

THE
PEW
CHARITABLE TRUSTS



CENTER FOR
Science IN THE
Public Interest

Meat and Poultry Inspection 2.0

How the United States can learn from the practices and innovations in other countries

This report is intended for educational and informational purposes. References to specific policymakers or companies have been included solely to advance these purposes and do not constitute an endorsement, sponsorship, or recommendation by The Pew Charitable Trusts or the Center for Science in the Public Interest.

The Pew Charitable Trusts

Susan K. Urahn, *executive vice president*

Allan Coukell, *senior director*

Safe food project

Sandra Eskin

Juliana Ruzante

The Center for Science in the Public Interest

Caroline Smith DeWaal, J.D.

Marcus Glassman, M.S.

Michael F. Jacobson, Ph.D.

External reviewers

The report benefited from the insights and expertise of two external reviewers: Dr. Craig Reed, DVM, former USDA FSIS associate administrator and USDA-APHIS administrator, and Dr. Katharina Staerk, DVM, PhD, professor of Veterinary Public Health Policy at the Royal Veterinary College, University of London. These experts provided feedback and guidance at critical stages in the project. Although they have screened the report for accuracy, neither they nor their organizations necessarily endorse its findings or conclusions.

Acknowledgments

We want to express our gratitude to the international researchers who participated in the survey and also provided in-depth information regarding their approaches to meat and poultry inspection. They are, for Australia: Ann McDonald, assistant secretary, Export Standards Branch, Department of Agriculture, Fisheries and Forestry; Greg Read, first assistant secretary, Export Standards Branch, Department of Agriculture, Fisheries and Forestry; and Ian Jenson, manager, Market Access Science and Technology, Meat & Livestock. For Denmark: Flemming Bager, head of division, Division for Epidemiology and Microbial Genomics, National Food Institute, Technical University of Denmark; and Jørgen Schlundt, director, National Food Institute, Technical University of Denmark. For the Netherlands: Peter Bootsma, counselor for health, welfare and sports, Netherlands Embassy in Washington, DC; and Tamara van Riet, policy officer on veterinary market access, Ministry of Economic Affairs. For New Zealand: Roger Cook, manager, food risk assessment, Ministry for Primary Industries; Bill Jolly, chief assurance strategy officer, Ministry for Primary Industries; and Sharon Wagener, manager, production and processing, Animal and Animal Products Directorate, Standards Branch, Ministry for Primary Industries. For Sweden: Elsie Carjemo, veterinary inspector, Food Control Department, National Food Agency. We appreciate the assistance of Michelle Harris and Emily Lando with fact checking and Marcia Kramer with copy editing. Thank you to the following Pew colleagues for their contributions to this report: Lisa Gonzales and Matt Mulkey for their editorial input; and Dan Benderly, Stephen Howard, Jerry Tyson, Gaye Williams, and Sara Flood for their work preparing this report for publication.

For further information, please visit:

pewtrusts.org/foodsafety



Cover photos:

1. John A. Rizzo 2. Sanjay Deva 3. Shutterstock 4. Shutterstock

Contact: Matt Mulkey, communications manager

Phone: 202-862-9864

Email: mmulkey@pewtrusts.org

The Pew Charitable Trusts' safe food project seeks to reduce health risks from foodborne pathogens by strengthening federal government authority and the enforcement of food safety laws.

The Center for Science in the Public Interest is a nonprofit health-advocacy group based in Washington, DC, that focuses on nutrition and food safety.

Table of Contents

- 1 Overview
- 3 Introduction
- 4 The importance of meat and poultry inspection
 - International perspectives on meat and poultry inspection 4
- 6 Meat and poultry inspection in selected countries
 - Specific inspection approaches in other countries 8
- 10 Moving toward Inspection 2.0: The push to modernize meat and poultry inspections
 - Scientific opinion on inspection modernization in the European Union 11
- 14 The use of data to enhance the public health benefit of inspection
 - Food chain information 14
 - 360-degree information sharing of in-plant data in Australia and Denmark 15
- 19 Findings and recommendations
- 20 Conclusion
- 21 Appendix: Questionnaire on National Meat and Poultry Inspection Modernization Practice
- 23 Endnotes

Overview

The Centers for Disease Control and Prevention estimates that illnesses from contaminated food sicken 48 million Americans each year, resulting in 128,000 hospitalizations and 3,000 deaths.¹ For the almost 9.4 million illnesses caused by known agents, outbreak data suggest that at least 22 percent of these illnesses (over 2 million cases) are associated with meat and poultry consumption.² In addition, the cost of foodborne diseases associated with these products has been estimated to be almost \$7 billion each year.³

The safety of meat and poultry is regulated by the United States Department of Agriculture.⁴ USDA inspectors are required by law to be present at all times during slaughter and to visit, on a daily basis, every meat and poultry processing plant engaged in interstate commerce in the United States.* However, traditional slaughter inspection methods, which are based upon a system that is more than 100 years old, are not designed to detect most of the current microbial and chemical contaminants of public health importance.

In *Meat and Poultry Inspection 2.0*, The Pew Charitable Trusts and the Center for Science in the Public Interest (CSPI) examine the efforts and approaches undertaken by other countries as well as the European Food Safety Authority (EFSA) to modernize meat inspection. This review is intended to identify innovations that could offer improved protections for U.S. consumers.

This analysis of international practices and recommendations found that:

1. Meat and poultry inspection at slaughter is essential for ensuring human health and the health and welfare of food animals, but it needs to be modernized to take into account current public health hazards such as *Salmonella*, *Campylobacter*, and Shiga toxin-producing *Escherichia coli*.
2. While several countries are evaluating how traditional meat and poultry inspection can be modernized, few have made significant changes to their practices.
3. Robust data collection, analysis, and sharing are fundamental components of efforts to transform existing inspection practices into a modern, risk-based, and science-based inspection system.
4. None of the countries deploys meat inspectors to every meat and poultry slaughter and processing plant every day, as is done in the United States.
5. Some countries use private or quasi-governmental inspectors in their meat and poultry inspection systems. Others have turned certain aspects of meat or poultry inspection completely over to industry.

Based upon these findings, Pew and CSPI recommend that:

1. As has been done by the European Union and the United Kingdom, the United States should commission comprehensive scientific assessments to evaluate its existing meat inspection approaches and alternatives for modernization.
2. While the United States has made efforts to improve data collection related to meat and poultry production and testing, a more significant effort should be undertaken, including analysis of results and real-time data sharing.
3. As has been done by the European Union and Australia, the United States should evaluate incorporating food chain information and comprehensive data management and review into its meat and poultry inspection system.

* USDA inspectors are present at all times in over 95% of slaughterhouses; however, there are a few exemptions to the federal inspection requirements. For example, those that slaughter animals for non-commercial uses are covered by an exemption for “custom” slaughter. Also, some states use state employees to conduct federal inspection of small and very small meat and poultry processors, with the costs for these inspections partially reimbursed by the federal government.

This report discusses the importance of meat and poultry inspection and how selected countries operate their inspection systems; provides an overview of recent reports by EFSA on meat and poultry inspection; and presents several innovations being used in different countries and regions to modernize existing inspection systems. While many of these innovations are relatively new and data have yet to be collected and analyzed to determine their impact on foodborne illnesses, they represent models with the potential to improve public health and better target regulatory resources.

