Risk factors associated with the A2C resistance pattern among *E.coli* isolates from broiler flocks in Canada

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BACKGROUND

- Antimicrobial resistance (AMR) is a serious threat to global public health[1].
- Antimicrobial use (AMU) for treatment of disease, and growth promotion is common in broiler production[2].
- AMU can lead to the development and enrichment of resistant bacteria that can be spread to humans through the food chain[2].

Simultaneous resistance to:
Amoxicillin –clavulanic acid
Cefoxitin
Ceftiofur

=

A2C resistance pattern

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

- CIPARS tracks selected bacteria that reside in the intestinal tract of people and animals in order to understand trends in antimicrobial use and resistance[3].
- CIPARS conducts AMR surveillance of *E.coli* in chickens at farm, slaughter and in retail[4].
- Ceftiofur (TIO) was used *in ovo* for the prevention of *E.coli* associated omphalitis prior to 2014[5].
- Use of ceftiofur lead to increased AMR in *Salmonella* and *E.coli* isolates in broilers and humans[6].
- There is a potential for cross resistance with drugs of importance in human medicine[7].
- The use of ceftiofur in the Canadian poultry industry has been phased out.

OBJECTIVES

To investigate the potential effects of AMU and farm management factors on the AMR to a specific group of β-lactam antibiotics in *E.coli* isolates recovered from the CIPARS broiler surveillance program.

METHODS

CIPARS Broiler Surveillance Program:

- Questionnaires used to collect data on farm level management factors:
  - farm demographics
  - animal health
  - antimicrobial exposure
- Antimicrobial susceptibility testing of generic *E.coli* using Clinical and Laboratory Standards Institute breakpoints.
- Laboratory data on AMR, survey data on AMU, and farm–level management factors merged for analysis.

STATISTICAL ANALYSIS

- Descriptive statistics evaluated at bird level, flock level, farm level and hatchery level.
- 1,478 *E.coli* isolates recovered from 371 flocks from four regions of Canada.
- A2C resistant *E.coli* isolates recovered from 64 flocks.

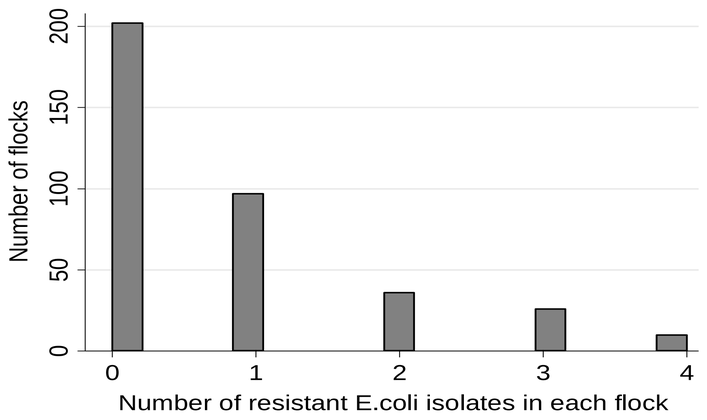

Figure 1: Frequency distribution of the number of E.coli isolates resistant to three specific β-lactam antimicrobials (ceftiofur, cefoxitin, amoxicillin-clavulanic acid) from 371 broiler flocks in four regions of Canada.

Mixed-effects Poisson regression model with random effects of the hatcheries.

Outcome

The prevalence of A2C resistant *E.coli* in each flock

RESULTS

- Use of TIO = Prevalence Ratio (PR) of 1.82 (95% CI: 1.35 – 2.46)
- Use of avilamycin in feed = PR of 0.64 (95% CI: 0.42 – 0.98)
- Use of a pest control program for controlling wild birds = PR of 0.61 (95% CI: 0.46 – 0.81)
- Storage of manure on the farm = PR of 0.66 (95% CI: 0.50 – 0.87)
- Having horses present on the farm = PR of 1.73 (95% CI: 1.19 – 2.51)
- Use of hydrogen peroxide to treat water lines during the production cycle = PR of 1.53 (95% CI: 1.12 – 2.08)
- Random effect variance at the hatchery level was 0.32, (95% CI: 0.12 – 0.85)

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RESULTS

Table 1: Results for the mixed-effects Poisson model evaluating the prevalence of resistant E.coli isolates to three specific β-lactam antimicrobials (ceftiofur, cefoxitin, amoxicillin-clavulanic acid) from 371 broiler flocks in Canada

Fixed effects[a]	PR[b]	SE	95% CI	P
Use of ceftiofur (Injected at hatchery[c])	1.82	0.28	1.35, 2.46	0.0001
Use of avilamycin (in feed)	0.64	0.14	0.42, 0.98	0.041
Pest control program for wild birds	0.61	0.09	0.46, 0.81	0.001
Presence of horses on the farm	1.73	0.33	1.19, 2.51	0.004
Treatment of water with hydrogen peroxide during production cycle	1.53	0.24	1.12, 2.08	0.008
Storage of manure on the farm	0.66	0.09	0.50, 0.87	0.003
Constant	0.22	0.04	0.15, 0.32	0.0001

[a]All predictors are dichotomous
[b]The Prevalence Ratio for each variable was the expected prevalence at one level of that variable divided by the expected prevalence at the corresponding reference level.
[c]In ovo or subcutaneously with Marek's Disease Vaccine

CONCLUSIONS

- This study identified a number of important management factors that influence the prevalence of A2C-REI.
- Use of ceftiofur was associated with an increased prevalence of A2C-REI.
- Provide a national baseline from which to monitor the effects of the removal of ceftiofur from poultry production in Canada.

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