Antibiotic Algorithm & Trends in Antimicrobial Resistance

Elizabeth Race, MD, MPH
Infectious Diseases / Internal Medicine
Medical City Dallas

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**Gram Stain**

**PCN→ Mouth Strep, oral anaerobes**

<table>
<thead>
<tr>
<th>AMPCILLIN</th>
<th>Anti-Staphylococcal:</th>
<th>Anti-Pseudomonal:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OXACILLIN / NAFCILLIN</td>
<td>TICARCELLIN</td>
</tr>
<tr>
<td></td>
<td>(hepatitis)</td>
<td>(neutropenia)</td>
</tr>
<tr>
<td>PO=DICLOXACILLIN</td>
<td>PIPERACILLIN</td>
<td>MEZLOCILLIN</td>
</tr>
</tbody>
</table>

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Some community-acq. E.coli
Staph. aureus (MSSA) + Anaerobic coverage
H.influenzae + Sensitive Enterococcus strains + Listeria

PCN→ Mouth Strep, oral anaerobes

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MSSA
To pick up Staph. aureus and anaerobic coverage: UNASYN (amp/sulbactam)

1st GENERATION CEPHALOSPORINS:

CEFAZOLIN IV (Ancef, Keefol) = equivalent to AMP + OXACILLIN + PCN coverage
i.e. covers Strep, oral anaerobes, community-acquired E.coli & Proteus mirabilis & Staph. aureus

po = Cepalexin (Kelex): poor po absorption; major gap in coverage is Pasturella in dog and cat bites - use Amoxicillin/clavulanic acid (Augmentin) instead

Note: Augmentin = CIDAL but poor po absorption; Vs. Clindamycin = STATIC but excellent po absorption
### 2nd GENERATION:

<table>
<thead>
<tr>
<th>Respiratory Type:</th>
<th>Anaerobic Types:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEFUROXIME</td>
<td>CEFOTETAN / CEFOTAXIME</td>
</tr>
</tbody>
</table>

- S. pneumonia
- H. influenzae
- Moraxella

Po: Cefuroxime axetil, Cefaclor (Ceclor); Ceprozil (Cefzil); Loracarbef (Lorbid)

### 3rd GENERATION:

<table>
<thead>
<tr>
<th>GNR Types</th>
<th>Anti-Pseudomonal</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIAMOXIDE (Rocephin)</td>
<td>CEFTRIAXONE</td>
</tr>
<tr>
<td>CEFOTAXIME</td>
<td>CEFOPERAZONE</td>
</tr>
</tbody>
</table>

- Covers: (As for 2nd gen. + Serratia, Citrobacter, Proteus vulgaris, resistant Klebsiella, Enterobacter, GC)
- Covers: (as for 2nd-gen. + Serratia, Citrobacter, Proteus vulgaris, resistant Klebsiella, Enterobacter, GC, Pseudomonas)

Po = Cefpodoxime (Vantin); also: Cefixime (Suprax) - good for single-dose GC tx; NO Staph. aureus coverage

### 4th GENERATION:

<table>
<thead>
<tr>
<th>CEFEPIME</th>
</tr>
</thead>
</table>

- Covers:
  - Resistant Pseudomonas, Serratia, Citrobacter, Enterobacter, Klebsiella, Proteus
  - GOOD Staph. aureus coverage

- Regarding Cephalosporins:
  - DOC for:
    - Staph. aureus = Cefazolin
    - Pseudomonas = Cefazidime or Cefepime

### BUT FOR:

- Enterococcus: NO ORAL CEPHALOSPORINS ARE EFFECTIVE
- Listeria - NO ORAL CEPHALOSPORINS ARE EFFECTIVE
- Pasteurella multocida - CEPHALEXIN (KEFLEX) vs. INEFFECTIVE. (For dog & cat bites - must use Augmentin; or, in the case of PCN-allergic pts: a combo of clinda (for Staph and Strep) + doxycycline or levofloxacin (Levaquin) (for Pasteurella)