Introduction

For more than a century, government oversight of the slaughter and processing of meat—and more recently poultry—has been considered critically important for ensuring the safety of the food supply. Live animals such as cattle, pigs, and poultry carry hazards that can contaminate food products at many stages during production and distribution.⁵ Concerns about conditions for animals and workers in meat and poultry plants, chronicled by Upton Sinclair in his 1906 novel *The Jungle*, led to the adoption of the first nationwide meat inspection law in the United States.⁶ Today's hazards of human health importance in meat and poultry—bacteria, viruses, and other pathogens—were largely unknown at that time. Yet, more than 100 years later, the United States and many other countries employ virtually unchanged inspection practices.

While they are not effective against all major hazards to human health found in meat and poultry, traditional slaughter inspection practices serve numerous important functions. They are effective if there are visible signs of lesions indicating a disease process, by ensuring that sick animals do not enter the human food supply. They also help assess animal welfare, and they identify important animal diseases that may also have an impact on international trade. While fecal contamination, signs of animal disease, and some other visible hazards can signal the presence of pathogens on animals before or during slaughter, animals can harbor bacteria of public health significance without showing any external signs of contamination.

The importance of meat and poultry inspection

Ensuring that only safe meat from healthy animals is provided to consumers continues to be the goal of government oversight of the meat and poultry supply. On-site inspections verify that facilities are complying with legal requirements related to food safety.

The Federal Meat Inspection Act of 1906 and the Poultry Products Inspection Act of 1957 cover all beef, pork, and poultry products sold in the United States. These laws require that the U.S. Department of Agriculture employ government inspectors to visually inspect each animal when alive (ante-mortem inspection) and then its carcass, head, and viscera after slaughter (post-mortem inspection). These inspections entail:

1. **Ante-mortem:** Primarily visual inspection of live animals is conducted by veterinarians. This inspection ensures, among other things, that all animals are screened before slaughter; clinical information and animal identification are obtained on site; animals are treated humanely; reportable animal diseases are identified; and sick animals and those with visible signs of drug injection suggesting recent treatment are identified and handled appropriately.⁷
2. **Post-mortem:** Inspectors base their assessments on several factors: information obtained from live animals; observations of the carcass based on their senses of sight, touch, and smell; the evaluation of the head, carcass, and viscera; and routine palpation and incision of key organs and lymph nodes.⁸

On-site government inspection at slaughter allows countries to meet trade obligations by ensuring that national food safety and animal health controls at all levels are effective and that production controls are trustworthy (such as the removal of high-risk, “specified risk-materials” in cattle to manage the risk related to bovine spongiform encephalopathy).

While on-site inspection in processing plants in the United States may help prevent some mishandling or cross-contamination, the frequency of conducting inspections at least once daily is not based on the risk the products pose to human health. For example, plants producing canned beef and those grinding beef receive daily visits even though the potential risk from ground beef far exceeds that from the fully processed meat in canned beef.

International perspectives on meat and poultry inspection

The importance of government inspection is captured in numerous documents prepared by international bodies such as the Food and Agriculture Organization of the United Nations, World Health Organization, World Organization for Animal Health, regional bodies such as the European Food Safety Authority, and the international standard-setting body Codex Alimentarius. These organizations have confirmed that slaughterhouse inspection activities protect human and animal health and that Hazard Analysis and Critical Control Points plans serve as a proactive means of ensuring food safety.⁹

The Codex Alimentarius defines “inspection” as the examination of food or food systems to ensure that food, raw materials, and food processing meet requirements, usually those set by government authorities.¹⁰ To maximize consumer confidence, the Codex standards for meat and poultry inspection recommend that inspections or other appropriate controls should extend to all stages of production, including manufacture, importation, processing, storage, transportation, distribution, and trade, and can include both in-process and finished-product testing.¹¹

However, the Codex does not specify that inspectors must be government officials. Instead, it differentiates activities that require “official controls,” usually observation by a government veterinarian, from those activities that are important but could be performed by a non-government employee.¹²

Food Safety and Hazard Analysis and Critical Control Points

The United States adopted preventive approaches to improve food safety in the late 1990s by implementing the mandatory Hazard Analysis and Critical Control Points (HACCP) regulations in facilities that slaughter or process meat or poultry. HACCP requires each facility to develop a written food safety plan, conduct active management and monitoring of microbial and chemical hazards identified in the plan, and make records available to government inspectors upon request.

The U.S. HACCP model included a number of important advances, such as performance standards (limits on pathogenic contamination) and a government sampling program for *Salmonella* directed at meat and poultry slaughter and grinding facilities. The regulations do not specify which hazards a company must address in its food safety plan; therefore, each company takes responsibility for identifying and justifying the hazards to be included or excluded. Instead of reliance on traditional inspections alone, HACCP innovated by allowing for better information collection, more effective enforcement, and improved consumer protection tools. An area for further modernization of HACCP would be to incorporate quantifying the measures of risk such as the likelihood that a hazard is present at a level that can cause harm, rather than just its potential presence.

Source: Food Safety and Inspection Service, "Progress Report on Salmonella and Campylobacter Testing of Raw Meat and Poultry Products, 1998-2012," U.S. Department of Agriculture, accessed May 27, 2014, <http://www.fsis.usda.gov/wps/wcm/connect/8d792eef-f44d-4ccb-8e25-ef5bdb4c1dc8/Progress-Report-Salmonella-Campylobacter-CY2012.pdf?MOD=AJPERES>; Robert L. Buchanan, "Food Safety Risk Management, a U.S. Perspective," Center for Food Safety and Security Systems, University of Maryland, accessed May 27, 2014, <http://www.foodprotection.org/events/european-symposia/11Ede/Buchanan.pdf>.

Meat and poultry inspection in selected countries

Five national governments with well-established food safety and public health systems that made recent changes to their meat and inspection programs were surveyed: Australia, Denmark, the Netherlands, New Zealand, and Sweden. (For details on the questionnaire used, see Appendix.) This survey was intended to identify differences and similarities in inspection approaches and the roles played by public and private entities within each country.

Over the past 10 to 15 years, the responsibility for meat and poultry inspection has changed in these countries. While all five countries accomplish similar inspection tasks, including ante- and post-mortem inspections, some rely on local or regional governments and others use private or quasi-governmental inspectors overseen by the government.

All five countries conduct carcass-by-carcass inspection of red meat at slaughter. Meat inspectors, either private or public, inspect all cattle and swine, both ante- and post-mortem. Government inspectors in all countries conduct post-mortem inspections on poultry, but only Denmark, the Netherlands, and New Zealand require ante-mortem inspections of all flocks (though inspections are sometimes conducted by the industry itself). In Sweden, a random representative sample of birds is inspected from each flock, and in Australia, where there is no ante-mortem inspection at the slaughterhouse for poultry, farms are expected to produce “clean birds” through hygienic husbandry practices.

Only Denmark has moved away from some traditional post-mortem inspection activities. It eliminated the incision and palpation of lymph nodes and other organs for fattening pigs raised in controlled housing systems.*

All five countries require inspectors to be present in slaughterhouses during slaughter. Most countries use government veterinarians in slaughterhouses to conduct ante-mortem inspections, though there are a few exceptions. In Denmark, facilities classified as low risk can in some cases substitute inspection by the official veterinarian with inspection by government-approved nonveterinarian experts who work under the supervision of the official veterinarian. Sweden provides the only exception to this rule and allows small slaughterhouses to operate without inspectors present during slaughter. Official inspectors, however, still carry out ante- and post-mortem inspection, and the exempt small slaughterhouses must undergo annual plant audits.

