

A Systems-Based Framework Integrating Clinical Risk Governance, Safety Culture, and Palliative Oncology for the Comprehensive Management of Canine Mammary Tumors

SRI RUSMINI^{1,2*}, ESTI YUNITASARI³, HANIK ENDANG NIHAYATI⁴, SUPRIYADI⁵

¹Doctoral Program Student from The Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia; ²Universitas Telogorejo Semarang, Semarang, Indonesia; ³Department of Child Maternity Nursing, Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia; ⁴Department of Advanced Nursing, Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia; ⁵Division of Veterinary Reproduction, Faculty of Veterinary Medicine, Universitas Airlangga, Surabaya, Indonesia.

Abstract | Canine mammary tumors (CMTs) are among the most common malignancies in female dogs and remain a major clinical challenge due to persistent variability in diagnostic interpretation, staging accuracy, and therapeutic decision-making. Biologically, CMTs share important similarities with human breast cancer, including hormonal risk factors, tumor progression patterns, and metastatic behavior, making them a valuable comparative model for understanding breast oncology across species. This systematic review synthesizes literature published between 2012 and January 2025, integrating 46 international studies with interdisciplinary insights, including those from UNAIR-affiliated research, to examine how clinical risk governance, safety culture, and palliative oncology collectively influence outcomes in CMT management. The findings indicate that delayed diagnosis, inconsistent staging, and heterogeneous surgical choices are more consistently associated with systemic and organizational barriers than with isolated clinician error. Evidence from veterinary medicine, nursing, public health, and occupational safety demonstrates that a strong safety culture characterized by transparent communication, supportive leadership, structured incident reporting, and non-punitive learning can strengthen clinical risk governance and reduce preventable harm. Alongside these system-level factors, palliative care is frequently implemented late despite its demonstrated benefits in pain control, wound care, caregiver support, and quality-of-life improvement. Caregiver burden emerges as an important but underrecognized influence on clinical decision-making and adherence to recommended care. Despite advances across these domains, no existing model explicitly integrates clinical risk governance, safety culture, and palliative principles to guide the comprehensive management of canine mammary tumors. This review proposes a theory-informed, systems-based framework to support more consistent decision-making, enhance patient safety, and promote compassionate, patient-centered outcomes for dogs with mammary tumors and their caregivers.

Keywords | Canine mammary tumors, Clinical risk governance, Safety culture, Palliative care, Veterinary oncology

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***Correspondence** | Sri Rusmini, Doctoral Program Student from The Faculty of Nursing, Universitas Airlangga, Surabaya, Indonesia; Email: sri.rusmini-2023@fkip.unair.ac.id

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INTRODUCTION

Canine mammary tumors (CMTs) remain one of the most prevalent and clinically significant neoplasms

in female dogs worldwide. Recent epidemiological evaluations indicate that mammary tumors account for up to 40–50% of all tumors in intact bitches, with malignancy rates frequently exceeding 45% in clinical populations

(Benavente *et al.*, 2022; Ramos *et al.*, 2023). Current data confirm that CMTs predominantly affect middle-aged to senior dogs and exhibit strong associations with reproductive status, with intact females demonstrating substantially higher lifetime risk than those spayed early in life (Genevois *et al.*, 2021; Kristiansen *et al.*, 2023). Despite advances in diagnostic imaging, histopathologic classification, and therapeutic approaches, late-stage presentation remains common, complicating treatment planning and reducing the likelihood of curative outcomes (Rasotto *et al.*, 2017; Campos *et al.*, 2020).

Modern studies highlight the multifactorial influences governing CMT management in general practice, including comorbidities, owner expectations, financial constraints, and variable clinic-level resources (Uva *et al.*, 2022; Vascellari *et al.*, 2020). These real-world complexities shift the clinical focus from purely technical decisions toward broader considerations involving clinical risk stratification, structured communication, and quality-of-life-centered care. Updated evidence also emphasizes that although ovariectomy or ovariohysterectomy before the second estrus decreases risk, recent systematic reviews caution that the magnitude of this protective effect may be less definitive than historically presumed (Beauvais *et al.*, 2012; Genevois *et al.*, 2021). These findings underscore the need for nuanced, evidence-informed preventive counseling in modern veterinary oncology.