### AMINOGLYCOSIDES: Two Groups

I. GENT = TOBRA against most GNR's (except that Tobra is more effective against Pseudomonas); Gent is more effective vs. gram positives (Staph = Ox/Gent, Vanc/Gent; Enterococcus = Amp/Gent or Vanc/Gent; Strep = PCN/Gent)

- Suspected Staph aureus endocarditis gets Vanc/Gent;
- Strep endocarditis gets PCN/Gent
- Enterococcal endocarditis gets Amp/Gent (or Vanc/Gent)
- Neutropenic fever with Pseudomonas gets Zosyn/Tobra

II. STREPTOMYCIN - primarily used for TB

(Also PAROMOMYCIN (Humantin) is an oral aminoglycoside; NOT ABSORBED SIGNIFICANTLY FROM THE GI TRACT; which has some efficacy against Cryptosporidiosis in AIDS, although now we use nitazoxanide)
**INDICATIONS FOR AMINOGlicosides:**

I. Synergy for severe GNR Infections: (want high peaks)  
   Pseudomonas, Serratia, Enterobacter, Proteus vulgaris

II. Synergy for Enterococcal Infections: (want low peaks)  
   Note that "low-level" resistance to gent is still associated with successful synergy  
   with Amp or Vanc; while "high-level" gent resistance indicates that  
   gent will not add any Enterococcal coverage to the Amp or Vanc.  
   Call Micro to get the additional "low-level" or "high-level" report - it  
   does not usually come up in the computer.

**ANAEROBIC DRUGS:**

Metronidazole (Flagyl) - all GNR anaerobes; most importantly  
the DOC for B. fragilis infections  
(Note: P. acnes, a GPR, is flagyl-resistant)

Clindamycin - all gram-positive anaerobes and a few GNR  
aerobes (will NOT cover all strains of Bacteroides)

Combo Drugs: Unasyn, Timentin, Zosyn - excellent B.frag as  
well as gram + anaerobic coverage; no need to add  
metronidazole/clindamycin to these drugs

**ANAEROBIC DRUGS:**

Imipenem, Meropenem - excellent broad anaerobic coverage; cover  
MSSA, Strep, GNR's, anaerobes. Imipenem has more gram-positive,  
shifted coverage - better for Enterococcus; Meropenem/Doripenem more  
GNR - better for Pseudomonas

Call Micro to get the additional "low-level" or "high-level" report - it  
does not usually come up in the computer.

**Bactericidal Activity of Fluoroquinolones**

All Fluoroquinolones  
are not the same

<table>
<thead>
<tr>
<th>GPC</th>
<th>Other GNR</th>
<th>GNR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. pneumoniae</td>
<td>LEVOFLOXACIN</td>
<td>Pseudomonas</td>
</tr>
<tr>
<td></td>
<td>CIPROFLOXACIN</td>
<td></td>
</tr>
<tr>
<td></td>
<td>MOXIFLOXACIN (Avelox)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>GEMIFLOXACIN (Factive)</td>
<td></td>
</tr>
</tbody>
</table>
GNR’s-Resistance Patterns

- Gram-Negative Bacteria have potential to acquire resistance in ICUs.
- Spread thru devices, hands, water, plants.
- Periodically cause outbreaks: May be single or group of antibiotic-resistant GNR’s.
- Extended-Spectrum B-Lactamases (ESBL) responsible for latest outbreaks (Klebsiella, E.coli’s).

Emerging Bacterial Resistance in Complicated UTI

<table>
<thead>
<tr>
<th>% of Resistant Pathogens in Complicated UTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampicillin</td>
</tr>
<tr>
<td>First-gen Ceph (Keflex)</td>
</tr>
<tr>
<td>TMP/SMZ (Bactrim)</td>
</tr>
</tbody>
</table>


USA Database: % Resistance in E. coli UTI

Source: The Surveillance Network (TSN), Focus Technologies

Susceptibility of Gram-Negative Isolates: TRUST 12 Surveillance Study

Source: The Surveillance Network (TSN), Focus Technologies

Implications of Antimicrobial Resistance in Treatment of Community Acquired Pneumonia
Consider Pneumococcal resistance trends when selecting empiric abx therapy