In some of the surveyed countries, non-government employees perform slaughter inspections. In the Netherlands, a private independent agency under government supervision conducts post-mortem inspections. In New Zealand, industry handles some aspects of inspection for sheep, cattle, and goats. Specially trained company employees act as inspectors and carry out elements of the meat inspection not linked to food safety.¹³ Poultry facilities do their own ante- and post-mortem inspection for domestic products.¹⁴ Under the new poultry modernization rule in the United States, company employees can perform some of the slaughter inspection activities.¹⁵ (See “USDA Adopts Program to Modernize Poultry Inspection” on Page 7 for more detail.)

Meat processing inspections in the countries surveyed are not as intensive as those in the United States. For processing facilities, most countries rely on private audits, periodic inspections, and HACCP systems. Only New Zealand and the Netherlands conduct daily processing inspections similar to those required in the United States.

Some countries follow different inspection approaches for meat exports. In New Zealand and Australia, private inspectors perform slaughter inspections for the domestic market, while government-employed veterinarians inspect meat destined for many export markets. In Denmark, slaughter inspection approaches differ only when

* Intensive animal production systems with strict biosecurity measures, where pigs are kept for their entire lives.

requested by the receiving country. In the United States, there is no difference in inspection for domestically consumed and exported products.

Most countries surveyed require industry to pay for government inspection at slaughter. Regulations pertaining to fees vary. In Sweden, for example, a company's risk evaluation determines its fee amounts. In New Zealand and Sweden, fees are charged when a facility's non-compliance triggers additional inspections and costs to the government. Sweden provides grants to assist smaller facilities in paying for inspections. In the United States, companies do not pay a fee for inspection, unless a plant operates outside regular business hours, in which case it must reimburse the government for inspection costs.

USDA Adopts Program to Modernize Poultry Inspection

In July 2014, USDA finalized its Poultry Modernization Rule, a controversial initiative aimed at modernizing inspection of young chickens and turkeys. Under this voluntary program, companies can elect to use the New Poultry Inspection System (NPIS), which, among other things, reduces the number of inspectors in a plant and repositions them throughout the facility. Poultry plants that participate in the new program rely on employees to sort birds for defects, a task formerly performed by USDA inspectors. This frees the inspectors to more frequently remove birds from the evisceration line, take samples for testing, check plant sanitation, verify compliance with food safety plans, and observe live birds for signs of disease or mistreatment. USDA's Food Safety and Inspection Service estimates that the NPIS will prevent nearly 5,000 *Salmonella* and *Campylobacter* foodborne illnesses each year.

Some consumer advocacy organizations and groups representing inspectors and poultry workers oppose the NPIS, claiming that it would not improve public health and would harm workers. In September 2014, Food & Water Watch, a nongovernmental organization and consumer rights group, filed a lawsuit against USDA that would stop the implementation of the new inspection program. The group claims that the new inspection program violates the Poultry Products Inspection Act, which requires inspection by government employees.

Source: Food Safety and Inspection Service, Modernization of Poultry Slaughter Inspection, <http://www.fsis.usda.gov/wps/portal/fsis/topics/regulatory-compliance/haccp/haccp-based-inspection-models-project/himp-study-plans-resources/poultry-slaughter-inspection>, last modified Oct. 15, 2014; *Food Safety News*, "Food & Water Watch Sues USDA Over New Poultry Inspection Rule," Sept. 13, 2014, <http://www.foodsafetynews.com/2014/09/food-water-watch-sues-usda-over-poultry-rule/#.VEEyIPldVQ0>.

Specific Inspection Approaches in Other Countries

Australia



In **Australia**, state and territory authorities use audit-based oversight of establishments. Industry is responsible for meat inspection activities, which include ante- and post-mortem inspections as well as HACCP monitoring for meat and poultry produced for the domestic market. In some states, third-party inspectors perform system audits.

Prior to slaughter, animal ear tags and passports* are inspected. Meat safety inspectors, whether public or private, must inspect all animals at the slaughterhouse. Inspection, monitoring, and verification activities at processing establishments are risk-based in accordance with the development of a HACCP-based food safety plan. For poultry, inspectors are present for post-mortem slaughter inspection but not for processing.

Inspection practices differ for meat destined for domestic and international markets, depending on the rules of the importing country.

Netherlands



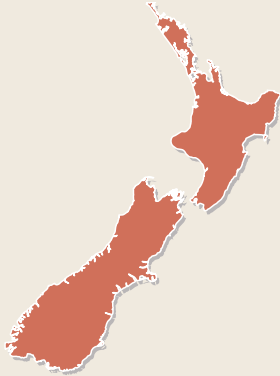
In the **Netherlands**, veterinarians from the Netherlands Food and Consumer Product Safety Authority perform ante-mortem inspections. A private, independent agency called the Animal Sector Quality Inspection Foundation (Kwaliteitskeuring Dierlijke Sector), which is under the Authority's supervision, conducts post-mortem inspections. The post-mortem inspection of poultry can be performed by plant staff under the supervision and responsibility of the official veterinarian.

The Food and Consumer Product Safety Authority follows a risk-based approach to set inspection frequencies. That is, different segments of the meat industry can be evaluated each year and selected for additional inspection and/or supervision. For example, on the company level, findings during previous inspections, which build the "company risk profile," determine the frequency of slaughter inspections.

Prior to slaughter, food chain information is collected, and all animals are inspected on the farm before slaughter except poultry, which is inspected at the flock level. (See "Food chain information" on Page 14 for more detail.) Meat destined for both domestic and international markets undergoes the same inspection procedures.

* Animal ear tags and passports are forms of identification used for domestic livestock and other animals. According to the USDA, ear tags are plastic or metal objects that usually contain an identification number and are complemented by transport documents supplied by vendors and used for identification and tracking. In the European Union, each bovine animal must have a passport document and tag in each ear carrying the same number. Some systems of animal identification use radio frequency devices and computer chips to log information. Although animal identification has long been recommended by the World Organization for Animal Health as an essential tool in the control of animal diseases, animal passports became more common in response to concerns about bovine spongiform encephalopathy to monitor animal movements across national borders. Source: Animal and Plant Health Inspection Service, "Animal Disease Traceability Framework: Official Eartags—Criteria and Options," U.S. Department of Agriculture, May 14, 2013, accessed May 27, 2014, http://www.aphis.usda.gov/traceability/downloads/ADT_eartags_criteria.pdf.

New Zealand



New Zealand differentiates food safety and food quality inspection tasks to better focus inspection responsibilities. Food quality aspects of meat inspection for sheep, cattle, and goats have been turned over to industry. Specially trained company employees act as inspectors and carry out those aspects of the meat inspection.¹⁶ AsureQuality, a government-owned enterprise, employs meat inspectors to conduct the required post-mortem inspections on all meat products. Poultry, which is mostly sold domestically, does not undergo government inspection except for a few export markets. Instead, facilities do their own ante- and post-mortem inspection.

Food chain information is collected from animals prior to slaughter. Inspection practices for slaughter differ for meat destined for domestic and international markets. Inspectors are present at all times during slaughter but not at processing, except when legally required for export.

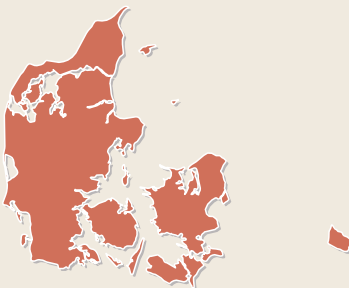
Sweden



In **Sweden**, national and local authorities share inspection responsibilities. Poultry is the exception: Inspectors are employed by industry, trained by the government, and work under the supervision of Sweden's official veterinarian. Each facility is evaluated on the products produced, production volume, and compliance history, and inspections are based on these findings. Each facility undergoes a yearly risk evaluation during which inspectors determine if major changes have occurred at the facility since the last audit.

