FSIS Risk Assessment for Guiding Public Health-Based Poultry Slaughter Inspection

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United States Department of Agriculture

January 2008

Executive Summary

BACKGROUND

Food Safety and Inspection Service on-line inspectors examine every young poultry carcass to ensure it is unadulterated, free of feathers, bruises, and defects and disease. FSIS off-line inspectors verify that establishments maintain sanitary operations and perform other health and safety-related assignments. By allowing FSIS personnel to perform additional wholesomeness, sanitation, sampling, and other offline procedures, it may be possible to reduce the number of human illnesses from *Salmonella*.

RISK MANAGEMENT QUESTIONS

This risk assessment addresses four risk management questions:

- Can FSIS reallocate inspection activities in young chicken slaughter establishments without significant negative impact on microbial prevalence in the establishments?
- How will the relocation of on-line inspectors to off-line duties, or other areas within or outside the establishment, affect human illness?
- Where within the establishment can relocated inspection activities have the most impact toward reducing microbial prevalence and corresponding human illness?
- What is the uncertainty about these effects?

STRUCTURE AND SCOPE

This is a quantitative microbial food safety risk assessment. It evaluates variations in personnel assignments and inspection activities in FSIS poultry slaughter facilities with the prevalence of *Salmonella* on young chicken and, subsequently, attributable salmonellosis in humans. Data used in the risk assessment came from several sources. Data for the prevalence of *Salmonella* for poultry carcasses, representing 154 young chicken slaughter establishments, came from the USDA/FSIS *Salmonella* Pathogen Reduction/Hazard Analysis and Critical Control Point (PR/HACCP) verification sampling collection program for 2003-2005. Data for inspection procedures performed in an establishment came from the FSIS performance based inspection system (PBIS) database. These data were paired with *Salmonella* prevalence data for the same establishments and timeframes. The FSIS Resource Management and Planning Staff provided personnel assignment profiles for each establishment. A stochastic simulation model using multiple variable logistic regression techniques was used to account for uncertainty in estimates of the association between food safety procedure activities in the establishment and corresponding *Salmonella* prevalence on poultry.

Baseline estimates for the mean number of human salmonellosis from young chicken were based on surveillance data gathered by the Centers for Disease Control and Prevention (CDC). An uncertainty distribution was estimated around that mean number of attributable illnesses. Changes in the number of annual human salmonellosis cases due to inspection personnel activities were estimated as a function of predicted changes in *Salmonella* prevalence in young chicken slaughter establishments. A Poisson uncertainty distribution was used to incorporate both the variability in *Salmonella* illnesses per year and uncertainty about the relationship between changes in prevalence levels at the establishment level and corresponding number of attributable *Salmonella* illnesses. This procedure is documented in the microbial risk modeling literature.[18] For this risk assessment, *Salmonella* serotypes were not delineated on pathogenicity. That is, all *Salmonella* were assumed to have the same potential to cause human illness.

MODEL RESULTS

Key model results are summarized below. These results describe changes in estimated human salmonellosis cases associated with the number of unscheduled procedures performed in an establishment, the number of unperformed procedures in an establishment, and the number of non-compliances.

Six scenarios were modeled out to human illness impact based on changes in microbial contamination in the plants. Other scenarios were evaluated and provided no useful information when modeled out to human illness due to uncertainty in predicted changes in microbial contamination that were overwhelmed by the uncertainty distribution about estimates of attributable human illness.

A 50% increase in UNSCHEDULED SANITATION procedures (U-1)

An uncertainty distribution was developed for the expected change in human illnesses due to a 50% increase in all unscheduled sanitation procedures across all young chicken slaughter establishments. Over 95% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 7,573 attributable *Salmonella* illnesses. The 95th percentile of the uncertainty distribution is a reduction of 2,593 illnesses.

A 50% increase in UNSCHEDULED SAMPLING procedures (U-5)

An uncertainty distribution was also developed for the expected change in human illnesses due to a 50% increase in all unscheduled sampling procedures across all young chicken slaughter establishments. Over 95% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 19,780 attributable *Salmonella* illnesses. The 95th percentile of the uncertainty distribution is a reduction of 9,916 illnesses.

A 75% decrease in UNPERFORMED SAMPLING procedures (B-5)

Similarly, an uncertainty distribution was developed for the expected change in human illnesses due to a 75% decrease in all unperformed sampling procedures across all young chicken slaughter establishments. Just under 85% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 5,482 illnesses. The 85th percentile of the uncertainty distribution, however, shows an increase of 258 illnesses. This implies that there is a 15% probability that attributable *Salmonella* illnesses would not decrease because of a decrease in the number of unperformed sampling procedures.