**TRUST 12 Anti_biogram:**
% Susc. of *S. pneumoniae* (TX, OK, LA, AK)

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Susceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levoflaxin, Moxiflox</td>
<td>100%</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>93%</td>
</tr>
<tr>
<td>Amox/clav (Augmentin)</td>
<td>82%</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>82%</td>
</tr>
<tr>
<td>Cefuroxime (oral)</td>
<td>77%</td>
</tr>
<tr>
<td>Trimeth-sulfa</td>
<td>64%</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>54%</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>54%</td>
</tr>
<tr>
<td>Penicillin</td>
<td>53%</td>
</tr>
</tbody>
</table>

Cipro not rec’d as 1st line drug for → Pneumococcal infection

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**Macrolide Susceptibility Has Decreased Over Time**

<table>
<thead>
<tr>
<th>Total US Rxs (millions)</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>150</td>
<td>300</td>
</tr>
</tbody>
</table>

In vitro activity does not necessarily correlate with clinical results.


**Macrolides Against *S. pneumoniae*: Pharmacokinetics & Potency**

- **Relative Potency**
  - Clarithro 24X
  - Erythro 4X
  - Azithro 1X

**Multidrug-Resistant *S. pneumoniae***

The most common MDR phenotype were PEN-AZI-SXT.


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Estimates place *Strep pneumoniae* macrolide resistance in Texas & Oklahoma at between 50-60%

Some recent improvement in resistance rates
Penicillin-Resistant S. pneumoniae Is Often Resistant to Other Antimicrobials

% Resistant

N=229 PRSP strains.


Therapy for CAP

IDSA / ATS Guidelines

Infectious Diseases Society of America/American Thoracic Society Consensus Guidelines on the Management of Community-Acquired Pneumonia in Adults

IDSA/ATS Guidelines for CAP in Adults • CID 2007;44 (Suppl 2) • 527


Guidelines for CAP

Due to growing concerns about resistant pathogens, the Infectious Diseases Society of America (IDSA) recommends quinolones as first-line therapy for at-risk outpatients with CAP, including:

- Previously healthy patients with recent antibiotic therapy (within 3 months)
- Patients with comorbidities (with or without recent antibiotic therapy)
- Chronic obstructive pulmonary disease (COPD)
- Diabetes mellitus
- Renal failure
- Congestive heart failure
- Malignancy
- Patients with influenza with bacterial superinfection


CAP Guidelines: Out-Patients

• AMOXICILLIN 3000-4000 mg/day
  (Augmentin: TWO 1000 mg XR tabs BID
  for Strep pneumo)
  PLUS
  azithromycin or doxycycline
  (for atypical pathogens: Mycoplasma, Chlamydia pneumoniae, Legionella)
  OR
• Anti-Pneumococcal Fluoroquinolone
  Levofloxacin or Moxifloxacin

17. In regions with a high rate (>25%) of infection with high-level (MIC, >16 μg/ml) macrolide-resistant S. pneumoniae, consider the use of alternative agents listed above in recommendation 16 for any patient, including those without comorbidities. (Moderate recommendation; level III evidence.)

CID/ATS Guidelines for CAP in Adults • CID 2007;44 (Suppl 2) • 527

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### IDSA/ATS Guidelines for CAP in Adults: Outpatient Therapy

**Previously healthy and no risk factors for DRSP infections**
- Level I: Macrolide - azithromycin, clarithromycin, erythromycin
- Level III: Doxycycline (weak recommendation).

**Presence of comorbidities, recent use of antimicrobials, other risks for DRSP infection**
- Level I: Respiratory fluoroquinolone: levofloxacin (750 mg qd), moxifloxacin, gemifloxacin
- Level I: β-lactam plus a macrolide (or doxycycline): β-lactams: high dose amoxicillin (1 g q8h) or amox/clav (2 g q12h); alternatives - ceftriaxone, cefpodoxime, cefuroxime (500 mg q12h)

**Regions with high rate (>25%) macrolide-DRSP**
- Respiratory FQ or β-lactam plus doxycycline

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### CAP Guidelines: Hospitalized Patients