Alongside clinical advances, recognition has grown for patient safety and clinical risk governance as critical components of high-quality veterinary care. Recent veterinary safety research identifies common vulnerabilities in oncology cases, including diagnostic delays, communication breakdowns, chemotherapy handling risks, and inconsistency in perioperative protocols (Oxtoby *et al.*, 2015, 2020; Ljungvall *et al.*, 2023). Veterinary professional organizations now emphasize safety culture, structured handovers, significant event audits, and system-focused error analysis as essential strategies to reduce preventable harm and support clinical decision-making (RCVS, 2018; Oxtoby and Mossop, 2021). However, these safety frameworks have rarely been applied in a comprehensive, disease-specific manner to CMT management, despite the high-risk nature of oncologic casework.

Terminology clarification. In this review, clinical risk governance refers to the overarching organizational structures, accountability mechanisms, and processes through which clinical risks are anticipated, identified, mitigated, monitored, and learned from within veterinary practice. Risk management is used exclusively to denote operational activities within this governance system (e.g., checklists, standardized protocols, audits, and incident reporting). For clarity and consistency, clinical

risk governance is adopted as the primary term throughout this manuscript.

At the same time, veterinary palliative care has evolved rapidly over the past decade. Contemporary literature supports integrating palliative principles early in the disease trajectory, particularly for cancers with high metastatic potential or limited curative options (Cooney *et al.*, 2015; Goldberg *et al.*, 2021; Lavelle *et al.*, 2022). Modern palliative oncology emphasizes structured pain assessment, owner-centered communication, caregiver burden management, and ethical decision-making regarding treatment limits and euthanasia (Spitznagel, 2019; Fawcett *et al.*, 2020). Despite broad acceptance of these principles, their incorporation into everyday oncology practice, including CMT cases, remains inconsistent across clinical settings.

Notably, while clinical risk governance, safety culture, and palliative care each represent expanding areas of veterinary research, no existing framework explicitly integrates these three domains into a unified model for canine mammary tumor management. Existing literature typically addresses these topics independently, without examining how system-level risk oversight, organizational safety practices, and early palliative pathways intersect within the clinical realities of canine mammary oncology. Given that CMT cases frequently involve complex medical risk, emotionally charged decision-making, repeated anesthetic procedures, and a frequent need for palliative intervention, this gap represents a significant deficiency in contemporary veterinary oncology. A modern, systems-based integrative model could enhance clinical consistency, reduce preventable harm, strengthen communication, and improve outcomes for both patients and caregivers.

Importantly, the proposed integration of clinical risk governance, safety culture, and palliative oncology is primarily theory-driven, informed by their demonstrated synergistic roles in managing complexity, uncertainty, and harm in healthcare systems, rather than by direct empirical trials within CMT-specific care. These domains were prioritized because together they address upstream risk anticipation, organizational behaviors influencing safety, and downstream mitigation of suffering when curative intent is uncertain dimensions repeatedly identified as critical yet fragmented in the reviewed literature.

In light of these gaps and emerging challenges in contemporary veterinary oncology, the present review seeks to provide a comprehensive and integrative understanding of canine mammary tumor management through the combined perspectives of clinical risk governance, organizational safety culture, and veterinary palliative care. Specifically, this manuscript aims to synthesize the most recent evidence on the epidemiology, clinical presentation,

and therapeutic approaches to canine mammary tumors, while critically examining current frameworks and developments in clinical risk governance and patient safety science. Furthermore, it endeavors to integrate these insights with modern principles of veterinary palliative oncology to propose an evidence-informed, systems-based model capable of supporting more consistent decision-making, reducing preventable harm, and promoting high-quality, patient-centered care in dogs with mammary neoplasia.

