Veterinary Laboratories Agency

Analysis of UK data comparing different sample types for purposes of monitoring *Salmonella* at slaughter

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Objectives

- To compare four different tests used in UK
  - What do they measure?
  - Are results from one test a useful indicator of results from another test?
  - What is the estimated sensitivity and specificity of these tests, considering all observed results?
- To interpret the results
- To consider how each test might be used for monitoring purposes

Aim of monitoring

- To provide a valid estimate of prevalence at a point in time
- To detect change over a period of time
- To do so using an appropriate representative sample of a large population
- A monitoring scheme need not use a "perfect" test so long as the characteristics of the test are used
- Must have defined purpose – eg for *salmonella* in pigs:
  - Estimate the prevalence of pigs that were **ever** infected
  - Estimate the prevalence of pigs infected at slaughter
  - Estimate prevalence of pigs carrying *salmonella* at slaughter
  - Estimate prevalence of contaminated carcasses at slaughter

Samples from EU finisher pig survey in UK

- Culture for *Salmonella:*
  - Lymph node sample
    1. Compulsory
    2. Measure of active infection esp. on farm
  - Caecal content
    - UK only (used in previous surveys)
    - Active infection or in transit through gut
    - Reflects farm + transport + lairage
  - Carcass swab
    - Voluntary
    - Contamination of surface;
    - From farm or transport or abattoir
    - Indicator of public health risk
- Immunological evidence
  - Meat juice ELISA test
    - Voluntary
    - Reflects exposure/ infection on farm

Comparison of sample types

- 4 tests
- No gold standard
- Compare using Bayesian analysis
  - Estimates sensitivity & specificity of each test
  - Estimates "overall" prevalence for each abattoir
  - *Estimates prevalence (UK) by each sample type (not presented)*
- Consider how each sample type might be used to monitor *Salmonella* in pigs

Test combinations

- 232 pigs negative in all tests
- 481 pigs positive to at least one test
- 15 different combinations of positive results observed – eg
  - 22 pigs positive in lymph node alone
  - 27 pigs positive in carcass swab alone
  - 26 pigs positive in caecal content alone
  - 135 pigs positive in meat juice test alone
  - 21 pigs positive in all 4 tests
  - *etc*

Biological plausibility

- Result for each test depends on:
  - **True** status of animal for the test
  - **Sensitivity** of each test – probability that a true positive individual will give a positive test result
  - **Specificity** of each test – probability that a true negative individual will give a negative test result
- For culture, assume specificity is 100%
- All combinations of test result are plausible:
  - MJ +ve may be true negative or true positive for one or more culture or may be false negative for one or more
  - Any culture may be true positive or true negative and may be true positive, true negative or false negative for any other culture and true positive, true negative, false positive or false negative for MJ ELISA

Model

- Expected (prior) values based on existing knowledge
- Uncertainty described using eg beta distribution
- Test data from each abattoir fitted
- Model run for 5000 iterations
- Repeated assuming conditional dependency between tests – little impact
- Sensitivity analysis varying priors – little impact

Results

- **Sensitivity**
  - Lymph node sample - 49%
  - Caecal content - 53%
  - Carcass swab - 36%
  - Meat juice ELISA - 63%
- **Specificity**
  - Meat juice ELISA - 89%

    Using MJ cut-off 0.25 s:p ratio
  - All culture assumed 100% specific – no "false positives"
- **Prevalence ("overall")**
  - Varied from 22%-27% between abattoirs – consistent with other UK abattoir studies; indicates model is valid

Interpretation

- All tests are imperfect
- *Salmonella* infection (shown by lymph node, caecal content or meat juice) is a poor indicator of carcass contamination
- Meat juice ELISA is only moderately associated with infection at slaughter

Use of MJ ELISA

- MJ ELISA – were pigs ever infected?
  - Interventions on farm may reduce the prevalence of infection during production
  - Pigs may have been infected but have recovered & be culture negative; may not be detected if culture at slaughter only test
  - BUT – if no difference at abattoir, is intervention "effective"?
  - Sensitivity & specificity depend on test cut-off (titres liable to reduce with time)
  - Results with different tests in different MS not comparable

Use of lymph node culture

- Demonstrates infection at point of slaughter
- Presence in lymph nodes suggests infection unlikely to occur between farm & slaughter
- 100% specific but may miss up to half of pigs that either have infection, carry *Salmonella* or have surface contamination
- Is it a good indicator of public health hazard?
- Lymph nodes not eaten; poor indicator of carcass contamination

Use of caecal content

- Captures recent infection/ passive carriage of *Salmonella* – from farm, transport & lairage
- Intervention on farm may not be reflected in change in caecal content if transport & lairage incidence is relatively high

Carcass swab

- Closest to public health hazard?
- Reflects process up to & including abattoir
- But poor indicator for primary production

Conclusions

- **Based on UK data:**
  - Aim of control of *Salmonella* in primary production is protection of public health
  - If carcass contamination represents public health risk then carcass swabs are best tool to monitor reduced threat
  - MJ ELISA represents a feasible method for monitoring trends in primary production at a population level and moderately correlated with **prevalence** of infected lymph nodes at slaughter

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