

What you and your staff need to know about *Staph!*

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Terminology

- Total of 4 samples at different time points
- Resident
 - Present in more than 75% of cultures
- Nomads
 - Present in 25-75% of cultures
- Transient
 - Present in <25% of cultures

Staphylococcus

- Coagulase positive
 - *S. pseudintermedius*
 - *S. aureus*
 - *S. schleiferi* subsp. *coagulans*
- Coagulase negative
 - *S. schleiferi* subsp. *schleiferi*
 - *S. xylosus*
 - *S. epidermidis*
 - *S. sciuri*
 - *S. felis*

Staphylococcus spp. Infections

- Pyoderma
- Otitis externa
- Pneumonia
- UTIs
- Soft tissue infections
- Surgical site infections
- Bacteremia
- Ocular infections
- Endocarditis

Staphylococcus pseudintermedius

- Most common commensal organism
 - Skin and mucosa
 - 31-68% adult dogs
 - Up to 100% puppies
 - 6.8-22% healthy cats
- Most common isolate from canine superficial pyoderma

Staphylococcus aureus

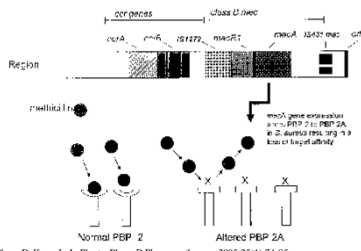
- Major cause of SSTI
- Colonizes ≈30% humans
- Colonize up to 12-14% of healthy dogs
- Colonize up to 4.3-20% of healthy cats
- Co-colonization with humans and dogs

Staphylococcus schleiferi

- Pyoderma and otitis
- Up to 57% being MRS+
- Commonly resistant to fluoroquinolones
- Colonization 0.5-2% in animals
 - Similar or more common than *Staphylococcus aureus*

Methicillin resistance

- *mecA* gene carried on DNA element called *SCCmec*
- PCR to confer the *mecA* gene (research setting)
- Encodes for an altered penicillin binding protein (PBP2a)



Michael J. Rybak, PharmD, Kerry J. TenPate, PharmD Pharmacotherapy, 2005:25(1):74-85

Methicillin Resistance

- Culture and sensitivity
 - Oxacillin – *S. aureus* and *S. pseudintermedius*
 - Cefoxitin – *S. aureus* and coagulase negative Staph

Organism	Staphylococcus	Pseudintermedius
Amikacin	<=18	18-32
Ampicillin	<=0.25	0.25-0.5
Amoxicillin	<=0.25	0.25-0.5
Azithromycin	<=2	2-8
Cefazolin	<=2	2-8
Cefepime	<=2	2-8
Ceftriaxone	<=2	2-8
Ceftazidime	<=2	2-8
Chloramphenicol	<=2	2-8
Clindamycin	<=8	8-32
Clotrimazole	<=0.25	0.25-1.0
Cloxacillin	<=0.50	0.5-2
Doxycycline	8	4-16
Erythromycin	1	0.5-2
Gentamicin	>8	2-8
Meropenem	<=1	1-4
Mupirocin	<=4	4-8
Potentiated sulfonamide	<=0.50	0.5-2

Methicillin Resistance

- Resistant
 - Penicillins
 - Carbapenems
 - Cephalosporins
 - β -lactam and β -lactamase inhibitor combinations

	Organism	Staphylococcus schleiferi
	iso #	1
	Specimen	1 Swab Skin
	Verified	Verified 02/28/14
ANTIBIOTICS		
	CLSI	
Amikacin	B	\leq 4 S
Amoxicillin / clavulanic acid	A	\leq 4 R
Ampicillin	A	2 R
Cefazolin	A	\leq 4 R
Cefovecin	C	\geq 8 R
Cefoxitin	D	4 R
Cefepime	A	\geq 16 R
Ceftiofur	C	\geq 4 R
Chloramphenicol	B	\leq 4 S
Clindamycin	A	\leq 0.5 S
Doxycycline	B	\leq 2 S
Enrofloxacin	A	\geq 2 R
Erythromycin	B	\leq 0.5 S
Gentamicin	A	\leq 1 S
Imipenem	D	\leq 1 R
Meropenem	A	2 I
Meropenem + 2% NaCl	B	\geq 4 R
Penicillin	B	2 R
Rifampin	D	\leq 1 S
Ticarcillin	D	16 R
Ticarcillin/Clav (Timentin)	D	\leq 8 R
Trimeth-Sulfa	B	\leq 0.5 S

Organism ID: Staphylococcus pseudintermedius

CLSI A - FDA Approved with CLSI Veterinary Interpretive Criteria

Antibiotic	CLSI	Interpretive
Ampicillin	\leq 4.0000	Susceptible
Clindamycin	4.0000	Resistant
Enrofloxacin	1.0000	Intermediate
Gentamicin	\leq 1.0000	Susceptible
Meropenem	2.0000	Intermediate