Inspectors check animal passports before slaughter and conduct ante-mortem inspections on all animals. For poultry, however, ante-mortem inspectors examine a representative sample from flocks. Inspectors are present continuously during slaughter in large slaughterhouses, but only for ante- and post-mortem inspection in small slaughterhouses. Inspectors are not present at processing.

Denmark



In **Denmark**, ante- and post-mortem inspection protocols are not risk-based, unlike audits and inspections of processing plants. Food chain information is collected for all animals prior to slaughter. Inspectors are present at slaughter, but an official auxiliary may stand in for the official veterinarian in designated "low-risk" facilities.

Moving toward Inspection 2.0: The push to modernize meat and poultry inspections

Pathogens that can cause severe illnesses and death associated with meat and poultry products today include *Campylobacter*, *Salmonella*, *Listeria monocytogenes*, Shiga toxin-producing *Escherichia coli* (*E. coli*), and *Toxoplasma gondii*.¹⁷ As previously noted, the traditional slaughter inspection process as designed does not detect and control today's major foodborne pathogens of concern. (See Table 1.) Moreover, some pathogenic bacteria, such as *Yersinia enterocolitica* and *Salmonella* species, can be spread by the incision and palpation of organs during post-mortem inspections.¹⁸

Table 1

Zoonotic Agents in the Food Chain and Measures Intended to Prevent Contamination

Agent (or disease)	Herd management	Slaughter hygiene	De-contamination by steam/hot water§	Traditional inspection	Freezing	De-boning	Processing storage and preparation
<i>Salmonella</i>	+++	++	++	-*	-	-	Reduction/elimination by heat treatment (+++). However, the avoidance of cross-contamination during processing, storage, and preparation of foods that are not heat-treated before consumption is an essential part of food safety protocol.
<i>Campylobacter</i> (poultry)	+++	-	++	-	+++	-	
VTEC** (cattle/sheep)	++	++	++	-	-	-	
<i>Y. enterocolitica</i> (pig)	+++	++	++	-	-	-	
<i>L. monocytogenes</i>	-	+	+	-	-	-	
<i>Toxoplasma</i> (sheep)	-	-	-	-	+++	-	
<i>T. gondii</i> (pig)	+++	-	-	-	+++	-	
<i>Trichinella</i> (pig)	+++	-	-	+++	+++	-	
<i>Cysticercus</i> (cattle)	++	-	-	++	+++	+	
Tuberculosis	+++	-	-	++	-	-	
BSE††/TSE‡‡	+++	+‡	-	+†	-	+	-

+++ great effect ++ good effect + limited effect - probably negligible effect

* In a few cases, *Salmonella* can be suspected during ante-mortem inspections in cattle showing clinical signs

† Assumes clinical signs

‡ Removal of specified risk material, or SRM

§ Article 3, point 2 in Regulation (EC) 853/2004

** Verocytotoxigenic *E. coli*

†† Bovine spongiform encephalopathy

‡‡ Transmissible spongiform encephalopathies

Source: Paul Skjaker and Truls Nesbakken, "Risk-based Meat Inspection in a Nordic Context," Nordic Council of Ministers, 2006, accessed August 8, 2014, <http://urn.kb.se/resolve?urn=urn:nbn:se:norden:org:diva-391>.

© 2014 The Pew Charitable Trusts and CSPI

Modernizing government inspection of meat and poultry plants would focus resources on the food safety risks posed by bacteria and other microbiological and chemical hazards, and away from some human and animal diseases, such as tuberculosis and brucellosis, that have been successfully controlled in most developed countries. This shift in emphasis would potentially improve consumer protection and reduce the likelihood of deaths or illnesses from meat or poultry products. However, out of a concern that modernizing government inspection could have unintended consequences, several countries, as well as the European Union, have begun the process by first commissioning scientific assessments by expert bodies that examined the impact of potential changes to their current inspection systems.

Scientific opinion on inspection modernization in the European Union

In 2010, EU authorities asked the European Food Safety Authority to develop a more rigorous inspection system grounded in 21st-century science and technology.¹⁹ EFSA convened an expert panel to examine current approaches to inspection covering each stage of production for different types of meat, including chicken, beef, pork, horse, goats, sheep, and game. It concluded that traditional slaughter inspection practices contribute more to animal health than human health.²⁰ The *Salmonella* and pathogenic *E. coli* strains associated with human illness commonly found on cattle, for example, are not identified on carcasses under current post-mortem inspection practices. The panel concluded that those hazards should be addressed from farm to fork with good manufacturing practices, good hygiene practices,* and HACCP systems.²¹

The panel acknowledged the value of certain current inspection practices. While noting that ante-mortem inspection does not directly contribute to control of pathogens hazardous to humans, the practice can detect those food animals heavily contaminated with fecal matter or other dirt coming into slaughter facilities.²² Further, post-mortem inspection of beef and pork provides important checks for visible fecal contamination. No changes to either of these inspection practices were recommended.²³ For poultry inspection, however, the expert panel observed that both the cages and line speeds interfered with effective visual inspection and concluded that “it would therefore be expected that more efficient procedures could be implemented to monitor the occurrence of non-visible hazards.”²⁴

The EFSA panel also recommended changes to some manual inspection practices for cattle and swine. For example, it advised ending practices that consistently triggered no findings during ante-mortem or post-mortem inspections.²⁵

EFSA found that many post-mortem inspection practices do not contribute to controlling pathogens of human importance.²⁶ For example, it proposed that during post-mortem inspection for cattle and swine, the manipulation of internal organs using palpations and incisions should be discontinued because of the risk of cross-contamination.²⁷ The panel considered the likelihood of finding carcass abnormalities (abscesses, septicemia, hepatitis, and parasites in the lungs) without organ manipulation, and it concluded that eliminating palpation and incision would not increase the chance of meat with these conditions reaching consumers because many of these conditions can be identified visually and removed through quality assurance programs.²⁸

* Good manufacturing practices and good hygiene practices are regulations intended to ensure the quality and safety of food products. In relation to meat production, good manufacturing practices are practices and procedures necessary to ensure the safety and quality of the meat. Good hygiene practices are hygienic practices that affect the safety of meat at all stages of production.

EFSA identified practices in slaughter facilities that enhance control of *Salmonella*, *Campylobacter*, pathogenic *E. coli* strains, and other priority pathogens.²⁹ These practices include:

- Assessment of visual cleanliness of animals.
- Prevention and reduction of pathogen spread during the period when animals are kept in holding pens (lairage).
- Hygienic removal of hide, pelt, and skin (hygienic dressing).
- Antimicrobial decontamination treatments; carcass-chilling practices.
- General management of microbial risks within the slaughter operation.

The European Food Safety Authority found that many post-mortem inspection practices do not contribute to controlling pathogens of human importance.

Effective controls of microbial and chemical hazards in cattle, pork, and poultry, according to the EFSA report, could be achieved only through integrated programs based on good manufacturing practices, good hygiene practices, and HACCP systems applied from farm to fork.³⁰ Further, a risk-based approach would require several components, including requirements that differentiate between lower- and higher-risk animals or flocks using food chain data to inform risk management during slaughter.³¹

Finally, for each species, EFSA identified priority foodborne hazards (see Table 2) and proposed a series of “harmonised epidemiological indicators,” or standardized metrics such as the prevalence of a hazard at different stages of the food chain or indirect measures of the hazards that correlate to human health risks. As Europe considers changes in meat inspection methods, those indicators will be important for categorizing farms, herds, and slaughterhouses according to risk; setting appropriate performance standards; and carrying out risk analysis to support such management decisions.³²

Capturing all of the relevant information in a unified system that is continually updated would provide food processors with much better information on the potential animal sources of contamination entering their facilities. A database could also serve as a surveillance system that would provide early warnings for processors and inspectors, notifying them when foodborne hazards are changing. A series of audits to monitor on-farm practices and housing conditions was also proposed.

