IMPLICATIONS OF FOODBORNE BACTERIA ON HUMAN HEALTH:

Isolation and Antibiotic Resistance of *Salmonella enterica* and *Campylobater spp.* on Retail Chicken Sold in California

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GW | Public Health

ABSTRACT

Overuse of antibiotics contributes to antimicrobial resistance (AMR), which continues to be a growing threat to human health. In the United States, industrial food animal production (IFAP) is a formidable driver for antibiotic use. Prior work has focused on the link between antimicrobial use in poultry and human AMR infections. Common foodborne pathogens such as *Salmonella enterica* (*S. enterica*) along with *Campylobacter coli* (*C. coli*) and *Campylobacter jejuni* (*C. jejuni*) are commonly associated with human gastroenteritis. However, it has been shown that these pathogens are capable of causing disease outside of the gastrointestinal tract, specifically urinary tract infections (UTIs). Due to their ubiquitous nature on raw and undercooked poultry, these pathogens serve as an overlooked source of UTIs for individuals with exposure to retail poultry. AMR has become a major public health concern and predicted to cause more than 10 million AMR related deaths.

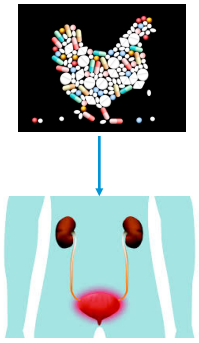
In 2015, California passed senate bill 27 (SB27), the first bill of its kind to restrict the use of antimicrobial drugs in the poultry industry. Implemented on January 1, 2018, the legislation places poultry farmers' ability to administer "medically important antimicrobial drugs" to their livestock under the discretionary supervision of licensed veterinarians. The legislation is intended to reduce antibiotic usage in the poultry industry for non-therapeutic purposes such as preventative measures, promoting weight gain, or improving feed efficiency.

This study, therefore, examined the relationship between the implementation of SB-27 and rates of AMR in *Salmonella* and *Campylobacter* species present on retail chicken produced and sold in California. Samples were collected weekly from September 2017 through April 2018. Collection sizes ranged from 30-70 samples. *S. enterica*, *C. coli*, and *C. jejuni* were selected and isolated from the meat. Confirmed isolates were then subjected to AMR testing. *S. enterica* was found on 1.52% of samples and *Campylobacter spp.* on 2.80% of samples. Resistance was found in 14 of 15 antibiotics tested on Salmonella positive samples. Resistance was found on 7 of 7 antibiotics tested on Campylobacter positive samples. In future analyses, the AMR profiles of the retail poultry isolates will be compared to those of clinical isolates from UTI patients diagnosed in proximity to the outlets from which poultry samples were collected. This comparison probes the validity of the foodborne urinary tract infection (FUTI) paradigm for *Salmonella* and *Campylobacter*, which posits the significance of foodborne reservoirs of pathogenic bacteria leading to the acquisition of urinary tract infection.

OBJECTIVES

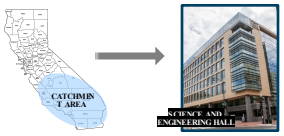
The objectives:

- To study the pathway of UTI causing bacteria from retail chicken to humans
- To observe if a decrease in antibiotics used on chickens results in fewer UTI cases



METHODS

Our Kaiser Permanente collaborators shipped retail poultry collected within the designated Southern California catchment area to our laboratory in Washington, D.C.



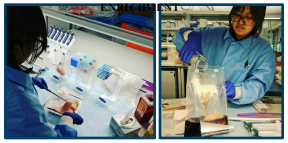
We enriched our chicken using a multi-step, multi-day process to select for *Campylobacter spp.* and *Salmonella spp.*

STEP 1: PROCESSING STATION SETUP

Pictured: Research assistant setting up racks and autoclaved broths prior to processing.

Pictured: Research assistants halfway through typical process. Multiple racks have been filled with broths and chicken samples.

