

# Antimicrobial Resistance – Food Animal Antibiotic Use

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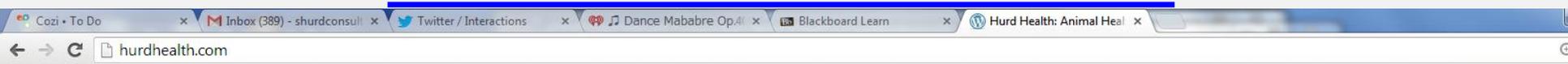


# Today's objectives

- Discuss the human health risk of on-farm antibiotic use
- Mention current events
- Answer SOME of your questions



# References and additional info at [www.HurdHealth.com](http://www.HurdHealth.com)



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POSTED BY DR. SCOTT HURD - OCTOBER 14, 2013

When I first moved to Iowa in 1998, many people asked if I was related to a person named "Hurd" or a person they knew up north. I was disappointed to say no, as my family is from the Southeast. Even though we had the same name, we were not related. The same fact needs ... [Continue reading](#) »

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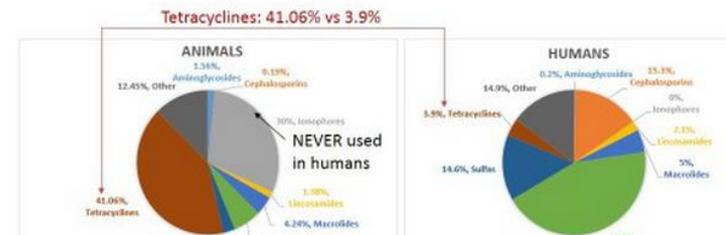
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FEATURED ARTICLE:

### Human vs Animal Antibiotic Sales are Relatively Different in U.S.



# The issues

- Antibiotic resistance in human infections is rising
  - CDC list of bacteria
- Some folks think modern agriculture is wrong
  - Use antibiotics as one of the “sticks”
- MOST people don't understand

# Residue vs Resistance

- **Residue:** A residue indicates that traces of a substance are present in meat. Residue does not mean that the substance is harmful, and it can be one of many classes of compounds. For antibiotics in particular, if a residue is present, it is likely due to the producer not waiting long enough after the animal was given antibiotics to send it to market (not following proper withdrawal guidelines).
- **Resistance:** If resistance is detected, this means that there are bacteria on the meat that have tested resistant to one or more antibiotics. Resistance is measured and reported through the National Antimicrobial Resistance Monitoring System ([NARMS](#)).
- If resistance is detected, that does not mean there are residues; likewise, if a residue is found, that does not mean that there are resistant bacteria to that antibiotic.

# Antibiotic resistance risk due to on-farm antibiotic use

## SUMMARY

1. Risk to humans is negligible
2. Failure to prevent or treat animal illness causes unnecessary suffering and death
3. Animals with residual effects of illness are more likely to cause human foodborne disease

# Evidence that risk is negligible?

- “Long way from farm to harm”
  - Many events must occur
  - Many interventions exist to prevent those events
  - Peer-reviewed risk assessments show low risk
- Resistant human illnesses of concern are unrelated to animal agriculture
- Antibiotics used on farm are dissimilar from those used in human medicine