CLSI B - FDA Approved with CLSI Human Interpretive Criteria

Antibiotic	CLSI	Interpretive
Amikacin	\leq 4.0000	Susceptible
Amoxicillin/Clavulanic Acid	\leq 4.0000	Susceptible
Chloramphenicol	\leq 4.0000	Susceptible
Erythromycin	4.0000	Intermediate
Penicillin	1.0000	Resistant
Trimethoprim/Sulfamethoxazole	\leq 0.5000	Susceptible

CLSI C - FDA Approved with No CLSI Interpretive Criteria

Antibiotic	CLSI	Interpretive
Cefovecin	1.0000	Susceptible
Cefepime	0.5000	Susceptible
Doxycycline	\leq 2.0000	Susceptible

CLSI D - AMDUCA (Extra-label Use Only)

Antibiotic	CLSI	Interpretive
Cefepime	\leq 2.0000	Susceptible
Imipenem	\leq 1.0000	Susceptible
Oxacillin + 2% NaCl	\geq 1.0000	Resistant
Rifampin	\leq 1.0000	No Interpret
Ticarcillin	16.0000	Susceptible
Ticarcillin/Clavulanic Acid	\leq 8.0000	Susceptible
Cefazolin	\leq 4.0000	Susceptible
Cefazolin	8.0000	Susceptible

Methicillin resistance *Staphylococcus*

- Risk factors
 - Previous hospitalization
 - Living in urban environment
 - Older age
 - Previous antimicrobial drug treatment

Methicillin resistant *S. pseudintermedius*

- U.S.
 - No reports in 1980's
 - First report in U.S. in 1999
 - Early 2000's, 15.6-17%
 - In 2008, 30%
- Japan
 - 66.7% in 2010
- Europe
 - New problem as of 2010

MRSP

- Healthy dogs
 - 1.5-17%
- Healthy cats
 - 1.2-4%
- Dogs with inflammatory skin disease
 - 7%
- Carriage sites
- In contact animals – 31-36%

MRSP in humans

- Veterinary personnel at increased risk of colonization
 - Carriage rate of 3-5.3%
- Rare cases of zoonosis reported
 - Dog bite wounds
 - Otitis externa
 - Sinus infection

MRSP - Environment

- Present in 5-10% of cultured sites in hospital
- Transmission by equipment (pens, stethoscopes, cell phones, white coats)
- Persistence in environment up to 6 months
 - Non accessible areas

MRSA

- Increased dramatically since 1960's
- Hospital-associated (USA100)
- Community-associated (USA300)
- Human nasal MRSA colonization
 - 1.5% (2001-2004)
 - Veterinarians
 - 3.5-21.4% (*North America, Europe, and Australia*)

MRSA

- Clinically healthy animals
 - Dogs – Up to 3.3%
 - Cats – Up to 4%
 - Emerging problem in horses, pigs, and cattle
- Risk factors in animals
 - Owned by human health care worker
 - Participation in hospital visitation programs
 - Contact with children
- Colonization is risk factor for humans and horses

MRSA

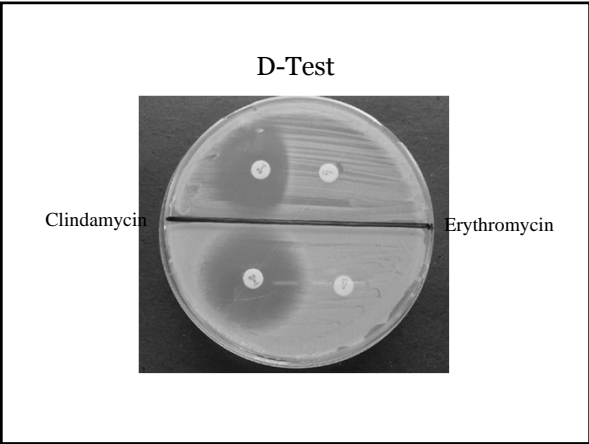
- Reported in dogs, cats, horses, parrots, rabbits, guinea pigs, turtles, bats, elephants, and marine mammals
 - Pyoderma, otitis, respiratory disease, cystitis, prostatitis, joint infections, septicemia
- Human to animal transmission
- Lack of transmission between infected dog and healthy dog

MRSA

- Risk factors
 - Number of antimicrobial courses administered
 - *Higher risk cephalosporins and fluoroquinolones*
 - Number of days admitted to veterinary clinics
 - History of surgical implant placement

Clindamycin

- Conveyed by the staphylococcal *msrA* gene
 - Antimicrobial efflux
- *Erm* gene
 - Constitutive
 - *Changes to ribosomal antimicrobial target site*
 - *Possible resistance to erythromycin as well*
 - Inducible
 - *Macrolides or lincosamides in vivo promote expression of resistant phenotype*
 - *Well documented in MRSA*
 - *Some MRSP*
 - *Suspected when resistant to erythromycin and susceptible to clindamycin*
 - *Tested with double disc diffusion test (D-test)*



Tetracycline Resistance

- tetK or tetL gene
 - Antimicrobial efflux
 - Resistant to tetracycline and doxycycline, but susceptible to minocycline
- tetM or tetO gene
 - Alteration of antimicrobial target site
- MRSP
 - tetK and tetM most important
- tetM and tetK positive are important for doxycycline resistance

