eISSN: 3108-6624 Review

GREEN FOODS
2025; 1(1): 7-10
Doi: 10.5281/zenodo.18110027
https://greenfoodsjournal.com

Veterinarian's Duties After Postmortem Meat Inspection with Current Technology

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Recevied: 03.12.2025 Accepted: 30.12.2025 Published: 31.12.2025

Abstract

Postmortem meat inspection is a fundamental component of modern food safety, animal health surveillance, and veterinary public health practices. Post-slaughter findings guide veterinarians in multifaceted tasks such as controlling zoonoses, detecting animal welfare violations, and conducting forensic procedures. Traditional palpation- and incision-based inspections have increasingly evolved into visual inspection and risk-based systems (RB-MSAS). This approach integrates elements such as Farm Chain Information (FCI), regional disease status, and slaughterhouse hygiene data, allowing inspection procedures to be tailored to the level of risk. The veterinarian's role has evolved from that of an inspector who merely detects lesions to a risk manager who evaluates the entire food chain. Decision-making processes are influenced by cognitive, systemic, and economic factors, and therefore, decision support systems are used to increase objectivity. Technological advances are significantly changing the nature of postmortem examinations. Artificial intelligence systems enable the automatic detection and scoring of lesions, while remote postmortem examination techniques reduce geographic constraints and ensure service continuity. Furthermore, digital pathology and big data analysis contribute to surveillance efforts. Furthermore, veterinarians are responsible for maintaining the chain of evidence in forensic medicine processes and are obligated to provide objective reporting. This review comprehensively evaluates the veterinarian's multifaceted duties after the postmortem examination, the impact of technological advances on professional practice, and future requirements.

Keywords: *Postmortem, veterinary, inspection, technology*

1. INTRODUCTION

Meat inspection is a cornerstone of modern food safety systems and animal health surveillance. This process not only protects consumers from potential hazards but also plays a critical role in animal welfare and the control of zoonotic diseases. Postmortem inspection involves the detailed examination of carcasses and organs after slaughter, and the findings from this examination trigger the veterinarian's multifaceted duties, including carcass fate, animal health surveillance, and forensic medicine. The veterinarian is at the center of this complex process, combining scientific knowledge with legal and ethical responsibilities. Its primary mission is to control zoonoses that threaten human health, particularly those potentially transmitted through meat.[1] In this context, meat inspection is an important tool in the detection of endemic diseases that concern both animal health and public health, such as bovine tuberculosis, cysticercosis, and fascioliasis.[2]

The primary objective of this review is to comprehensively examine the duties of the veterinarian following postmortem meat inspection, in light of current scientific literature. These duties encompass a wide range of tasks, from the final decision-making authority regarding the suitability of the carcass for consumption, to the obligation of detailed reporting contributing to animal health surveillance, and even to forensic responsibilities for uncovering animal welfare violations. This review will address the veterinarian's central role in this process and the technological and methodological advancements needed to enhance the effectiveness of this role.

1.1. Fundamentals and Evolution of Postmortem Meat Inspection

Meat inspection is a legal requirement implemented in slaughterhouses and consists of two main stages: ante-mortem inspection and post-mortem inspection. Legal frameworks stipulate in detail how these inspections are conducted and which findings warrant which decisions. Postmortem inspection is performed by visual inspection, palpation, and, when necessary, incision of the carcass and related organs (Figure 1). Traditionally, these techniques, combined with the veterinarian's experience and knowledge, aim to detect signs of disease, pathological anatomical changes, and zoonotic indicators. However, since the late 20th century, a shift from traditional inspection methods to visual inspection-based procedures has begun, particularly in species such as pigs and cattle.[3]

The primary reasons for this shift include the decline in the prevalence of classical zoonoses (e.g., tuberculosis)

How to cite this article: Alan S. Veterinarian's Duties After Postmortem Meat Inspection With Current Technology. *GREEN FOODS*, 2025; 1(1): 7–10. Doi: 10.5281/zenodo.18110027

thanks to modern animal husbandry practices and the desire to reduce the risk of cross-contamination during the inspection process. However, the transition to visual inspection-based procedures has been shown to significantly reduce the probability of detecting certain diseases, particularly bovine tuberculosis and cysticercosis.[2]

This highlights the need for veterinarians to continually calibrate their inspection techniques and decision-making processes. Inspection findings directly impact not only consumption safety but also animal health surveillance. For example, lesions in the lungs (pleuritis, pneumonia) or parasitic infections in the liver (fascioliasis) indicate animal health problems at the farm level.[4] Accurately recording these findings forms the basis for subsequent decisions and reporting by the veterinarian.