Antibiotic Resistant Bacteria

# IT'S A LONG WAY FROM THE FARM TO HARM



HACCP



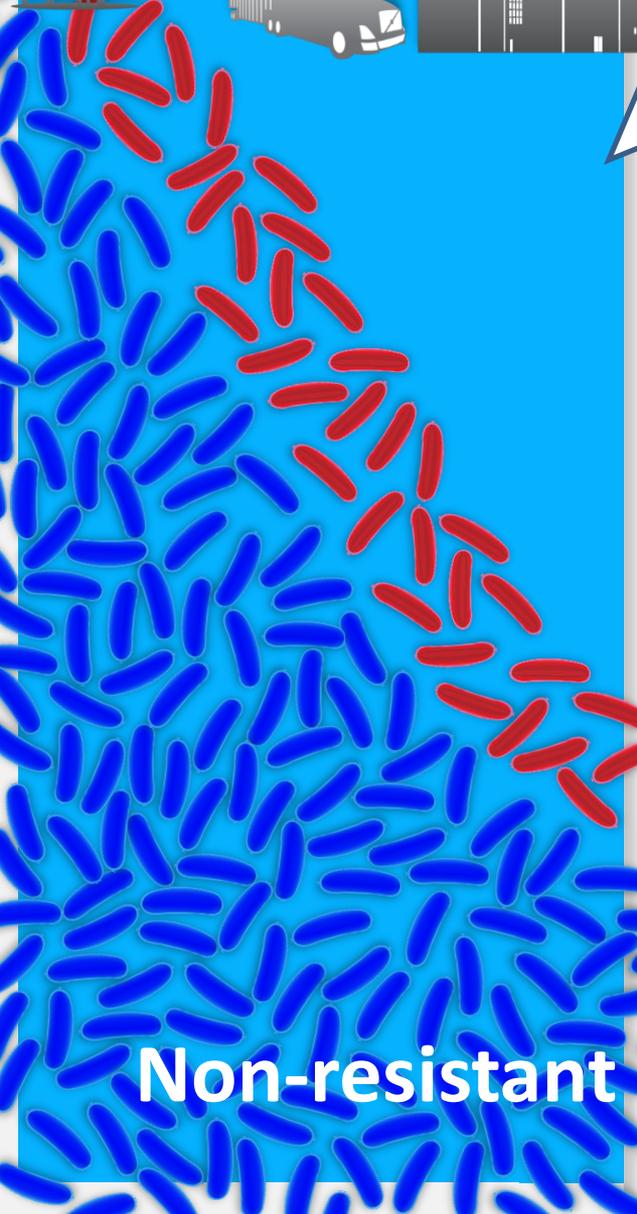
Cooking



Health & Immunity

Risk

Non-resistant Bacteria



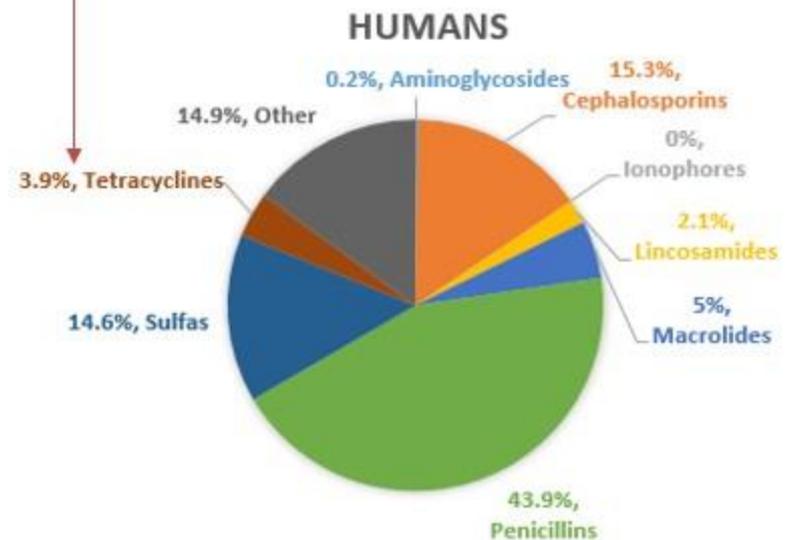
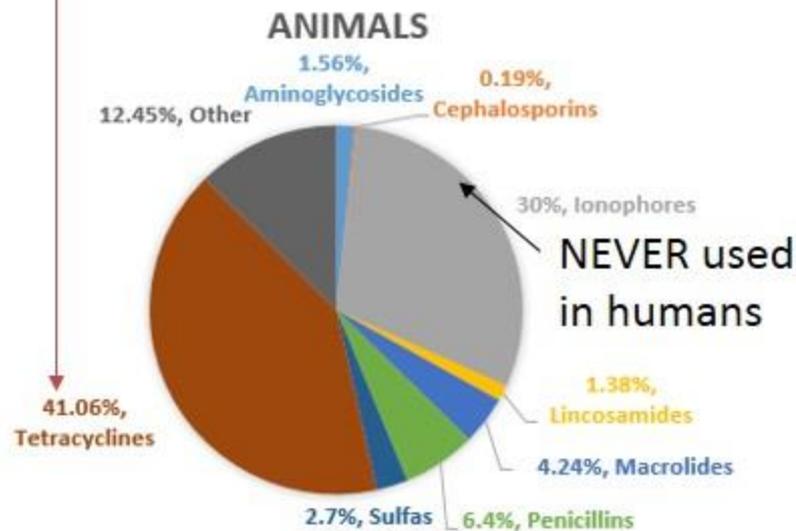
# Most important Resistant Bacteria of Concern

## NONE related to animal agriculture

- **Staphylococcus infections (MRSA) –**
  - hospital nosocomial infections,
  - occasionally associated with schools and athletic facilities.
  - CDC said “not a foodborne infection and cannot be acquired by eating meat. “
- **Acinetobacter baumannii** is an opportunistic pathogen associated with a high rate of infections in soldiers wounded in Iraq.
- **Vancomycin Resistant Enterococcus (VRE)**
  - hospital nosocomial infection due to extensive use of vancomycin in U.S. hospitals.
  - Vancomycin or drugs in its class have never been approved for or used in U.S. food producing animals.
- **Pseudomonas aeruginosa**
  - opportunistic pathogen found in intensive care units,
  - occurs rarely in dairy mastitis
- **Streptococcus pneumoniae** - strictly human pathogen causes respiratory disease
- **Neisseria gonorrhoea** sexually transmitted human pathogen
- **Drug resistant tuberculosis (M. tuberculosis)** : no known connection to food producing animals.
- <http://www.idsociety.org/Content.aspx?id=5650> . :