Similar scientific opinions and risk assessments have been commissioned by the Food Standards Agency in the United Kingdom to review the nation’s meat inspection practices with the goal of modernizing a system that dates from the 1880s.³³ The research looked at the scientific basis for the current system and gathered evidence that supported modernization. Denmark has also conducted risk assessments to quantify the impact of changing slaughter inspection practices in animal and public health and concluded that omitting the incisions into the mandibular lymph nodes and the routine opening of the heart did not seem to be associated with an increased risk for human health.³⁴

Table 2

Priority Foodborne Hazards Identified by EFSA for Poultry, Swine, and Cattle

	Poultry	Swine	Cattle
Biological hazards	<i>Salmonella</i>	<i>Salmonella</i>	<i>Salmonella</i>
	<i>Campylobacter</i>	N/A	N/A
	Bacteria carrying extended spectrum β -lactamase (ESBL)/AmpC genes	N/A	N/A
	N/A	<i>Yersinia enterocolitica</i>	N/A
	N/A	<i>Toxoplasma gondii</i>	N/A
	N/A	Trichinella	N/A
	N/A	N/A	Verocytotoxin-producing <i>Escherichia coli</i> (VTEC)
Contaminants	Dioxins	Dioxins	Dioxins
	Dioxin-like polychlorinated biphenyls (DL-PCBs)	Dioxin-like polychlorinated biphenyls (DL-PCBs)	Dioxin-like polychlorinated biphenyls (DL-PCBs)
	Chloramphenicol, nitrofurans, and nitroimidazoles	Chloramphenicol	N/A

Source: European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to Be Covered by Meat Inspection of Poultry," *EFSA Journal* 10 (2012): 2764; European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Public Health Hazards to Be Covered by Meat Inspection of Swine," *EFSA Journal* 9 (2011): 2371; European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to Be Covered by Meat Inspection of Bovine Animals," *EFSA Journal* 11 (2013): 3276.

© 2014 The Pew Charitable Trusts and CSPI

Epidemiological Indicators in Practice: *Salmonella* Monitoring in Cattle

1. Audit of animal handling practices that encourage the spread of *Salmonella* (such as purchasing policies, herd mixing practices, access of herd to pasture or surface water).
2. Audit of environmental conditions and facilities at the farm.
3. Microbiological testing of pooled fecal samples from a herd one month prior to slaughter.
4. Audit of transportation and holding facility conditions.
5. Visual inspection of animals' hide condition (clean animal scoring) upon arrival at the slaughterhouse.
6. Microbiological testing of incoming carcasses prior to de-hiding.
7. Microbiological testing of lymph nodes at the evisceration stage.
8. Microbiological testing of carcasses during pre-chilling at the slaughterhouse.
9. Microbiological testing of carcasses post-chilling at the slaughterhouse.

Source: European Food Safety Authority (2013): "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to be Covered by Meat Inspection of Bovine Animals," *EFSA Journal* 11 (2013): 3276.

The use of data to enhance the public health benefit of inspection

For changes in meat and poultry inspection practices proposed by EFSA and others to occur, a robust data system must be put in place to inform policy based on science and risk assessment. A number of countries are using innovative approaches to data collection and sharing to enhance their inspection systems and better protect public health.

Food chain information

Visual ante- and post-mortem inspections of livestock and meat performed in slaughterhouses allow many food safety hazards, such as microscopic pathogens, veterinary drug residues, and chemical contaminants, to pass undetected into the human food supply. Providing inspectors with food chain information, however, enables them to identify high-risk animals, herds, and flocks before they enter facilities so that slaughter practices, control measures, and monitoring can be targeted appropriately.

Food chain information refers to data collected over an animal's lifetime through animal identification, transportation, and other paper and electronic records that capture the animal's origin and welfare, on-farm practices and housing conditions, the use of antimicrobials, and other health information such as veterinary medical history and testing at holding facilities. In the United Kingdom, the farmer or holding facility manager completes a written questionnaire that accompanies animals as they move from farm to holding facility to slaughterhouse. The slaughterhouse can request the type, format, and time of delivery for the information and that additional information be provided.

Food chain data allow slaughterhouse inspectors and risk managers to categorize animals, herds, flocks, and production facilities into groups ranked by risk. Slaughterhouses and inspectors can employ risk-management techniques such as enhanced inspection, microbiological and target tissue testing, and quarantine practices for high-risk animals, to minimize cross-contamination, better identify hazards, and thereby ultimately reduce the likelihood of consumer exposure to hazards.³⁵

Major meat production markets around the world use food chain information to manage risk. In the EU, all 28 nations request, receive, check, and act upon food chain information with some country-by-country variation.³⁶ In 2010, the United Kingdom implemented its own food chain information system, which applies to all slaughtered cattle, goats, and sheep. No meat from those animals can be sold in the United Kingdom without these data.³⁷ (See Table 3.)

In Australia, advances in animal identification now include electronic tagging of cattle either through transponders within the animals' ear tags, or with a rumen bolus (a ceramic capsule and transmitter that lodges in an animal's gut).³⁸ The transponders in the ear tags provide individual information on animals and, through a national database, allow slaughterhouse inspectors to immediately identify high-risk animals due to specific diseases or chemical exposure.

Animals are flagged by the system when they enter the food chain and, where necessary, appropriate action is taken such as barring animals that come from farms that have tested positive for a certain hazard. The system minimizes the risk of human error in collecting and reporting food chain information. Most importantly, it provides inspectors with more detailed data.³⁹

Table 3
Food Chain Information in the United Kingdom

Livestock type	Food chain information required
For cattle	Provide any information about any animals showing signs of any conditions (e.g., bovine spongiform encephalopathy, bovine tuberculosis) that may compromise meat safety.
For lambs and young goats	Provide any information about any animals showing signs of any conditions (e.g., bovine spongiform encephalopathy, bovine tuberculosis) that may compromise meat safety.
For sheep and goats	Declare any localized health issue or injury for batches of sheep and goats; information on individual animals is helpful but not required.

Source: Food Standards Agency, "Guidance on Food Chain Information for Keepers of Cattle, Sheep and Goats," Government of the United Kingdom, 2010.

© 2014 The Pew Charitable Trusts and CSPI

Food chain data inform risk-mitigation decisions in ways that traditional inspection of the live animals or flocks cannot. Veterinary medical histories, for example, provide inspectors with information on animals' treatment history and help veterinarians assess if animal drug withdrawal periods have been properly observed. Location information can alert inspectors of animals raised in a region with an endemic disease of concern so that they can examine animals and carcasses closely for signs of the disease.⁴⁰

Denmark uses this information to help categorize animals based on risk. For example, slaughterhouses electronically receive *Salmonella* testing results from flocks, which along with ante-mortem inspections inform risk-management decisions that minimize cross-contamination in the plants.⁴¹ In 2007, the Danish veterinary authorities issued a regulation determining that *Salmonella*-positive broiler flocks must be either destroyed on the farm or the meat diverted for heat treatment.⁴²

In summary, slaughterhouse inspectors with access to food chain information can make risk-mitigation decisions about animal or carcass handling and slaughter procedures that inspectors relying solely on traditional inspection cannot. Using records of veterinary drug use, disease risks, and animal and farm histories, inspectors are able to target their resources to high-risk herds or flocks, prevent cross-contamination of meat during slaughter, and more effectively protect the food supply and public health.