MATERIALS AND METHODS

REVIEW DESIGN

This study was designed as a systematic review and conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Page *et al.*, 2021) guidelines. The review protocol was developed in advance and defined the research objectives, eligibility criteria, search strategy, study selection procedures, and approach to data extraction and synthesis. The overarching aim was to identify, appraise, and synthesize contemporary literature addressing clinical risk governance, safety culture, and palliative care in relation to the veterinary management of canine mammary tumors.

ELIGIBILITY CRITERIA

Eligibility criteria were established using the Population–Concept–Context (PCC) framework, incorporating elements of PICO-S logic to refine search sensitivity and relevance. The population of interest included dogs with mammary tumors and veterinary healthcare professionals or clinical settings involved in their management. The core concepts were clinical risk governance, patient safety culture, and palliative or end-of-life care within veterinary oncology. The context was clinical veterinary practice rather than experimental or laboratory-only research.

Studies were eligible if they were peer-reviewed journal articles, guidelines, conceptual or qualitative papers, observational studies, or reviews published in English between January 2012 and January 2025. To be included, a paper needed to address at least one of the three main domains (clinical risk governance, safety culture, or palliative care) and be relevant to oncology or, preferably, canine mammary tumors specifically. Exclusion criteria comprised non-peer-reviewed sources, conference abstracts without full text, theses, publications before 2012, and purely molecular or genetic studies without clear clinical implications.

INFORMATION SOURCES

A comprehensive literature search was undertaken in several electronic databases considered highly relevant to

veterinary and medical sciences. The primary databases were PubMed/MEDLINE, Scopus, Web of Science, ScienceDirect, and CABI VetMed Resource. To minimize the risk of missing key publications, an additional search was conducted using Google Scholar, primarily to support citation tracking, identification of influential papers, and retrieval of relevant grey or cross-disciplinary literature not consistently indexed in traditional databases. Reference lists of all included articles were screened manually to identify further relevant studies through backward and forward citation searching. The final database search was completed in January 2025.

SEARCH STRATEGY

The search strategy combined free-text keywords and controlled vocabulary (where applicable) related to canine mammary tumors, clinical risk governance and operational risk management, safety culture, and palliative care. Boolean operators (AND, OR) were used to link terms and refine the search. An example of the search strategy used for PubMed was: (“canine mammary tumor” OR “canine mammary neoplasia” OR “dog mammary cancer”) AND (“risk management” OR “clinical risk” OR “patient safety” OR “safety culture”) AND (“palliative care” OR “hospice” OR “end-of-life care”) AND (“veterinary oncology” OR “veterinary practice”) AND (2012:2025).

The term “risk management” was included in the search strategy to maximize retrieval of relevant literature; however, during synthesis, findings were conceptually organized under the broader construct of clinical risk governance, reflecting system-level oversight, accountability, and learning rather than isolated procedural activities alone.

The search string was adapted as necessary for each database to account for differences in indexing and search syntax, while maintaining conceptual consistency across platforms.

STUDY SELECTION

All retrieved records were exported into a reference management program, where duplicate entries were identified and removed. Study selection proceeded in two phases. In the first phase, two reviewers independently screened titles and abstracts against the eligibility criteria to identify potentially relevant studies. In the second phase, full texts of selected articles were obtained and evaluated independently by the same reviewers.

Any disagreements at either stage were resolved through discussion and consensus; if consensus could not be reached, a third reviewer was consulted. The overall selection process, including numbers of records identified, screened, excluded, and included, was documented using

a PRISMA flow diagram in line with (Page *et al.*, 2021) recommendations.

DATA EXTRACTION

A standardized data extraction form was developed to ensure consistency and transparency. For each included study, the following information was extracted where available: authors and year of publication, country and setting, study design, characteristics of the animal or professional population, primary domain(s) informed (clinical risk governance, safety culture, palliative care, or combinations thereof), key outcomes or themes, and the study's implications for clinical practice in canine mammary tumor management.