# Human vs Animal Antibiotic Sales are Relatively Different in U.S.

Tetracyclines: 41.06% vs 3.9%



Penicillins: 6.4% vs. 43.9%

# Antimicrobial resistant bacteria are a Hazard

- We are concerned
- But concern does not mean there is a great risk
  
- Risk  $\sim$  exposure and dose
- Risk  $\sim$  probability and consequence
  
- Manage the risk by multiple methods

# Hazard Does Not Mean Risk

Hazard × **Dose (Exposure)** = Risk



Hazard

×



**Dose**

= Drowning

# Example Hazardous Material

- Human Health Effects
  - cramps
  - nausea
  - dizziness
  - respiratory difficulties
  - convulsions capable of leading to death



# Example Hazardous Material = Oxygen

- Human Health Effects
  - cramps
  - nausea
  - dizziness
  - respiratory difficulties
  - convulsions capable of leading to death



**iSOC® Technology**

**Material Safety Data Sheet: Oxygen**

<b>Product Name:</b> Oxygen	<b>CAS:</b> 7782-44-7
Oxygen; Oxygen, compressed (D.O.T.)	<b>DOT I.D No.:</b> UN 1072
<b>Chemical Name and Synonyms:</b> Oxygen	<b>DOT Hazard Class:</b> Division 2.2
<b>Formula:</b> O <sub>2</sub>	<b>Chemical Family:</b> Oxidizer

**HEALTH HAZARD DATA**

**Time Weighted Average Exposure Limit:**  
None established (ACGIH 1994-1995). Oxygen is the "vital element" in the atmosphere in which we live and breathe.

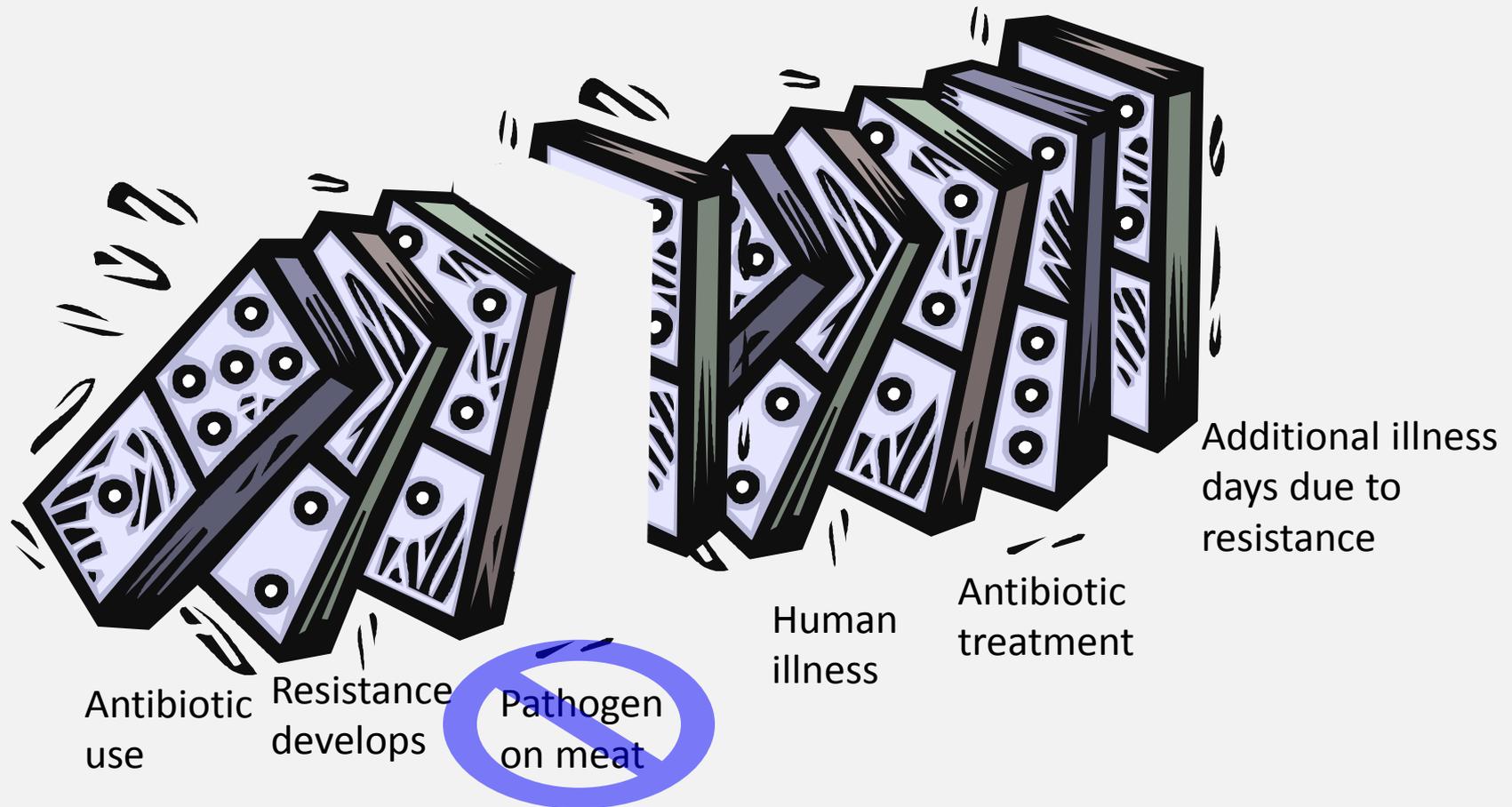
**Symptoms of Exposure:**  
Breathing high concentrations (greater than 75 molar percent) causes symptoms of hyperoxia which includes cramps, nausea, dizziness, hypothermia, amblyopia, respiratory difficulties, bradycardia, fainting spells, and convulsions capable of leading to death. For additional information on hyperoxia, see Compressed Gas Association's Pamphlet P-14.