A 75% decrease in UNPERFORMED HACCP procedures (B-3)

An uncertainty distribution was developed for the expected change in human illnesses due to a 75% decrease in unperformed HACCP procedures across all young chicken slaughter establishments. Over 70% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 2,060. The 75th percentile of the uncertainty distribution, however, shows an increase of 297 illnesses. This implies that there is a 25% probability that attributable *Salmonella* illnesses would not decrease because of a decrease in the number of unperformed HACCP procedures.

A 75% decrease in UNPERFORMED SANITATION procedures (B-1)

In addition, an uncertainty distribution was developed for the expected change in human illnesses due to a 75% decrease in unperformed sanitation procedures across all young chicken slaughter establishments. Over 95% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 8,592

illnesses. The 95th percentile of the uncertainty distribution shows a reduction of 2,021 illnesses.

A 75% decrease in NON COMPLIANCES for SANITATION procedures (NC-1)

Finally, an uncertainty distribution was developed for the expected change in human illnesses due to a 75% decrease in non-compliances (NRs) for sanitation procedures across all young chicken slaughter establishments. Over 65% of all iterations with the model show expected reduction in human *Salmonella* illnesses, with an average reduction of 2,321 illnesses. The 70th percentile of the uncertainty distribution, however, shows an increase of 297 illnesses. Again, this implies that there is a 30% probability that attributable *Salmonella* illnesses would not decrease because of a decrease in the number of non-compliances (NRs) related to sanitation procedures.

CONCLUSIONS

The results of the risk assessment provide answers to each of the four risk management questions.

- Can FSIS reallocate inspection activities in young chicken slaughter establishments without significant negative impact on microbial prevalence in the establishments?

  Yes, risk assessment model results using 2003-2005 PR/HACCP *Salmonella* verification data from 154 young chicken slaughter establishments show that reallocating some on-line inspectors to off-line inspection duties (replacing some online inspector with establishment personnel) could be more effective at reducing *Salmonella* prevalence in establishments.

  Establishments with more off-line inspectors have lower *Salmonella* prevalence than establishments with fewer off-line inspectors.

- How will the relocation of on-line inspectors to off-line duties, or other areas within or outside the establishment, effect human illness?

  This risk assessment suggests a high probability that *Salmonella* attributable illnesses could decline or remain the same when additional off-line inspection procedures are performed. Both increases in unscheduled sanitation procedures and increases in unscheduled sampling

procedures are associated with decreases in attributable human *Salmonella* illnesses with greater than 90% certainty. Other off-line duties, such as reducing the number of unperformed sanitation, sampling, and HACCP procedures, may also reduce attributable human *Salmonella* illnesses, but we are less certain about these (85%, 70%, and 70% certainty, respectively).

- Where within the establishment can relocated inspection activities have the most impact toward reducing microbial prevalence and corresponding human illness?

  Relocated inspectors can have the most impact on reducing *Salmonella* prevalence and corresponding attributable illnesses by performing increased unscheduled sampling procedures (U-5) and increased unscheduled sanitation procedures (U-1). In addition, a reduction in uncompleted sanitation procedures (B-1) can lower *Salmonella* prevalence and illness.

- What is the uncertainty about these effects?

  Uncertainty in establishment-level *Salmonella* prevalence is accounted for using the mean of a Beta Inverse distribution incorporating available sampling data. Uncertainty in *Salmonella* prevalence across all young chicken slaughter plants is modeled using a bootstrap simulation analysis. Uncertainty about attributable human illness is based on the central limit theorem and is lognormal in shape. The uncertainty in the relationship between attributable *Salmonella* human illness and *Salmonella* prevalence is represented by the Poisson distribution.

FUTURE PLANS

In 2008, FSIS plans to have results from a new expanded FSIS microbiological baseline data collection program for young chicken slaughter establishments. These results will include rehang and post-chill observations for prevalence and bacterial counts of *Salmonella, Campylobacter, E. coli,* and other indicator organisms. The quantitative risk assessment model used in this analysis has been specifically designed to incorporate these data in combination with data from the FSIS' performance based inspection system (PBIS) program.

The explanatory inspection procedures records that were used in this analysis were aggregated across similar procedures codes. A new analysis is planned to disaggregate further the inspection procedures data used in the belief that individual procedure code records will provide results that are more specific when the model is used to guide resource allocation decisions.

There is also the ability to revise the current model to differentiate results based on available speciation categories from the forthcoming microbiological baseline data. This new information will facilitate the strengthening of the quantitative linkage between inspection activities in the establishment and attributable human cases of illness from *Salmonella*, *Campylobacter*, and *E. coli*.

In sum, the analytical capabilities of this risk assessment model, once the new FSIS microbiological baseline data for young chicken slaughter establishments are available, should prove useful for future establishment inspector assignment allocations within a given establishment based on that establishment's individual risk profile.