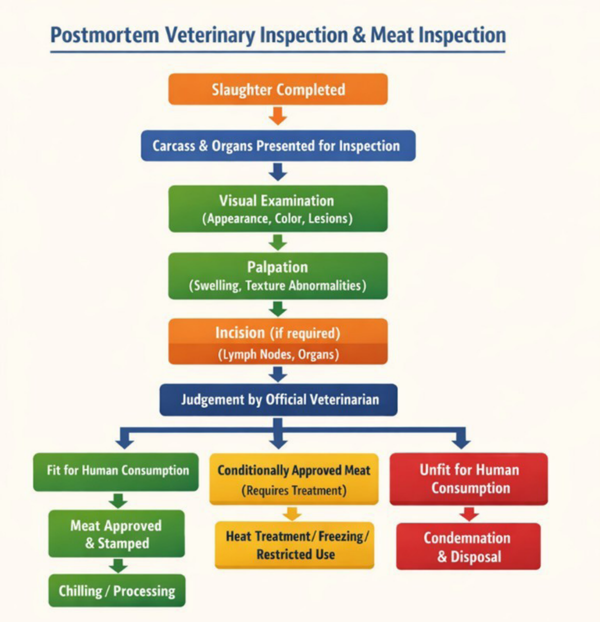

Figure 1. Postmortem veterinary inspection and meat inspection

1.2. Risk-Based Meat Safety Assurance Systems (RB-MSAS) and the Veterinarian's Decision-Making Duties

While traditional meat inspection systems apply the same level of scrutiny to every carcass, modern approaches embrace Risk-Based Meat Safety Assurance Systems (RB-MSAS). These systems aim to use resources more efficiently by focusing on hazards that pose the greatest risk to public health.[5] The Veterinarian's Role Change: From Inspector to Risk Manager With the implementation of RB-MSAS, the veterinarian's role has evolved from that of an inspector who merely detects pathological lesions to a risk manager encompassing the entire food chain.[6] In this new role, the veterinarian's primary duties include:

1. Risk Assessment: Determine the risk level for each animal or batch by analyzing a wide range of information, including Farm Chain Information (FCI) from the animal's farm, the animal's health history, regional disease prevalence, and slaughterhouse hygiene data.

2. Determine the Inspection Protocol: Determine the intensity and type of postmortem inspection procedure to be performed based on the determined risk level (e.g., visual inspection only or a detailed inspection including incision and palpation).

3. Decision Making and Calibration: Combine inspection findings with risk assessment results to make the final decision on the carcass's fate. These decisions may include suitability for consumption, conditional suitability for consumption, or destruction (condemnation).

1.3. Factors Influencing Decision-Making Processes and Decision Support Systems

The veterinarian's decision-making process depends not only on scientific data but also on a number of complex factors. These factors can be examined under two main headings (Table 1).

Decision Support Systems (DSS) are being developed to address these inconsistencies and increase objectivity. DSSs integrate FCI and inspection data, providing the veterinarian with risk scoring and standardized protocols.[12] The veterinarian's role is to interpret the output of these systems and make the final decision based on scientific and ethical responsibility.

1.4. Veterinarian's Surveillance and Technological Oversight Duties

The veterinarian's duties after postmortem inspection include actively contributing to national and international animal health surveillance systems. Slaughterhouses are a valuable source of data reflecting the health status of the animal population, and the veterinarian is the key person collecting and analyzing this data.

1.5. Automation, Artificial Intelligence (AI), and the Role of the Veterinarian

The development of technology is radically changing postmortem inspection processes. Automation and Artificial Intelligence (AI) are taking over routine and repetitive tasks, allowing the veterinarian to focus on more complex tasks (Table 2).

These technological advances are shifting the veterinarian's role to specialized tasks. The veterinarian is no longer just an inspector; he or she also:

1. Validation of Technological Systems: Continuously monitoring and calibrating the reliability, sensitivity, and specificity of AI and automation systems.

2. Critical Decision Maker: Making the final decision and managing human health risks in situations that automation cannot detect or leaves unclear.