**Toxicological Properties:**

- The property is that hyperoxia which leads to pneumonia. Concentrations between 25 and 75 molar percent present a risk of inflammation of organic matter in the body.
- Oxygen is not listed in the LARC, NTP or by OSHA as a carcinogen or potential carcinogen.
- Persons in ill health where such illness would be aggravated by exposure to oxygen should not be allowed to work with or handle this product.

**Recommended First Aid Treatment:**  
Prompt medical attention is mandatory in all cases of overexposure to oxygen. Rescue personnel should be cognizant of extreme fire hazard associated with oxygen-rich atmosphere.

# Conversion of hazard to risk requires a causal pathway



# What does risk science say?

- No peer-reviewed scientific quantitative risk assessment has demonstrated any detectable risk of treatment failure in humans caused by current on-farm antibiotic uses in animals.

# Quantitative risk assessments report negligible risk

Risk (High to Low)	Yearly Probability	Outcome <i>Comments</i>
Enrofloxacin use in poultry to treat disease	1 in 30,000 (low)	<p><b>Compromised treatment - <i>By FDA, overestimated attributable fraction</i></b></p> <p>FDA-CVM, 2001. "Human Health Impact of Fluoroquinolone Resistant <i>Campylobacter</i> Attributed to the Consumption of Chicken", US Food and Drug Administration, Center for Veterinary Medicine (Revised Jan, 2001). <a href="http://www.fda.gov/cvm/antibmicrobial/RRAssec5.pdf">http://www.fda.gov/cvm/antibmicrobial/RRAssec5.pdf</a></p>
Enrofloxacin use in poultry to treat disease	Removal is more hazardous to health	<p>Cox, L. A. and Popken, D. A. (2006), Quantifying Potential Human Health Impacts of Animal Antibiotic Use: Enrofloxacin and Macrolides in Chickens. <i>Risk Analysis</i>, 26: 135–146</p>
All macrolide uses (cattle, swine, poultry)	1 in 10 million	<p><b>Compromised treatment</b></p> <p>Hurd, H. S., S. Doores, D. Hayes, A. Mathew, J. Maurer, P. Silley, R. S. Singer, and R. N. Jones. 2004. Public health consequences of macrolide use in food animals: a deterministic risk assessment. <i>J. Food Prot.</i> 67:980–992.</p> <p>Alban L, Nielsen EO, Dahl J. (2008). A human health risk assessment for macrolide-resistant <i>Campylobacter</i> associated with the use of macrolides in Danish pig production. <i>Prev Vet Med</i> 83(2):115-29.</p>
Streptogramin/Virginiamycin use	~ 100 in 100 million	<p><b>Impaired treatment: <i>By FDA, still a draft</i></b></p>
Penicillin growth promoter	~4 in 1 billion	<p>Cox LA Jr, Popken DA, Mathers J. Human health risk assessment of penicillin/aminopenicillin resistance in enterococci due to penicillin use in food animals. <i>Risk Analysis</i>, 2009; 29(6):796–805.</p>
Fluoroquinolone use in dairy heifers	~1 in 61 billion	<p><b>Compromised treatment</b></p> <p>H. Scott Hurd, Michael B. Vaughn, Derald Holtkamp, James Dickson, and Lorin Warnick. <i>Foodborne Pathogens and Disease</i>. November 2010, 7(11): 1305-1322. doi:10.1089/fpd.2010.0550.</p>

## 2. Failure to prevent or treatment illness causes unnecessary animal suffering and death

- Farm is a day care and a maternity hospital
- Need medicine
- Moral and ethical issue
  - Will we deny treatment?
  - Wrong to withhold veterinary care
  - How long can you wait to treat?



# Antibiotics are needed

- Only 13% is used for growth promotion
  - This will decline further due to FDA 209
- Treatment of a group requires water or feed medication
- Organic/antibiotic free farms must treat and remove →, financial penalty.