360-degree information sharing of in-plant data in Australia and Denmark

Some regulators are piloting programs that share information to build a system that provides a 360-degree view of conditions in individual plants. The United States has begun to develop a similar system, called the Public Health Information System, that examines government inspection and laboratory findings.⁴³ Other countries have gone even further.

Australia incorporates commercial data so that both industry and government can use the same information to assess conditions in plants registered to export red meat. Facilities covered by the export program include

slaughterhouses and certain processing (e.g., deboning) establishments.⁴⁴ Every month, slaughterhouses submit to the government their own monitoring and microbial testing results, which are combined with results from samples collected and analyzed by government inspectors. The government agency in charge of meat and poultry uses the combined data to evaluate and compare meat hygiene outcomes in individual plants according to the product hygiene index. Australia employs the index to monitor and compare establishments and support regulatory assessments to ensure that export facilities meet the market access requirements of foreign governments.⁴⁵

The product hygiene index includes key performance indicators that have a direct bearing on product hygiene and/or point to potential product re-contamination. Key performance indicators address specific hazards that relate to contamination and cross-contamination by enteric pathogens.⁴⁶ Some of the indicators are a direct objective measure of the wholesomeness of the meat at multiple stages of the process chain, while other indicators verify the microbial quality of products coming out of the process chain. For example, generic *E. coli* and *Salmonella* monitoring are included within the key performance indicators for all species of livestock exported from Australia.⁴⁷ If key performance indicator values remain above industry norms over time, the government may conclude that corrective or preventive action is required by the company to resolve the problem and issue a "Corrective Action Request." Australia plans to make this system Web-based so that individual establishments can compare their performance against the national baseline.⁴⁸ Currently, data are available to plants in spreadsheets published on the Australian Department of Agriculture's website.

Establishments operating under this program must conduct routine microbiological testing programs and submit these data on a monthly basis to the government. Government inspectors verify the data through independent product examination, observation of company testing procedures, and independent verification of the company's key performance indicators for each facility. Each month, company and government verification data are downloaded and analyzed. Establishments can use the data to assess their relative performance against national benchmarks. Government officials can analyze the trends in the data and give feedback to both establishment management and meat inspection and verification staff.

Key performance indicators serve many functions that benefit government regulators and specific meat sectors as well as individual facilities.⁴⁹ Companies can use the index to assess plant management and new technologies or processes, and identify and manage non-compliance.

In developing its product hygiene index, Australia applies a uniform method across all meat exporters to verify the ability of individual establishments to consistently produce meat products that conform to legal requirements. However, by downloading the data monthly, Australia may be missing the benefits from more rapid information sharing.

Sharing information allows both government and industry to benefit from all available data with minimal delays. Microbial testing, which contributes to the key performance indicator metric, creates a national performance baseline against which companies can compare themselves and helps inform the product hygiene index metric. The product hygiene index forms a ranked index based on plant microbial and verification test results, which can refocus inspection efforts. In addition to examining the products and testing procedures of each plant, inspectors seek to determine if key performance indicators accurately reflect the on-the-ground reality. By ensuring the validity of the key performance indicators and product hygiene index metrics through inspection, Australia provides its industry and government with accurate and current performance data.

Australia's example illustrates the power of timely data collection and sharing between the government and industry to provide more effective food safety oversight. A rapid information exchange that identifies potential contamination problems before the release of products to the market serves the interests of both government and industry. Even so, the system would work most effectively if the information exchange took place more often than monthly so both actors can operate on real-time (and not historic) data.

In Denmark, after slaughter of a flock, government inspectors collect five pooled samples of neck skins from each group to determine *Salmonella* status. Broiler farmers receive post-mortem inspection results electronically so that they can evaluate which practices lead to greater or fewer bacterial condemnation issues.⁵⁰

As part of the implementation of the National Salmonella Control Program, the Danish Veterinary Services created a *Salmonella* database for the results and analysis of all biological testing. The database is updated daily, and the information can be accessed by any registered member, including poultry producers, industry associations, researchers, and stakeholders. It serves as a tool for the Danish Veterinary and Food Administration and Denmark's regional veterinary and food control authorities.⁵¹ The database automatically runs sampling algorithms and sends automated bacterial sample requests to producers as needed. Producers typically collect the samples, but when they are unable or unwilling, the local veterinary authorities go to the producers' facilities to collect them.

The Danish Veterinary Services also run a *Salmonella* control program for swine. The Danish Veterinary and Food Administration assigns every swine herd in Denmark a number that is stored in a central database, and each animal carcass is electronically tagged at slaughter with its herd identification number. Slaughterhouse employees collect meat samples from the carcasses, which are sent to the central Danish Veterinary Laboratory. Samples are then tested for *Salmonella* contamination, and herds are assigned a risk level: Level 1 (low risk), Level 2 (moderate risk), or Level 3 (high risk). If a herd is identified as a Level 2 or 3, the herd owner must participate with government consultants on steps to reduce *Salmonella* levels in the herd. In addition, owners of Level 3 herds must submit to mandatory government on-farm sampling for *Salmonella*, and have their animals slaughtered under special hygienic precautions until *Salmonella* levels are brought under control.⁵²

By receiving regular information on *Salmonella* contamination rates on farms and on meat, slaughterhouses, swine, and poultry producers can employ strategic risk-mitigation practices to keep contamination from the pathogen to a minimum. (See "Denmark: Measuring Progress.")

A rapid information exchange that identifies potential contamination problems before the release of products to the market serves the interests of both government and industry.

Denmark: Measuring Progress

Denmark has been monitoring the decrease in the prevalence of *Salmonella* in broilers, pigs, and humans since the beginning of its comprehensive control program, and the results are shown in the table below. As described in this report, the Danish control program is based on strong on-farm measures, so the reductions in foodborne illnesses should be considered holistically and not attributed solely to changes made to its slaughter and processing inspection programs.

On-Farm <i>Salmonella</i> Infection Rates of Livestock in Denmark					
Danish broiler flocks		Danish swine herds (small)		Danish swine herds (large)	
Rate in 1988	> 65%	Rate in 1993	14.7%	Rate in 1993	22.2%
Rate in 2000	< 5%	Rate in 1998	7.2%	Rate in 1998	10.4%
Rate in 2012	0.8%	Rate in 2012*	5.8%	Rate in 2012*	5.8%

Human Broiler-associated Salmonellosis Cases		Danish Pork Contamination Rate at Retail	
<i>Reduced >95%</i>		<i>Down two-thirds</i>	
Rate in 1988	30.8 cases per 100,000 people	Contamination rate in 1993	3%
Rate in 2001	0.5 cases per 100,000 people	Contamination rate in 1998	3%
Rate in 2012	0 cases	Contamination rate in 2012[†]	1.2%

* All swine herds

† Carcass swabs in slaughter plants

Source: Henrik Wegener et al., "Salmonella Control Programs in Denmark," *Emerging Infectious Diseases* 9 (2003): 774-80; National Food Institute at the Technical University of Denmark, Annual Report on Zoonoses in Denmark, 2012, 2013.