3. Data Analyst: Contributing to surveillance and risk assessment systems by analyzing large data sets (Big Data).

1.6. Contribution of Meat Inspection Data to Animal Health and Welfare Surveillance

Meat inspection findings are an indispensable resource for animal health and welfare surveillance. Slaughterhouse data can be used for the early detection of infections and welfare issues that are clinically undetectable or overlooked at the farm level.[17] Effective use of this data increases the success of disease control programs

Table 1. Factors affecting veterinary decision making process

Factor type	Description	References
Cognitive Factors	The veterinarian's personal experience, training, fatigue level, and subjective assessment tendencies. These factors can lead to inconsistency in inter-veterinary decision-making among different veterinarians..	7, 8, 9
Systemic Factors	Slaughterhouse line speed, time allocated for examination, staff shortages, and regulatory complexity. In high-speed slaughterhouses, insufficient time for detailed examination can reduce decision quality.	10, 11
Economic Factors	he economic cost of carcass disposal and industry pressures. The veterinarian must manage the delicate balance between public health and economic loss.	6

Table 2. Technological innovations transforming veterinary postmortem inspection

Technology	Application Area	Impact on the Veterinarian's Role	References
Artificial Intelligence (AI)	Automatic detection and scoring of lesions on carcasses and organs (e.g., pleurisy lesions in pigs).	Automating routine lesion detection frees up veterinarians' time for more complex and rare pathologies.	13
Remote Postmortem Examination (Remote PMI)	Field technicians transmit images via action cameras to a remote veterinarian. uzaktaki bir veteriner hekime iletmesi.	Eliminating geographical limitations on surveillance authority, ensuring continuity of service, especially in areas with staff shortages.	14, 15
Digital Pathology	Remote examination and consultation of digital images of tissue samples.	Providing fast and easy consultation for specialized diagnoses.	16

and provides feedback on the source of animal welfare violations.[18]

1.7. Veterinary Forensic Medicine and Ethical Responsibilities

Postmortem examination plays a critical role not only in food safety and animal health surveillance but also in veterinary forensic medicine. Veterinarians carry unique expertise and ethical responsibilities in this field.

1.8. Forensic Necropsy and Chain of Evidence Management

In forensic cases (e.g., animal abuse, suspicious deaths), the necropsy (autopsy) performed by the veterinarian provides essential evidence for legal proceedings. Forensic necropsy, unlike routine necropsy, places a special emphasis on the collection, documentation, and preservation of evidence.[19] One of the veterinarian's most critical duties in this process is to ensure the management of the Chain of Custody (CHC). The COC is a chronological documentation process that demonstrates that the integrity and identity of evidence remain intact from the moment it is collected until it is presented in court.[20] Veterinarians are obligated to adhere to the following principles when collecting and preserving evidence:

•Impartiality and Independence: The veterinarian's duty is to conduct an impartial, objective, and independent investigation, rather than serving a specific individual, organization, or client.[20]

•Evidence Collection and Preservation: All evidence obtained during the examination (tissue samples, photographs, lesions) must be meticulously collected, labeled, and appropriately preserved for future analysis.

•Reporting: Findings and decisions must be prepared in written summary reports for submission to legal authorities. These reports can be used as evidence in court.

1.9. Animal Welfare and Ethical Responsibilities

Postmortem examination provides objective evidence of animal welfare violations (malnutrition, trauma, neglect). The veterinarian interprets these findings and reports the animal's cause of death and welfare in legal terms.

The veterinarian's ethical responsibilities require maintaining a delicate balance between public health, animal welfare, and professional integrity. Minimizing the risk of zoonosis is the veterinarian's highest ethical priority. It is also their ethical responsibility to use examination findings to provide feedback on the source of animal welfare issues (farm, transport).

2. CONCLUSIONS

Postmortem meat inspection is a critical process in which the veterinarian fulfills their multifaceted duties in the fields of food safety, animal health, and forensic medicine. The veterinarian undertakes vital tasks such as deciding the fate of the carcass based on inspection findings, providing data for animal health surveillance, and providing impartial evidence in forensic cases.

Key Findings:

•The veterinarian's role is evolving from the traditional inspector to the Risk Manager.

•RB-MSAS systems necessitate the integration of FCI and surveillance data.

•Technological advancements such as AI and Remote PMI support the oversight role while requiring the veterinarian to maintain calibration and on-site intervention competence.

•Chain of Evidence (COC) management in forensic cases is one of the veterinarian's most important legal and ethical responsibilities.

Recommendations:

1. Continuous Calibration and Training: Regular training should be made mandatory to eliminate decision-making inconsistencies among veterinarians and to increase the risk assessment competence required by RB-MSAS.

2. Technological Integration: Technologies such as remote inspection systems and AI-assisted image analysis should be integrated into standard protocols to increase inspection efficiency and objectivity.

3. Data Sharing and Integration: More effective integration of meat inspection data with farm information systems (FCI) and national surveillance systems will increase the success of disease control programs.

The role of veterinarians in this area will become even more important in the future in the control of zoonoses and the implementation of the "One Health" approach.

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