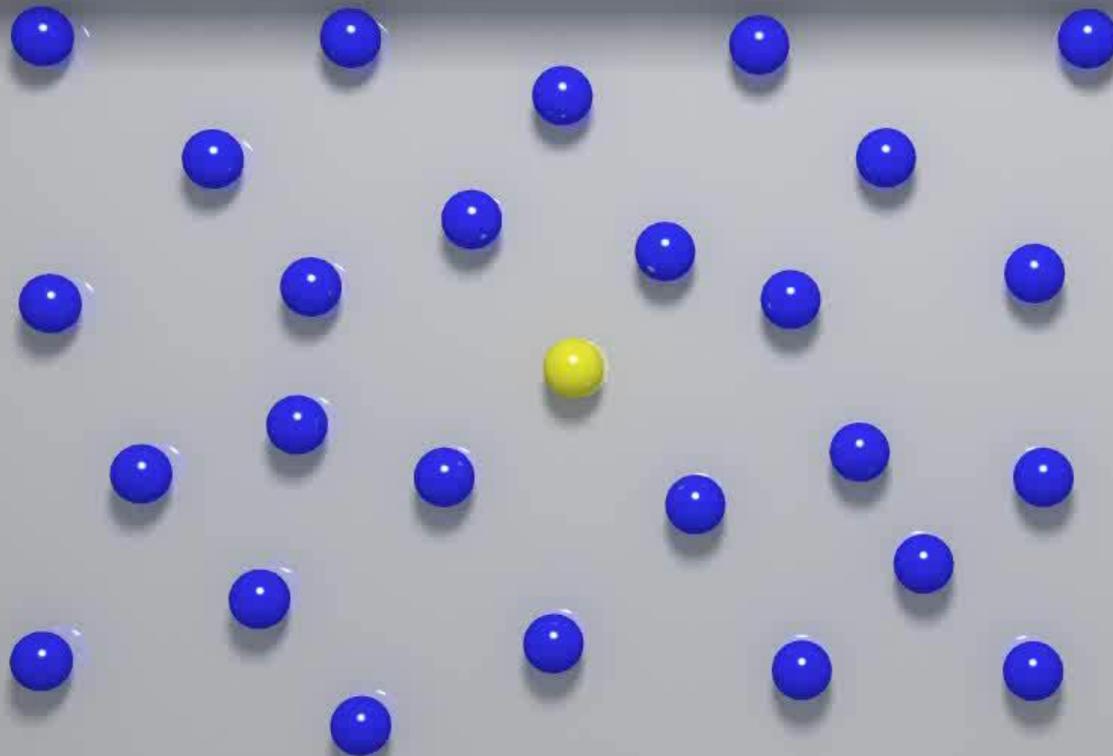


# Group prevention needed in human & animal medicine



- Infectious individual not evident until has spread
- Infection can move quickly through group
- Animals cannot “stay home” when ill
- Prevention stops spread reducing treatments and suffering