Fluoroquinolone Resistance

- gyrA gene
 - DNA gyrase
- grlA gene
 - Topoisomerase IV
 - Drug efflux pumps
 - Altered membrane diffusion channels

Virulence factors

- Various enzymes
 - Hemolysin, Proteases, Hyaluronidase, Lipase, Leukocidins
- Endotoxins
 - Found in toxic shock syndrome, staphylococcal scalded skin syndrome
- Biofilm production
 - S. aureus and S. pseudintermedius
- Multidrug efflux pumps
 - qacA, qacB, and smr

Culture Indications

- Failed to respond to appropriate empiric therapy
- Clinical lesions consistent with deep pyoderma
- Mixed infections
- Recurrent or relapsing pyoderma
- Recent antimicrobial administration
- Prior methicillin resistant Staphylococcal infection

Therapy

- Aminoglycosides
- Tetracyclines
- Rifampin
- Chloramphenicol

- Cephalosporins
 - Ceftaroline fosamil and ceftobiprole

- Topical therapies

First tier	Primary choice empirical therapy of known or suspected SGB Additional choices only if local regional susceptibility of <i>Staphylococcus pseudintermedius</i> is known	Cloxacillin or flucloxacillin First generation cephalosporins (e.g. cefalexin, cefadroxil), Amoxicillin-clavulanate Trimethoprim- and ormetoprim-potentiated sulphonamides
First or second tier		Third generation cephalosporins (ceftiofur, ceftiofexime). There is insufficient evidence for this working group to reach consensus on categorization of these agents as first or second tier drugs (see text under 'Systemic antimicrobial therapy' and concerns about selection of ESBL-producing <i>Escherichia coli</i>)
Second tier	When empirical selection of first tier systemic AMD and topical therapy are not appropriate and when cultures indicate susceptibility	Doxycycline or minocycline Cloramphenicol Fluoroquinolones (such as enrofloxacin, marbofloxacin, orbifloxacin, pradofloxacin and ciprofloxacin) (should only be used when other feasible options are not available) Rifampicin. Commonly used in combination with another drug to which the causative organism is susceptible; however, this process may not reduce development of resistance in staphylococcal infection. ⁷⁶ Aminoglycosides, including gentamicin and amikacin. See Table 5 for comments on nephrotoxicity and ototoxicity First tier AMD (clindamycin, lincomycin and potentiated sulphonamides) may also be considered when cultures indicate susceptibility
Third tier	When first and second tier are not appropriate and cultures indicate susceptibility	Linezolid, teicoplanin, vancomycin. Regardless of the fact that most (or all) MRSP are susceptible, the use of these three AMDs is strongly discouraged. These drugs can be considered 'reserved' for the treatment of serious MRSA infections in humans ⁷⁷ .

Eliminate Carriage

- Humans – Mupirocin cream
- Animals – Fusidic acid

Infection Control

- Often spread through direct skin contact
- Personal protective equipment
- Isolation control

Homecare

- Not allowed to share bed
- Cleaning and disinfecting
 - Daily cleaning of food and water bowls
- Proper hand hygiene

Strategies to Prevent Resistance

- **P** = Prophylactic administration of Ab should be discouraged except if indicated in high-risk patients
- **R** = Routine appropriate and adequate treatment of infections with antibiotics
- **E** = Encourage avoidance of unnecessary use of Ab
- **V** = Develop specific infection and treatment protocols
- **E** = Employ antiseptic techniques for all invasive procedures
- **N** = Noncompliance with local infection prevention and Ab treatment protocols should not be tolerated
- **T** = Try to use narrow spectrum antibiotics on basis of C&S

Strategies to Prevent Resistance

- **R** = Resist use of specific antimicrobial agents or drug classes for outbreaks of resistant bacteria
- **E** = Promote appropriate mixing of antibiotic drug classes
- **S** = Strict isolation of pets with highly resistant infections
- **I** = Infectious disease consultation with a specialist for difficult to manage cases
- **S** = Systematic disinfection of commonly used equipment
- **T** = Teach infection control practices to doctors and staff
- **A** = Active culture surveillance programs to identify patients infection with Ab-resistant bacteria
- **N** = NARROW spectrum antibiotics whenever possible
- **C** = Cease antibiotics only after clinical cure is achieved
- **E** = Embrace locally developed antibiotic guidelines and protocols aimed at balancing antibiotic efficacy and preventing the emergence of resistance

VTH Policy # Bio402a

- 5-3.5. See that any open wounds (per supervising clinician instructions) are covered with an appropriate dressing during transportation.
- 5-3.5.1. Any floor or other surface contamination involved must be promptly disinfected using a 1% potassium peroxymonosulfate solution or equivalent.
- 5-3.5.2. Transport relevant known infected or suspect patients between hospital areas on a disinfectable (metal) gurney or carrier. **DO NOT TRANSPORT ANIMALS BY CARRYING THEM IN YOUR ARMS.**
- 2.4. **Personal Protective Equipment (PPE)** - Personal protective equipment may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators, or coveralls, vests and full body suits.