Operational findings (e.g., inconsistent staging, variable surgical protocols) were recorded separately from governance-level constructs, allowing differentiation between procedural gaps and system-level oversight or accountability failures.

Data extraction was performed independently by two reviewers. Extracted data were then compared, and discrepancies were resolved through discussion. When essential information was unclear or missing, it was noted as a limitation of the respective study.

RISK OF BIAS AND QUALITY ASSESSMENT

Because the review included a diverse range of study types quantitative, qualitative, observational, and conceptual different critical appraisal tools were applied according to study design. The Joanna Briggs Institute (JBI) critical appraisal instruments were used for observational and descriptive studies, while the Critical Appraisal Skills Programme (CASP) checklists were applied to qualitative and conceptual papers. Systematic reviews included in the synthesis were appraised using the AMSTAR 2 tool.

Each study was evaluated for methodological rigor, clarity of reporting, and overall risk of bias. Based on these assessments, studies were categorized as having low, moderate, or high risk of bias. Studies judged to have serious methodological flaws that could compromise the validity of their findings were excluded from the final synthesis.

DATA SYNTHESIS

Given the heterogeneity of study designs, populations, and outcome measures, a meta-analysis was not feasible. Instead, a narrative synthesis approach was employed. Findings were organized around three major domains: (1) clinical risk governance, including relevant operational risk management activities, in the context of canine mammary tumors and oncology practice; (2) veterinary safety culture,

including incident reporting, communication practices, and organizational learning; and (3) palliative and end-of-life care in veterinary oncology, with emphasis on canine cancer and, where available, canine mammary tumors.

Evidence from adjacent fields (e.g., general veterinary safety research or human healthcare literature) was included only when findings addressed transferable system-level processes such as communication failures, safety culture, or caregiver burden rather than disease-specific biological mechanisms. Within and across these domains, thematic analysis was used to identify recurring patterns, points of convergence, and gaps in the literature. These themes were then integrated to inform the development of a systems-based conceptual framework illustrating how clinical risk governance, safety culture, and palliative care can be jointly operationalized in the clinical management of canine mammary tumors.

PROTOCOL AND REGISTRATION

A review protocol was developed prior to data collection to define the research objectives, eligibility criteria, and analysis procedures. The protocol was not registered in PROSPERO or any international systematic review registry because veterinary-focused systematic reviews are not currently eligible for registration under PROSPERO guidelines.

RESULTS

IDENTIFICATION OF STUDIES

The comprehensive search across multiple databases resulted in a total of 498 records. PubMed/MEDLINE contributed 112 articles, Scopus yielded 134, and Web of Science provided 98 records. Science Direct added 63 articles, while the CABI VetMed Resource generated 41 publications related to veterinary oncology, clinical risk governance, and palliative practice. From Google Scholar, more than 300 entries were screened, and 50 relevant, non-duplicate records primarily identified through citation tracking and cross-disciplinary literature were included for further consideration. These combined results formed the initial dataset for the review.

SCREENING AND SELECTION PROCESS

All 498 records were imported into a reference management system, where 182 duplicates were identified and removed. A total of 316 unique records remained for title and abstract screening. Of these, 204 articles were excluded because they were not relevant to canine mammary tumors, did not address clinical risk governance, safety culture, or palliative care, or were limited to molecular or experimental studies without clinical relevance.

Table 1: Summary of the 46 included studies in the review.