# Why is group prevention needed? (DRAFT animation)



- Healthy
- Infectious (Not Sick)
- Sick

**Why take additional risk??**



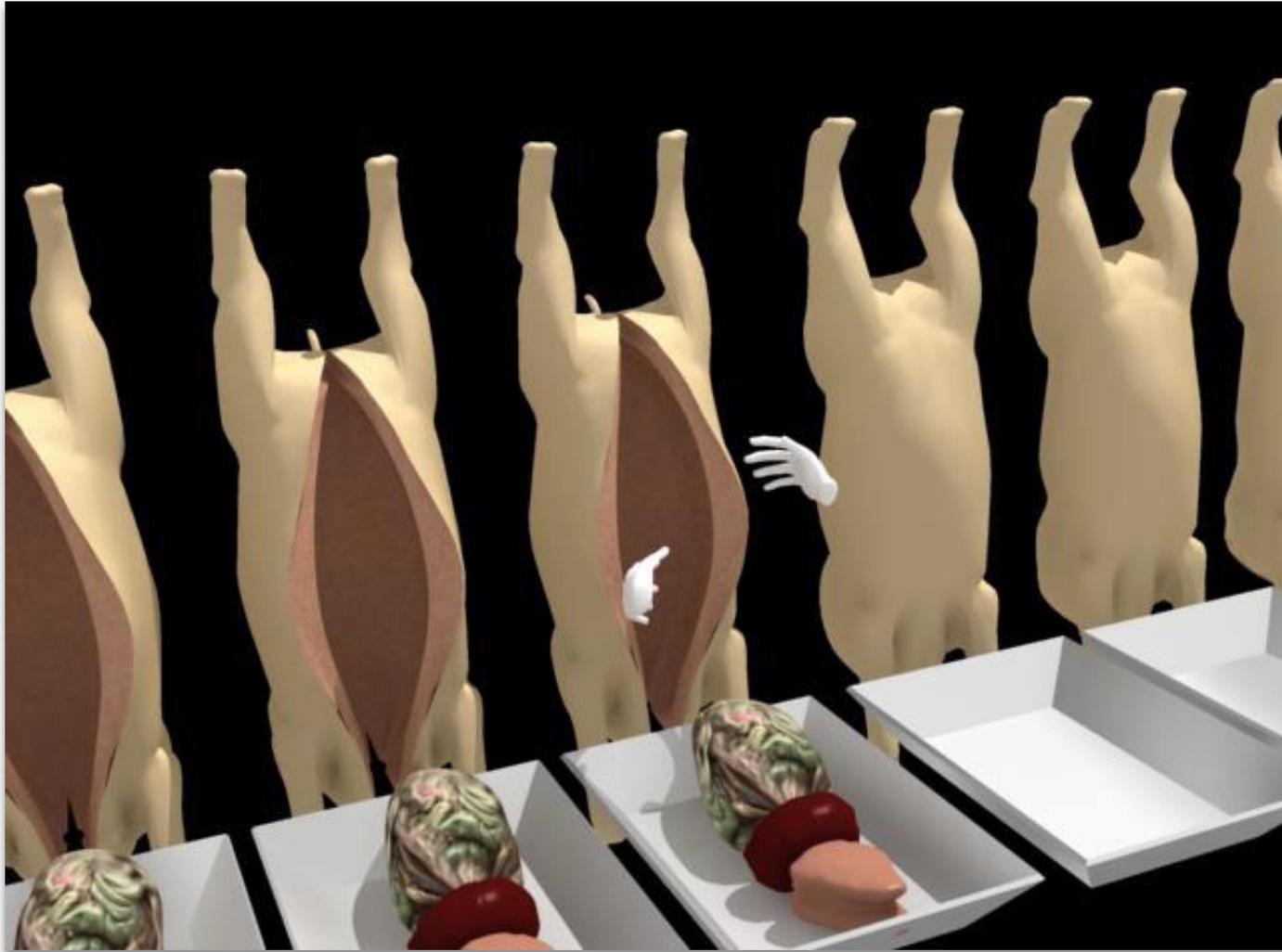
### 3. Animals with residual effects of illness are more likely to cause human foodborne illness

- Meat Inspection Act 1906 requires healthy animals
- Antemortem inspection enforces

Largest meat recall in U.S. history due to slaughter of downer cows February, 2008



# Adhesions increase chance of fecal contamination



**Table 4. Regression coefficients (univariate and multivariate with antibiotic use group as a covariate) between percentage of representative health variables and percentage of carcasses positive for *Enterococcus* spp. or *Campylobacter* spp. in the bung or pleural cavities<sup>a,b</sup>**

Health indicator	Bacterial contamination	Location on carcass	Regression coefficient ( $\beta$ ) (univariate)	95% CI	Regression coefficient ( $\beta$ ) (multivariate)	95% CI
Fatigued <sup>c</sup>	<i>Campylobacter</i>	Bung	41.0	(219.0, 102.0)	10.0	(-50.0, 70.0)
Peel-outs <sup>d</sup>	<i>Campylobacter</i>	Pleura	5.7	(20.3, 11.7)	5.1	(0.4, 9.9)
Peel-outs	<i>Enterococcus</i>	Bung	5.1	(21.3, 11.5)	4.4	(1.3, 7.4)
Abscessed heads <sup>e</sup>	<i>Campylobacter</i>	Pleura	-12.7	(231.0, 5.0)	-6.2	(-33.0, 21.0)
Abscessed heads	<i>Enterococcus</i>	Bung	-13.3	(231.0, 0.5)	-2.5	(-24.0, 19.0)