© 2014 The Pew Charitable Trusts and CSPI

Findings and recommendations

Findings

Based upon EFSA's scientific opinion and the survey of five national governments with well-established food safety and public health systems, our analysis found that:

- Meat and poultry inspection at slaughter is essential for ensuring human health and the health and welfare of food animals, but it needs to be modernized to take into account changes in the most relevant public health hazards.
- While several countries are evaluating how traditional meat and poultry inspection can be modernized, few have made significant changes to their practices.
- Robust data collection, analysis, and sharing are fundamental components of international efforts to transform existing inspection practices into a modern, risk-based, and science-based inspection system.
- None of the countries deploys meat inspectors to every meat and poultry slaughter and processing plant every day, as is done in the United States.
- Some countries use private or quasi-governmental inspectors in their meat and poultry inspection systems. Others have completely turned over to industry certain aspects of meat or poultry inspection.

Recommendations

Based upon these findings, Pew and CSPI recommend that:

- As has been done by the European Union and the United Kingdom, the United States should commission comprehensive scientific assessments to evaluate its existing meat inspection approaches and alternatives for modernization.
- While the United States has made efforts to improve data collection related to meat and poultry production and testing, a more significant effort should be undertaken, including analysis of results and real-time data sharing.
- As has been done by the European Union and Australia, the United States should evaluate incorporating food chain information and comprehensive data management and review into its meat and poultry inspection system.

Conclusion

Inspection methods developed in the early 1900s still form the backbone of meat inspection programs. These techniques focus largely on ensuring that food comes only from healthy animals. They are much less effective in protecting consumers from the modern-day hazards that commonly contaminate meat and poultry products. In fact, the European Food Safety Authority has concluded that some antiquated inspection methods may increase the likelihood of spreading pathogens during processing.

Some countries and regions are using a variety of approaches to enhance and target their meat and poultry inspection activities with robust data collection, and others are experimenting with new systems of government oversight. Internationally, a number of important innovations in information management and integrated surveillance have the potential to improve practices at slaughterhouses to minimize the spread of contamination. Food chain information on animals entering processing facilities allows for better risk management at slaughter and processing, and sharing of data between industry and government gives a better overall view of operations in meat plants.

Many of these innovations hold the potential to improve public health. Some have contributed to a decrease in the burden of human foodborne illness. Others that are relatively new still lack data to determine whether they have led to reductions in foodborne illnesses linked to meat and poultry products.

Innovations in inspection systems based upon real-time data and targeted mitigations offer models for the United States to consider when modernizing its own meat and poultry inspection system so that it better protects public health.

Appendix: Questionnaire on National Meat and Poultry Inspection Modernization Practice

The Center for Science in the Public Interest, which represents over 900,000 households in the U.S. and Canada, is analyzing how different countries have updated and changed their meat and poultry inspection protocols. We hope to use the lessons learned from other countries' experiences to help inform changes in the United States. If you could answer the following questions on your country's meat inspection practices for domestic products, and the changes which were made or are being considered, it would be very helpful.

Please describe meat and poultry inspection in your country. Specifically we are interested in:

- For each species (cattle, pigs, chicken and turkey), indicate who conducts inspection (ante and post mortem)? Please describe the specific functions of the following entities, if they are involved in meat or poultry inspection:

	The national government	Local/provincial/state governments	Third party inspectors (are these private or quasi-governmental)	Industry	Other (specify)
Cattle					
Pigs					
Poultry					

- Who pays for meat inspection?
- What specific inspection activities are carried out at the slaughterhouse? At the processing plants?
 - Pre slaughter
 - Check of animal passport and ear tag
 - Testing for pathogens (If "Yes" which pathogens and what species is tested)
 - Testing for disease (If "Yes" what diseases and what species is tested)
 - Ante-mortem inspection of each animal by official veterinarian
 - Ante-mortem inspection by someone other than official veterinarian (Who? _____)
 - Other (Describe) _____
 - Slaughter
 - Post-mortem inspection by official veterinarian
 - Post-mortem inspection by someone other than official veterinarian (Who? _____)
 - Carcass by carcass organoleptic inspection
 - Sampling carcasses for pathogens or disease
 - Premises inspection (Frequency _____)
 - Other (Describe) _____

c. Processing

- Sampling for contamination
- Visual inspection of product
- HACCP records review
- Premises inspection (Frequency _____)
- Other (Describe) _____

4. What is the frequency of inspection for:

	ante mortem	post mortem
Cattle		
Pigs		
Poultry		

5. Are ALL carcasses and birds being slaughtered inspected?

- Yes
- If no, please describe how it is done: _____

6. Do inspectors need be present in a slaughterhouse at ALL times during slaughter?

- Yes
- If no, please describe how it is done: _____

7. Do inspectors need be present at a processing facility at all times during processing?

- Yes
- If no, please describe how it is done: _____

8. Are inspection protocols and/or frequencies risk-based? If so, how is risk assessed for individual facilities and/or products and how are these reassessed?

9. How has responsibility for meat or poultry inspection changed in the last 10-15 years? Is your country considering changes in the near future? If so please describe the changes being contemplated.

10. Are inspection responsibilities different for meat and poultry destined for domestic and export markets?

- If yes, please describe how do they differ: _____

- No

Endnotes

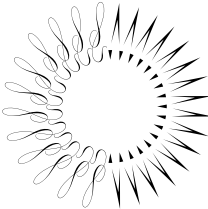
- 1 Elaine Scallan et al., "Foodborne Illness Acquired in the United States—Major Pathogens," *Emerging Infectious Diseases* 17 (2011): 7-15; Elaine Scallan et al., "Foodborne Illness Acquired in the United States—Unspecified Agents," *Emerging Infectious Diseases* 17 (2011): 16-22.
- 2 John A. Painter et al., "Attribution of Foodborne Illnesses, Hospitalizations, and Deaths to Food Commodities by Using Outbreak Data, United States, 1998-2008," *Emerging Infectious Diseases* 19 (2013): 407-15.
- 3 Michael B. Batz et al., "Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation," *Journal of Food Protection* 75 (2012): 1278-91.
- 4 Caroline Smith DeWaal and Marcus Glassman, "Outbreak Alert! 2014: A Review of Foodborne Illness in America from 2002-2011," *Center for Science in the Public Interest*, April 2014, accessed May 27, 2014, <http://cspinet.org/reports/outbreakalert2014.pdf>.
- 5 Food and Agriculture Organization of the United Nations, "Good Practices for the Meat Industry," 2004, accessed May 27, 2014, <ftp://ftp.fao.org/docrep/fao/007/y5454e/y5454e.pdf>.
- 6 Marion Nestle, *Safe Food: Bacteria, Biotechnology, and Bioterrorism* (Berkeley: University of California Press, 2003), 50-51.
- 7 Drago Herenda et al., "Manual on Meat Inspection for Developing Countries," Food and Agriculture Organization of the United Nations, 2000, accessed May 27, 2014, <http://www.fao.org/docrep/003/t0756e/t0756e00.HTM>.
- 8 Codex Alimentarius Commission, "Codex Code of Hygienic Practice for Meat: CAC/RCP 58-2005," World Health Organization/Food and Agriculture Organization of the United Nations, 2005, accessed May 27, 2014, <http://www.codexalimentarius.org/standards/list-of-standards/en/?provide=standards&orderField=fullReference&sort=asc&num1=CAC/RCP>.
- 9 Thimjos Ninos, Janne Lunden et al., *Meat Inspection and Control in the Slaughterhouse* (West Sussex, UK: John Wiley & Sons, 2014), http://books.google.com/books?id=4JOtAwAAQBAJ&pg=PA654&lpg=PA654&dq=World+Health+Organization+slaughterhouse+inspections+protect+health&source=bl&ots=Y_afs5KZRx&sig=hbwoikiMyqKzqafGK25KgW8WO4&hl=en&sa=X&ei=2_fYU9zBNOnLsATB6IK4Bg&ved=0CCgQ6AEwAQ#v=onepage&q&f=false.
- 10 Codex Alimentarius Commission, "Food Import and Export Inspection and Certification Systems, 4th ed.," World Health Organization/Food and Agriculture Organization of the United Nations, 2009, accessed May 27, 2014, ftp://ftp.fao.org/CODEX/PUBLICATIONS/BOOKLETS/INSPECTION/CCFICS_2009_EN.PDF.
- 11 Codex Alimentarius Commission, "Codex Code of Hygienic Practice for Meat: CAC/RCP 58-2005."
- 12 Ibid.
- 13 Ministry for Primary Industries, "Meat Inspection Reform Questions and Answers," Government of New Zealand, 2012, accessed May 27, 2014, <http://www.foodsafety.govt.nz/elibrary/industry/meat-inspection-change-q-a.pdf>.
- 14 Center for Science in the Public Interest, "A Survey of Foreign Governments' Meat Inspection Procedures," unpublished, 2013.
- 15 Food Safety and Inspection Service, "Modernization of Poultry Slaughter Inspection, Final Rule, 9 CFR Parts 381 and 500," U.S. Department of Agriculture, 2014.
- 16 Ministry for Primary Industries, "Meat Inspection Reform Questions and Answers."
- 17 "Ranking the Disease Burden of 14 Pathogens in Food Sources in the United States Using Attribution Data from Outbreak Investigations and Expert Elicitation."
- 18 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards to Be Covered by Inspection of Meat (Bovine Animals)," *EFSA Journal* 11 (2013): 3266.
- 19 "Meat Inspection," European Food Safety Authority, last modified Dec. 3, 2013, accessed May 25, 2014, <http://www.efsa.europa.eu/en/topics/topic/meatinspection.htm>.
- 20 European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to Be Covered by Meat Inspection of Bovine Animals."
- 21 Ibid.
- 22 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards to Be Covered by Inspection of Meat (Swine)," *EFSA Journal* 9 (2011): 2351; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)," *EFSA Journal* 11 (2013): 3266; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Poultry)," *EFSA Journal* 10 (2012): 2741.
- 23 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards to Be Covered by Inspection of Meat (Swine)," *EFSA Journal* 9 (2011): 2351; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."