No	Authors and year	Title / Focus	Journal	Domain	Core pillars informed
1	Benavente <i>et al.</i> , 2022	Epidemiology of canine mammary tumors	J. Vet. Sci.	CMT Epidemiology	CRG
2	Ramos <i>et al.</i> , 2023	Malignancy patterns in canine mammary cancer	Animals	CMT Pathology and Prognosis	CRG
3	Campos <i>et al.</i> , 2020	Clinical management updates of CMT	Vet Comp Oncol	CMT Clinical Management	CRG
4	Rasotto <i>et al.</i> , 2017	Prognostic pathology of CMT	Vet Pathol	CMT Pathology	CRG
5	Vascellari <i>et al.</i> , 2020	CMT characteristics in general practice	BMC Vet Res	Practice Patterns	CRG
6	Kristiansen <i>et al.</i> , 2023	Reproductive risk factors for CMT	JVIM	Risk Factors	CRG
7	Genevois <i>et al.</i> , 2021	Effect of early spaying	Prev Vet Med	Prevention	CRG
8	Santos <i>et al.</i> , 2020	Staging trends in CMT	Braz J Vet Res	CMT Staging	CRG
9	Ferreira-Silva <i>et al.</i> , 2019	Prognostic indicators	Vet Pathol	Prognosis	CRG
10	Ferreira <i>et al.</i> , 2021	Metastasis patterns	Animals	Metastasis	CRG
11	Queiroga <i>et al.</i> , 2023	Advances in canine breast neoplasia	Vet Sci	Translational Oncology	CRG
12	Dey <i>et al.</i> , 2020	Trends in canine cancer care	Animals	Oncology Trends	CRG
13	Horta <i>et al.</i> , 2020	Surgery outcomes	Animals	CMT Surgery	CRG, SC
14	Junior <i>et al.</i> , 2022	Surgical complication risks	Braz J Vet Med	Surgical Risk	CRG, SC
15	Bevilacqua <i>et al.</i> , 2021	Anesthetic risks	Vet Anaesth Analg	Anesthetic Risk	CRG, SC
16	Drobatz <i>et al.</i> , 2017	Emergency oncology risks	J Vet Emerg Crit Care	Emergency Risk	CRG, SC
17	O'Neill <i>et al.</i> , 2020	Common clinical risks	Vet Record	Risk Governance	CRG
18	Witte <i>et al.</i> , 2022	Diagnostic errors	JVIM	Diagnostic Risk	CRG, SC
19	Bousquet <i>et al.</i> , 2023	Risk governance in practice	Vet Sci	Risk Governance	CRG
20	Morello <i>et al.</i> , 2022	Risk communication	Vet Sci	Risk Communication	CRG, SC
21	Marchetti <i>et al.</i> , 2017	Ethical risk issues	J Vet Med Ethics	Ethical Risk	CRG, PC
22	Oxtoby <i>et al.</i> , 2015	Veterinary error patterns	Vet Record	Patient Safety	SC
23	Oxtoby <i>et al.</i> , 2020	Safety culture and reporting	Vet Record	Safety Culture	SC
24	Oxtoby and Mossop, 2021	Safety in vet education	J Vet Med Educ	Safety Culture	SC
25	Ljungvall <i>et al.</i> , 2023	Patient safety incidents	Front Vet Sci	Patient Safety	SC
26	Corrêa <i>et al.</i> , 2023	Clinical safety audits	Vet Sci	Safety Audits	SC
27	McMillan <i>et al.</i> , 2023	Anesthesia checklist	Animals	Safety Tools	SC
28	Polton and Brearley, 2022	Cytotoxic drug handling	JSAP	Occupational Safety	SC
29	Traversa <i>et al.</i> , 2020	Antineoplastic drug safety	Vet Comp Oncol	Chemotherapy Safety	SC
30	Ismail <i>et al.</i> , 2024	Safety culture systems	IJOSH	Comparative Safety	SC
31	Syaiful and Dwiyantri, 2022	Leadership and safety climate	IJOSH	Safety Leadership	SC
32	Kartikasari <i>et al.</i> , 2025	ADR reporting and culture	IJ Risk Saf Med	Medication Safety	SC
33	Uva <i>et al.</i> , 2022	Owner decision-making	Front Vet Sci	Shared Decision-Making	CRG, PC
34	Lima <i>et al.</i> , 2018	Owner satisfaction	Animals	Veterinary Communication	CRG, SC
35	Stabile <i>et al.</i> , 2021	Oncology decision-making	BMC Vet Res	Clinical Decisions	CRG
36	Goldberg <i>et al.</i> , 2021	Veterinary palliative care	Front Vet Sci	Palliative Oncology	PC

Table continues on next pages.....