STEP 2: CHICKEN PROCESSING AND



Pictured: Research assistant cutting into raw chicken breasts for sampling. Half a breast per package was used for each bacterium tested.

Pictured: Research assistant pouring Bolton broth into sample to encourage *Campylobacter* growth.

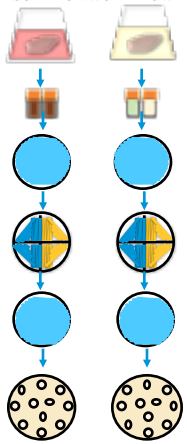
PREPARATORY AND INTERMEDIATE PROCESSING STEPS: BROTH PREPARATION, SUBSTITUTION, AND FREEZING

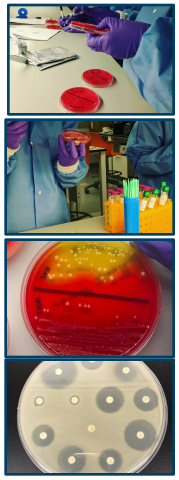
Pictured: Addition of lysed horse blood to Bolton broth, used for the selection of *Campylobacter*.

Pictured: Substitution of broth for second-day enrichment step for selection of *Salmonella*.

Pictured: Flash freezing of enriched specimen broths.

ISOLATION WORKFLOW





RESULTS AND CONCLUSIONS

CAMPYLOBACTER

- *Campylobacter* was isolated from 28.0% (166/523) of samples.
- *Campylobacter* was **resistant to 3 of 3 antibiotics** tested.

SALMONELLA

- *Salmonella* was found on 15.2% (90/592) of samples.
- *Salmonella* was **resistant to 14 of 15 antibiotics** tested.
- **Elevated resistance rates** were noted for 7 of 15 antibiotics tested. These were antibiotics for which more than 30% of the specimens tested were found to be resistant.

Table 1. *Salmonella* Resistance Rates

Antibiotic	ARAC	NARMS
Ampicillin	45.5%	15.6%
Amoxicillin/Clavulanic Acid	43.6%	13.1%
Azithromycin	52.8%	–
Cefoxitin	30.8%	–
Ceftiofur	3.4%	12.2%
Ceftriaxone	1.9%	12.7%
Chloramphenicol	34.0%	
Ciprofloxacin	0.0%	0.0%
Gentamicin	7.2%	4.2%
Kanamycin	2.4%	–
Nalidixic Acid	3.4%	0.0%
Streptomycin	58.8%	30.8%
Sulfisoxazole	45.4%	27.0%
Tetracycline	56.0%	47.3%
Trimethoprim-Sulfamethoxazole	1.4%	0.4%

*Based on most recent year reported

Table 2. *Campylobacter* Resistance Rates

Antibiotic	ARAC	NARMS*
Ciprofloxacin	15.7%	18.5%
Erythromycin	28.6%	5.0%
Tetracycline	35.2%	44.7%

*Based on most recent year reported

Table 3. GW versus NARMS Recovery Rate

	Salmonella	Campylobacter
GW*	90/592 (15.2%)	166/523 (28.0%)
NARMS (2015)	145/2373 (6.1%)	577/2402 (24.0%)

*Based on first 592 meat samples for which complete data are available

FUTURE WORK

CLINICAL CROSS-REFERENCING

- Our Kaiser Permanente collaborators will be collecting clinical UTI samples from the Southern California catchment area and send them to us for further testing.
- These samples will undergo isolation processing to test for the presence of *Salmonella* and *Campylobacter*.
- Positive *Salmonella* and *Campylobacter* isolates from clinical samples will undergo antibiotic susceptibility testing.
- Isolates from clinical and meat samples will undergo whole genome sequencing (WGS) to determine their genetic makeup.
- Sequences from meat samples will be compared to sequences from clinical samples to hypothesize their phylogeny and to determine whether clinical UTI cases may have originated from bacteria present on retail poultry.
- Any links found will further shape the changing paradigm of how UTIs are contracted and how they might best be treated and prevented from clinical and public health perspectives, respectively.

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