- Beta lactam (usually cefotaxime 2gm iv q 6 to 8 hours or ceftriaxone 2 gm iv q day)
  - PLUS azithromycin
  - OR

- Anti-Pneumococcal Fluoroquinolone

  - Levofloxacin
  - Moxifloxacin

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### Staphylococcus aureus

*FIGURE: Scanning electron micrograph of Staphylococcus aureus*

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### Update on MRSA

#### Clinical Syndromes & Treatment Options

- Furuncles
- Impetigo
- Scalded Skin Syndrome
- Necrotizing soft tissue infections
- Septic Arthritis / Osteomyelitis
- Pneumonia
- Endocarditis
- Toxic Shock Syndrome
- Pyomyositis

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*PVL+/SEC+

Community Acquired MRSA
Emerging Clinical Syndromes

Skin & Soft Tissue Infections
“Spider Bites”

CA-MRSA Syndromes

- **Furunculosis**: PVL assoc. with cutaneous necrosis, leukocytoclasis, vascular necrosis; also with ↑ lesions, ↑ erythema
- **Toxic Shock Syndrome**: 4 pts in Chicago with shock; DIC, pneumonia & desquamation; no TSST-1 detected, but all pts had at least 2 genes associated with TSS: SEB, SEC,SEH (2 had CA-MRSA with PVL; 2 with MSSA)
- **Necrotizing Fasciitis/Myositis**: 14 cases in LA; all had ST8 USA300 strain; PVL+; 78% required radical debridement

Therapy for Mild to Moderate to CA-MRSA Infections

Skin & Soft Tissue

**Estimated Susceptibility of CA MRSA**

- FDA Approved: 100% to linezolid, daptomycin, vanco
- Off-Label:
  - 95 – 100%: TMP-SMZ, doxycycline, minocycline (but CA-MRSA TMP-SMZ resistance 30% in Europe)
  - 91-99%: Rifampin
  - 80-95%: Clindamycin (only 43% susc. in Boston area)
  - 60-85%: Quinolones • avoid ciproflo; use levoflox 750 mg; moxiflox 400

**Oral Antibiotic Selection:**
MSSA (only 40%) vs. MSSA (approx. 60%)

<table>
<thead>
<tr>
<th>MSSA</th>
<th>CA-MRSA</th>
</tr>
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<tbody>
<tr>
<td>• Dicloxacillin</td>
<td>• TMP-SMZ</td>
</tr>
<tr>
<td>• Cephalexin</td>
<td>• Doxycycline, Minocycline</td>
</tr>
<tr>
<td>• Amoxi/Clav.</td>
<td>• Clindamycin</td>
</tr>
<tr>
<td></td>
<td>• Rifampin</td>
</tr>
<tr>
<td></td>
<td>• Respiratory Quinolones</td>
</tr>
<tr>
<td></td>
<td>• Linezolid</td>
</tr>
</tbody>
</table>

(FDA-approved for MRSA)

**Updated List of Anti-Staphylococcal Agents**

- Dox/minocycline (static)
- TMP/SMX (inferior to vancomycin); recent report of 30% CA-MRSA TMP-SMZ resistance in Europe
- Levofloxacin 750 / rifampin for MRSA osteomyelitis
- Clindamycin-inducible cross-resistance in 20%-26%; related to macrolide resistance
- New report of CA-MRSA clinda resistance rate approaching 60% in Boston area

**TMP-SMZ (Bactrim) in CA-MRSA**

- In a rabbit model of MSSA endocarditis, TMP-SMZ was no better than placebo
- In a rabbit model of MRSA, TMP-SMZ was better than placebo but not as effective as vancomycin
- Markowitz published pivotal randomized, double-blind study of vancomycin vs. TMP-SMZ in IDU (1992): 47% of pts had MRSA; 65% of pts bacteremic
- Cure rates significantly higher on vancomycin, P<0.02
- Adra & Lawrence reviewed subject in 2004; concluded that TMP-SMZ was sufficient for "low bacterial burden infections"