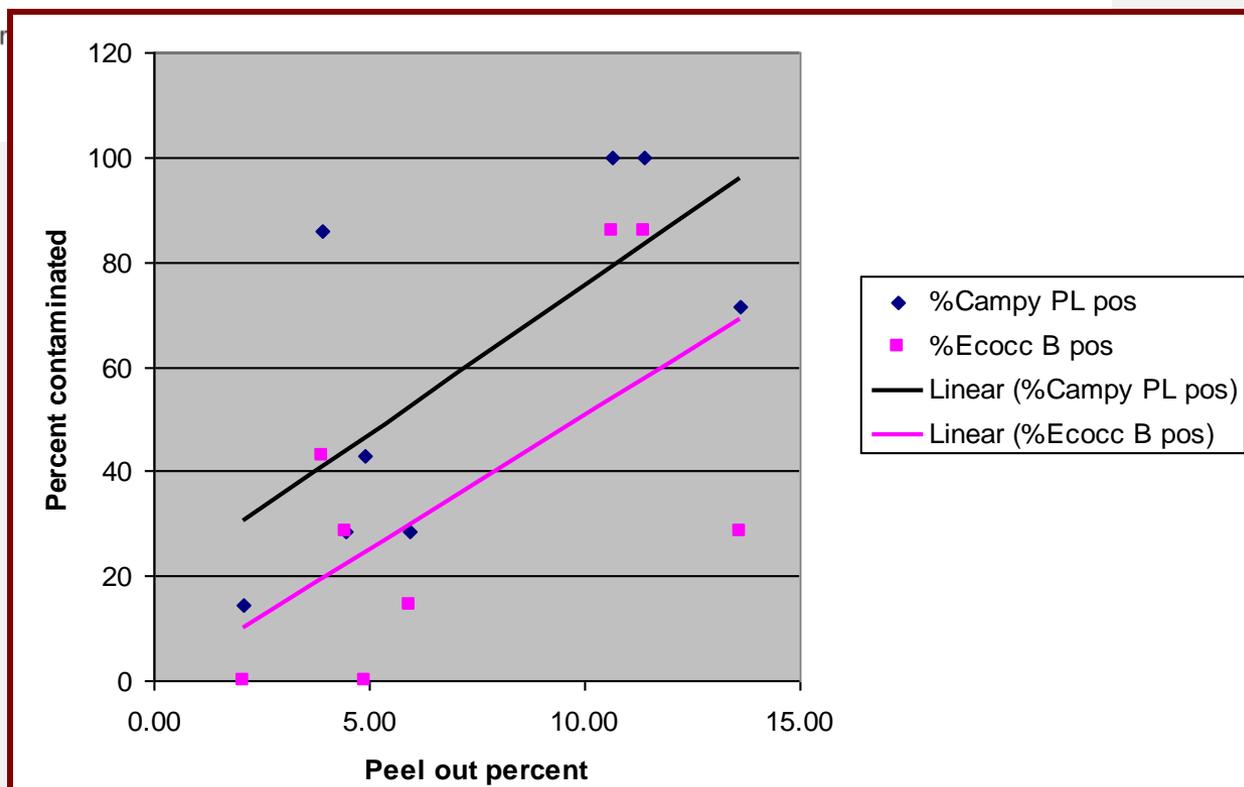
<sup>a</sup>All health and contamination relationships were tested. Only those with  $p < 0.2$  in the univariate comparison are shown.

<sup>b</sup>Conventionally raised animals received antibiotics for growth promotion and disease prevention and treatment; antibiotic-free animals never received antibiotics.

<sup>c</sup>Anaerobic metabolism, respiratory distress, recur

<sup>d</sup>Pleuritis and pleural adhesions

<sup>e</sup>Heads condemned due to visible abscess(es)



# Impact of pig health on foodborne Risk (*Salmonella*)

- Study of 358 healthy pigs: (passed FSIS antemortem inspection, not visibly ill)
- ~7% had internal adhesions from previous infection
- Compared to carcasses without lesions (case-control study)