- 24 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards to Be Covered by Inspection of Meat (Poultry)."
- 25 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 26 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Poultry)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 27 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 28 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine)."
- 29 European Food Safety Authority, "Scientific Opinion on The Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Poultry)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 30 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Poultry)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 31 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Swine)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Poultry)"; European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 32 European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to Be Covered by Meat Inspection of Poultry," *EFSA Journal* 10 (2012): 2764; European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Public Health Hazards to Be Covered by Meat Inspection of Swine," *EFSA Journal* 9 (2011): 2371; European Food Safety Authority, "Technical Specifications on Harmonised Epidemiological Indicators for Biological Hazards to Be Covered by Meat Inspection of Bovine Animals," *EFSA Journal* 11 (2013): 3276.
- 33 Peter Koolmees, "The Development of Veterinary Public Health in Western Europe, 1850-1940," in *Sartoniana*, vol. 12 (Ghent, Belgium: Communication and Cognition, 1999), 153-79, accessed May 27, 2014, http://lib.ugent.be/fulltxt/RUG01/000/170/842/BIB-G-024341-12_2010_0001_AC.pdf#page=155.
- 34 Lis Alban et al., "Assessment of Risk for Humans Associated with Supply Chain Meat Inspection—The Danish Way," Danish Meat Association, Dec. 2008, accessed May 27, 2014, https://www.lf.dk/Aktuelt/Publikationer/-/media/lf/Aktuelt/Publikationer/Svinekod/Modernisation%20of%20Meat%20Inspection_DK.ashx.
- 35 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 36 Regulation (EC) No 853/2004, "Laying Down Specific Hygiene Rules for the Hygiene of Foodstuffs," Apr. 2004, L 139/55, <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF>; Food Standards Agency, "Review of official meat controls," <http://www.food.gov.uk/enforcement/monitoring/meat/reviewofmeatcontrols>, accessed October 7, 2014.
- 37 Food Standards Agency, "Guidance on Food Chain Information for Keepers of Cattle, Sheep and Goats," Government of the United Kingdom, 2010, accessed May 27, 2014, <http://www.food.gov.uk/multimedia/pdfs/publication/fcifactsheet0110.pdf>.
- 38 John Wyld, "Australia's System for Identifying and Tracking Cattle," *Proceeding of the First OIE Global Conference on Animal Identification and Traceability*, "From Farm to Fork," Buenos Aires, Argentina, March 2009.
- 39 European Food Safety Authority, "Scientific Opinion on the Public Health Hazards Covered by Inspection of Meat (Bovine Animals)."
- 40 Ibid.
- 41 Ulrich Löhren, "External Scientific Report: Overview on Current Practices of Poultry Slaughtering and Poultry Meat Inspection," European Food Safety Authority, 2012, accessed May 27, 2014, <http://www.efsa.europa.eu/en/supporting/doc/298e.pdf>.
- 42 Lis Alban et al., "Assessment of Risk for Humans Associated with Supply Chain Meat Inspection—The Danish Way."
- 43 Food Safety and Inspection Service, "FSIS PHIS Directive: Verifying an Establishment's Food Safety System," U.S. Department of Agriculture, April 11, 2011, accessed May 27, 2014, http://www.fsis.usda.gov/OPPDE/rdad/FSISDirectives/PHIS_5000.1.pdf.
- 44 Meat Standards Committee, "Microbiological Testing for Process Monitoring in the Meat Industry: Guidelines," Department of Agriculture, Fisheries and Forestry, Government of Australia, Oct. 30, 2002, accessed May 27, 2014, http://www.primesafe.vic.gov.au/uploads/Victorian%20Standards/Microbiological%20Guidelines_Meat.pdf.
- 45 Ibid.

- 46 Ibid.
- 47 Meat and Livestock Australia Limited, "Australian Beef: Safe, Healthy and Delicious," March 2014, accessed May 27, 2014, safemeat.com.au/_literature_65274/Australian_Beef_Brochure.
- 48 "Australian Export Meat Inspection System (AEMIS) Information Package," Department of Agriculture, Australian Government, last modified June 25, 2014, accessed May 27, 2014, <http://www.daff.gov.au/biosecurity/export/meat/elmer-3/meat-inspection-aemis-package>; Greg Read, e-mail message, Aug. 20, 2014.
- 49 Meat and Livestock Australia Limited, "Australian Beef: Safe, Healthy and Delicious."
- 50 Lis Alban et al., "Scientific Report Submitted to EFSA: Overview on Current Practices of Meat Inspection in the EU," Danish Agriculture and Food Council, 2011, accessed May 27, 2014, <http://www.efsa.europa.eu/en/supporting/doc/190e.pdf>.
- 51 Danish Veterinary and Food Administration, "The National Salmonella Control Program for the Production of Table Eggs and Broilers, 1996-2002," Government of Denmark, March 2004, accessed May 27, 2014, <http://www.foedevarestyrelsen.dk/Publikationer/Alle%20publikationer/2004006.pdf>.
- 52 Henrik Wegener et al., "Salmonella Control Programs in Denmark," *Emerging Infectious Diseases*, 9 (2003): 774-80.



cspinet.org



pewtrusts.org