**Tetracyclines and CA-MRSA**

- CA-MRSA is most susceptible in vitro to minocycline, then to doxycycline – least susceptible to tetracycline
- Two resistance mechanisms: 1) tetK & tetL genes encoding efflux pumps; and 2) tetM & tetO – encoding ribosomal mutations
- If only tetK is present, an isolate should be resistant to TCN but susceptible to minocycline
- However, if tetM or tetKM are present, the isolate should be resistant to the entire class

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**Fluoroquinolones**

- Activity:
  - Cipro < levo < max < moxi = geme
- Clinical success have been seen w/ FQs
  - However clinical data limited
- FQs + rifampin may be better
- Many CA-MRSA resistant to FQs


Therapy for Moderate to Severe CA-MRSA Infections

CA MRSA necrotizing post viral pneumonia


Current FDA-Approved Drug Treatments for Health Care-Associated MRSA

<table>
<thead>
<tr>
<th>PNEUMONIA</th>
<th>COMP. SKIN / SOFT TISSUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linezolid (IV, PO)</td>
<td>Linezolid (IV, PO)</td>
</tr>
<tr>
<td>Vancomycin (IV)</td>
<td>Vancomycin (IV)</td>
</tr>
<tr>
<td>Daptomycin (IV)</td>
<td></td>
</tr>
<tr>
<td>Tigecycline (IV)</td>
<td></td>
</tr>
</tbody>
</table>

Drug Penetration (% Tissue/Serum)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Vanco</th>
<th>Linezolid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung (ELF)</td>
<td>11-17%</td>
<td>450%</td>
</tr>
</tbody>
</table>


cSSSI=complicated skin and skin structure infection.

Comparison of Adult & Pediatric Doses
Emerging issues with FQ’s

*C. difficile* Colitis

Both the Rate and the Severity of *C. difficile* Colitis May Be Increasing

- NNIS data collection noted an upsurge in the in CDAD rates from the late 1980’s through 2001
- Between 2000 & 2001, a 26% increase was noted in the proportion of pts d/c’d from non-federal US hospitals with CDAD
- Also between 2000 & 2001, institutions such as the Univ. of Pittsburgh noted a doubling of the rate of CDAD as compared to the prior 10 years


A New, Epidemic, Multiple-Toxin-Positive Strain of *C. difficile*

- McDonald examined 187 *C. difficile* strains from 6 states (GA, IL, ME, NJ, OR, PA) obtained during the 2000-3 outbreaks
- Compared them with a database of over 6000 isolates from previous years
- Described the dominant strain: Restriction Endonuclease Analysis (REA) Group BI; North American PFGE type 1 (NAP1); toxigenotype III; pos. for binary toxin CDT; with an 18bp tcdC deletion


Increased severity by CDAD

Dallal RM et al. Pittsburgh, PA 2000
- Rates increased 0.68% to 1.2%
- Life threatening disease from 1.6% to 3.2%
- 44 colectomies and 20 deaths

- Cases rose by >30% over previous 10 years
- Overall mortality 15.3% up from 3.5%

Disease particularly severe in transplant recipients

Epidemic, Multiple-Toxin-Positive Strain of *C. difficile*

REA BI/NAP1
Toxigenotype III
Binary Toxin CDT+
Quinolone-Resistant

States with the North American Pulsed Field Type 1 strain of C. difficile confirmed by CDC as of November 15, 2005 (N=16)

Normal Inhabitants of the Healthy GI Tract
Normal Colonic Flora

<table>
<thead>
<tr>
<th>Organisms/g feces</th>
<th>Normal Colonic Flora</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anacrobotes</td>
<td>10^6</td>
</tr>
<tr>
<td>Bacteroides</td>
<td></td>
</tr>
<tr>
<td>Clostridium</td>
<td></td>
</tr>
<tr>
<td>Peptostreptococcus</td>
<td></td>
</tr>
<tr>
<td>Peptococcus</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Aerobes</td>
<td></td>
</tr>
<tr>
<td>Esherichia coli</td>
<td>10^9</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>10^7</td>
</tr>
<tr>
<td>Proteus</td>
<td>10^7</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>10^7</td>
</tr>
<tr>
<td>Others</td>
<td>10^7</td>
</tr>
</tbody>
</table>

