
   - Implement appropriate IPC measures (e.g., contact precautions)
   - Notify patient family, transferring facility if infection was present on admission
2. Conduct healthcare investigation
   - Review all healthcare received (last ≤30 days) to understand potential exposures leading to infection
   - If high-risk event (e.g., exposure to healthcare in high-risk country) can be identified, can use to define risk period for potential transmission

# Strategies for MDRO Containment (cont.)


https://www.cdc.gov/hai/pdfs/containment/Health-Response-Contain-MDRO-H.pdf

3. Conduct contact investigation
   - For inpatients, conduct colonization screening for epidemiologically linked patients
   - Broader screening if novel organism or not on contact precautions
4. Clinical laboratory prospective and retrospective surveillance
   - Lab(s) that performs cultures for facility look forward and back in records for similar resistance profiles
   - Additional testing for mechanism of action
5. Environmental cultures
   - For organisms with known environmental persistence
   - Questions about cleaning and disinfection quality
6. Implement system to ensure IPC measure adherence
   - Education, supplies, on-site assessment, adherence monitoring, communication across care transitions

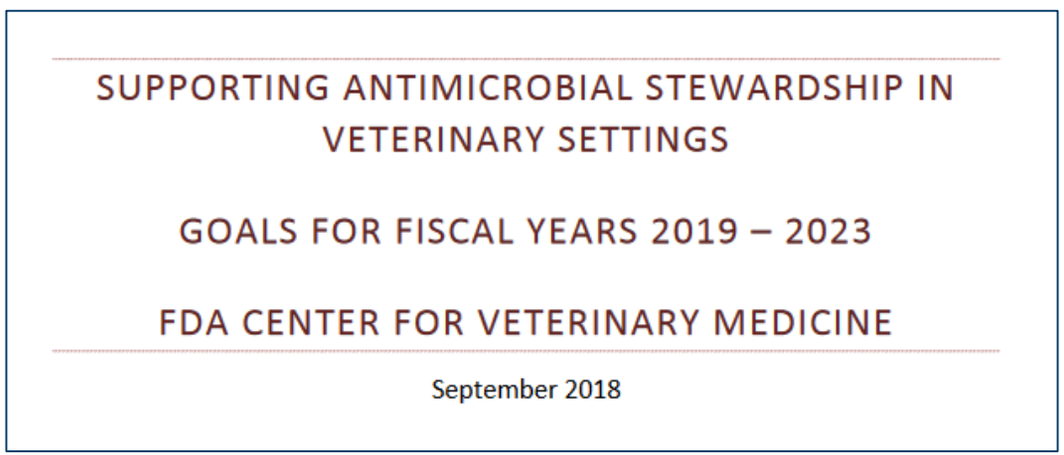
# How are we doing?

- 0-42% clinics have infection control plans
- 61% clinics have quarantine or isolation area
- 6%-37% used PPE when indicated, depending on situation
- Hand hygiene compliance is poor
  - 20% between patients
  - 76% before eating
- 16% of practitioners reported routinely using antimicrobials for clean surgical procedures (e.g., ovariohysterectomy, castration, uncomplicated mass removal)
- Approximately 40% of canine antibiotic prescriptions had no evidence of infection in one hospital
- Treated in line with published guidelines: 80% of upper respiratory tract infections, 67% of non-recurrent UTI, 44% of recurrent UTI, 22% of bronchitis

Wright JG, et al. *JAVMA* 2008;232(12):1863-72.
Murphy CP et al. Zoonoses Pub Health 2010;57(6):429-38.
Venkat et al. *Prev Vet Med* 2019;169.
Task Force Survey of AVMA Membership – unpublished
Shea et al. *J Small Animal Pract* 2011;52(6):310-318.
Banfield. Antimicrobial usage patterns among companion animal veterinarians. 2017

# Need to Heighten Awareness, Improve Practice

- Veterinary workers are at continued risk from zoonotic infections
- We pose an AMR infection risk to our patients
- There is a higher awareness of HAI among pet owners and growing expectations for IPC
- Antimicrobial stewardship becoming more of an expectation
  - FDA 5-year plan for veterinary stewardship
  - Increasing awareness of public and other health professions
  - State rules regarding antibiotic use, reporting passed
- Public health increasingly aware of clinic-based veterinary settings as potential site for MDRO transmission




https://www.fda.gov/animal-veterinary/cvm-updates/fda-releases-five-year-plan-supporting-antimicrobial-stewardship-veterinary-settings

# Important Resources

- **2018 AAHA Infection Control, Prevention, and Biosecurity Guidelines**
  - JAAHA.org
- **National Association of State Public Health Veterinarians: *Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel* (2015)**
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# Thank You!

**Acknowledgments**

Jennifer Granick

Jeff Bender

Leslie Kollmann

Joni Scheftel

Amanda Beaudoin, DVM, PhD

Director of One Health Antibiotic Stewardship, MN Dept. of Health
amanda.Beaudoin@state.mn.us

Adjunct Assistant Professor,
University of Minnesota
beau0209@umn.edu