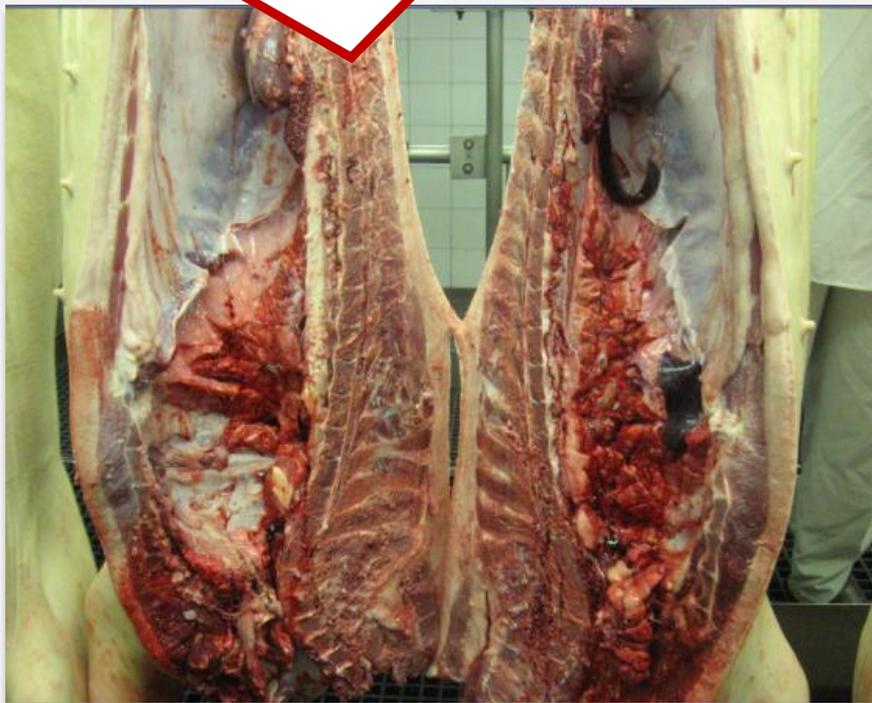
Photo credit: Hudson ISD FFA



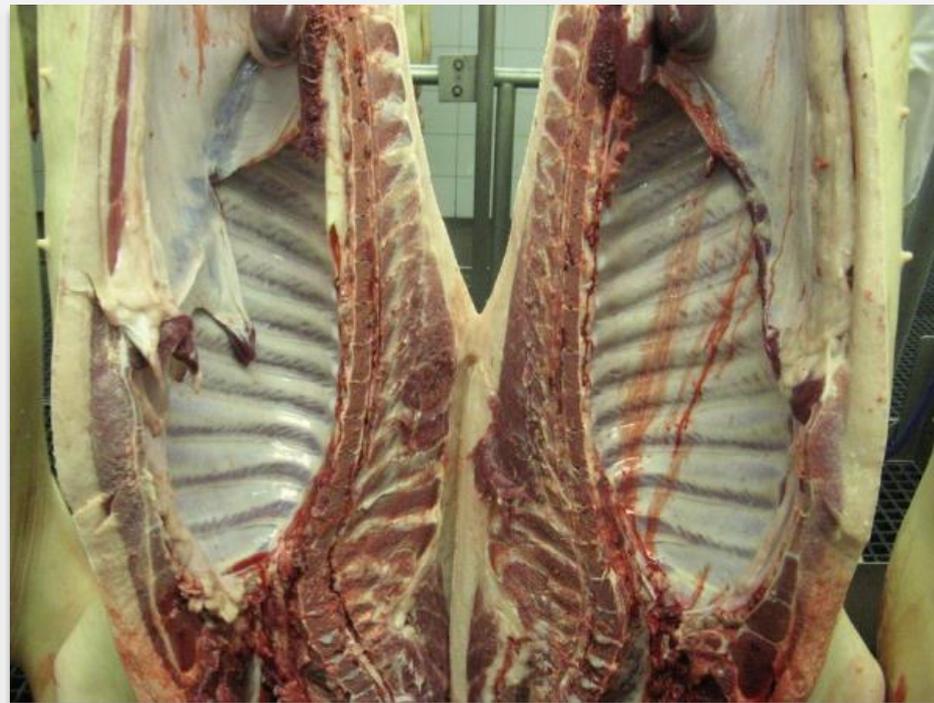
Photo credit: Agricultural Research Service

**90%** more likely to be contaminated with *Salmonella*

# Lesioned and non-lesioned wine carcass



**Residual impacts of illness**  
**Pathologist score ~ 6**



**Normal healthy**  
**Pathologist score ~ 0 to 1**

# Public Health Risk of Residual Animal Illness Effects

Foodborne illness / animal condition studied	Quantitative results	Citation
Campylobacter, airsacculitis in broiler poultry	Small increases in illness → increase in contamination	Singer RS, Cox LA, Dickson JS, <b>Hurd HS</b> , Phillips I, Miller GY: Modeling the relationship between food animal health and human foodborne illness. <i>Preventive Veterinary Medicine</i> . 79 pp 186-203, 2007.
Enrofloxacin use in poultry to treat disease	Removal is more hazardous to health	Cox, L. A. and Popken, D. A. (2006), Quantifying Potential Human Health Impacts of Animal Antibiotic Use: Enrofloxacin and Macrolides in Chickens. <i>Risk Analysis</i> , 26: 135–146
Campylobacter in pork carcass	1% increase in peelouts →5% increase in contamination	Hurd HS, et al. 2008. Swine health impact on carcass contamination and human foodborne risk. <i>Public Health Rep</i> . 123:343–351
Salmonella in pork carcass	Carcass with peelout is 90% more likely to be contaminated	Hurd H.S., M.J. Yaeger, J.M. Brudvig, D.D. Taylor and B. Wang. 2012. Lesion severity at processing as a predictor of Salmonella contamination of swine carcasses. <i>American Journal of Veterinary Research</i> , 73(1):91-97.

References available at [www.hurdhealth.com](http://www.hurdhealth.com)

# Antibiotic resistance risk due to on-farm antibiotic use

## *Layman's Summary*

1. Long way from farm to harm
2. Animals, like children, need Medicine
3. Healthy Animals make Safe Food

# QUESTIONS



a



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## 4. Managing the risk in U.S.

- Case by case (bug-drug) risk assessments required by FDA (Guidance 152)
- Prudent use guidelines without broad legislation
- Voluntary removal of growth promotion claims (Guidance 209)
- Producer quality assurance programs
- Increasing veterinary oversight



# A word about foodborne illness outbreaks and resistance

- Most foodborne illness are not supposed to be treated with antibiotics
  - Therefore resistance is irrelevant
  - Treat with fluoroquinolones (never in poultry ) and 3<sup>rd</sup> generation cephalosporins (rarely in poultry for illness)
- Almost every species of bacteria is resistant to some antibiotics
  - Therefore on-farm use may not be the cause
- Current Salmonella Heidelberg isolates are resistant to ampicillin, chloramphenicol, gentamicin, kanamycin, streptomycin, sulfisoxazole, and tetracycline