Mandell Infectious Diseases

Novel Risk Factors for CDAD

- Impact of Antibiotics on Risk for CDAD:
  - > 7 days Vanco - OR 1.9
  - > 7 days FQ - OR 2.5
  - > 7 days 1st-gen ceph - OR 5.6 (Cefazolin/Aneef, Kefzol)
  - > 7 days 3rd-gen ceph - OR 9.2 (Ceftriaxone/ Rocephin, Cefotaxime/ Clavulanan)
  - > 7 days 4th-gen ceph - OR 3.3 (Cefepime/Maxipime)
  - Metronidazole use - OR 0.5


Recent C. diff Treatment Guidelines Recommend Oral Vancomycin (125 mg po QID) for moderate to severe disease

Metronidazole failures reported

Agents with Activity Against C. difficile

- Rifaximin is a rifamycin with excellent in vitro activity vs. C. difficile & low intestinal absorption
- Clinical trial of 8 women (43-88yo) with h/o 4 to 8 C. difficile recurrences; received vancomycin followed by 400-800 mg of rifaximin divided q 8-12 hrs
- 7/8 pts remained negative by cx & toxin assay and asymptomatic (F/U 81-431 days); rifaximin was well tolerated
- 1 pt required a second course of rifaximin & was asymptomatic thereafter (but stool grew a rifaximin-resistant strain, MIC > 256 mcg/mL)

**Combination Therapy for C. difficile?**

- Single-blind randomized clinical trial
- 39 inpatients with a primary episode of CDAD were randomized to receive 10 days of metronidazole vs. 10 days of metronidazole + rifampin
- 65% of pts on monotherapy had improved by day 10 vs. 63% of pts on combination therapy (P=NS)
- Proportion of pts who relapsed was also similar between the two treatment arms


**Nitazoxanide for CDAD**

- Nitazoxanide is FDA-approved for tx of giardiasis & cryptosporidiosis; has in vitro activity vs. C. difficile at conc. well below those achieved in the colon after po dosing
- Prospective, double-blind clinical trial
- 142 pts with CDAD randomized to receive metronidazole X 10 d vs. nitazoxanide (1 gm total daily dose) X 7 or 10 days
- Response rates:
  - Metronidazole: 82.4%; 4 recurrences
  - Nitazoxanide X 7d: 90%; 9 recurrences
  - Nitazoxanide X 10d: 88.9%; 4 recurrences
- Nitazoxanide not inferior to metronidazole


**Probiotics for Abx-Associated Diarrhea**

- Incidence of Abx-associated diarrhea is 5-25%, depending on the series; C. difficile is responsible for approx. 24% of abx-assoc. diarrhea (and for 90% of cases of pseudomembranous colitis)
- Placebo-controlled, double-blind clinical trial of 193 pts given Saccharomyces boulardii within 72 hrs of β-lactam abx to prevent diarrhea
- Diarrhea developed in only 7.2% of pts given S. boulardii; vs. 14.6% of pts given placebo


**Guidelines for Probiotic Use in Abx-Associated Diarrhea & CDAD**

- Prevention of Abx-Associated Diarrhea:
  - Adults: S. boulardii 1 gm/d - Strength of Evidence: Good
  - Children: LGG* 1-2 X 10^10 cfu/d- Strength of Evidence: Good

- Prevention of CDAD:
  - No evidence to support primary prevention of CDAD
  - Recurrent CDAD:
    - Adults: S. boulardii 1gm/d – Strength of Evidence: Moderate
    - Children: Insufficient evidence
  - AVOID IN IMMUNOCOMPROMISED PATIENTS


**12 Steps to Prevent Antimicrobial Resistance in Hospitalized Adults**

1. Vaccinate
2. Get the catheters out
3. Target the pathogen
4. Access the experts
5. Practice antimicrobial control
6. Use local data
7. Treat infection, not contamination
8. Treat infection, not colonization
9. Know when to say "no" to vanco
10. Stop treatment when infection is cured
11. Isolate the pathogen
12. Break the chain of contagion

CDC. Available at: www.cdc.gov/drugresistance /healthcare.