No	Authors and year	Title / Focus	Journal	Domain	Core pillars informed
37	Cooney <i>et al.</i> , 2015	Palliative guidelines	JAVMA	Palliative Guidelines	PC
38	Lavelle <i>et al.</i> , 2022	Early palliative integration	Animals	Early Palliation	PC
39	Spitznagel, 2019	Caregiver burden	Vet Comp Oncol	Caregiver Burden	PC
40	Silva <i>et al.</i> , 2019	Quality of life	JSAP	Quality of Life	PC
41	Fawcett <i>et al.</i> , 2020	Ethics in palliation	Animals	Palliative Ethics	PC
42	Bishop <i>et al.</i> , 2018	Hospice and palliation	Vet Clin Small Anim	Veterinary Hospice	PC
43	Mendes <i>et al.</i> , 2022	Palliative nursing	J Vet Nurs	Palliative Nursing	PC
44	Mohamad <i>et al.</i> , 2024	Caregiver outcomes	Jurnal Ners	Caregiver Outcomes	PC
45	Nenobais <i>et al.</i> , 2019	Family burden (SR)	Jurnal Ners	Comparative Caregiver Burden	PC
46	Rossi <i>et al.</i> , 2021	Holistic oncology care	Front Vet Sci	Integrative Oncology	CRG, SC, PC

The 112 remaining articles underwent full-text review. During this phase, 66 articles were excluded due to insufficient relevance to clinical practice, lack of connection to the core domains of interest, publication prior to 2012, poor methodological quality, or lack of accessible full text. Ultimately, 46 articles met *all* inclusion criteria and were incorporated into the final synthesis.

integrative oncology. These articles collectively addressed diagnostic patterns, surgical approaches, veterinary team communication, owner–clinician interactions, organizational factors, pain management, and caregiver experiences related to canine mammary tumors.

FINDINGS RELATED TO CLINICAL RISK GOVERNANCE

The synthesis revealed that significant clinical risks arise during diagnostic evaluation and staging of canine mammary tumors. Many dogs presented at advanced disease stages, and staging procedures such as thoracic radiography or abdominal ultrasonography were inconsistently performed across general practices. Variability in histopathologic interpretation further contributed to diagnostic uncertainty.

Therapeutic decision-making was also highly variable. Differences in surgical choice, ranging from lumpectomy to radical mastectomy, were often based on clinician preference rather than standardized protocols. Anesthetic and chemotherapy-related risks were highlighted in several studies, emphasizing the need for structured checklists, standardized pathways, and monitoring systems. Communication-related risks were also recurrent, with owners frequently reporting limited understanding of prognosis, treatment burden, and recurrence potential. These communication gaps often preceded delayed decision-making, incomplete staging, or inconsistent follow-up, indicating that operational lapses were frequently underpinned by broader governance deficiencies. Collectively, these findings indicate gaps in clinical risk governance, particularly the absence of standardized diagnostic pathways, accountability mechanisms, and routine monitoring processes across practice settings.

FINDINGS RELATED TO SAFETY CULTURE

Across the reviewed literature, safety culture emerged as a

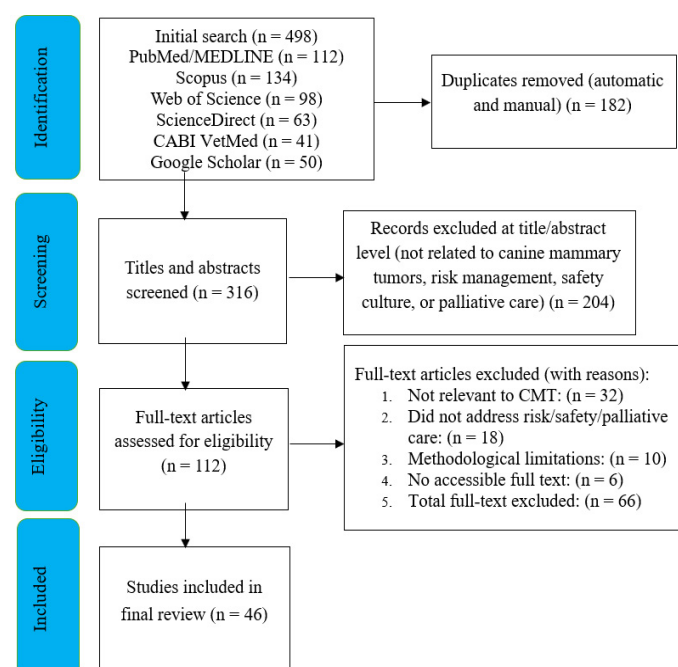


Figure 1: PRISMA 2020 flow diagram of the study selection process.

CHARACTERISTICS OF INCLUDED STUDIES

The 46 included studies consisted of epidemiological analyses, clinical oncology research, observational studies, conceptual papers on clinical risk governance and patient safety, and guidelines on veterinary palliative care. Most studies were published between 2017 and 2025, reflecting current trends in veterinary clinical governance and

persistent area of concern in veterinary practice. Studies identified recurrent system vulnerabilities, including diagnostic error, medication inaccuracies, and ineffective clinical handovers. Many veterinary teams operated without structured safety protocols or formal incident-reporting systems.

Barriers to safety culture improvement included fear of blame, hierarchical team structures, and underdeveloped communication channels. However, research also demonstrated that interventions such as structured communication tools (e.g., SBAR), preoperative checklists, standardized chemotherapy handling protocols, and incident-reporting frameworks significantly improved safety outcomes when implemented. Notably, failures in intra-team communication (e.g., veterinarian–technician handovers) were repeatedly implicated in adverse events, while inconsistent adoption of safety tools particularly in primary care settings limited the sustainability of these improvements.

FINDINGS RELATED TO PALLIATIVE CARE

Palliative needs were identified as central to the clinical management of canine mammary tumors. Many dogs required early and ongoing palliative support, particularly for pain control, management of ulcerated tumors, infection control, and maintenance of quality of life. Pain assessment tools were underutilized, leading to variability in analgesic strategies.

Multimodal analgesia, nutritional support, wound care, and psychological support for both pet and owner were highlighted as best practices. Caregiver burden emerged not only as an emotional challenge but also as a determinant of clinical risk, influencing owners' willingness to pursue diagnostic staging, surgical intervention, or continued treatment. Financial stress and emotional fatigue were frequently associated with delayed presentation, refusal of recommended diagnostics, or premature treatment discontinuation, thereby indirectly compromising clinical risk governance and patient safety. Despite clear benefits, palliative care remained unevenly integrated into routine oncology workflows.

CROSS-DOMAIN INTEGRATIVE FINDINGS

Despite the richness of literature in each domain clinical risk governance, safety culture, and palliative care no study proposed or evaluated an integrated framework explicitly linking these components within canine mammary tumor management. However, synthesis across domains revealed specific and recurring interactions.

Communication failures emerged as the most consistent cross-domain risk, particularly in veterinarian–owner discussions regarding prognosis, costs, and expected

treatment burden. These failures contributed to compromised informed consent, inconsistent adherence to diagnostic pathways, and heightened caregiver distress. In parallel, breakdowns in veterinarian–technician communication undermined safety culture, increasing the likelihood of procedural error and reducing opportunities for organizational learning.

Early integration of palliative care was found to mitigate both clinical and ethical risk by reducing unmanaged pain, emotional distress, and conflict surrounding treatment limits and euthanasia decisions. In this way, palliative care functioned as a downstream risk-mitigation strategy within broader clinical governance systems. Caregiver burden acted as a mediating factor across all three domains, influencing communication quality, safety behaviors, and acceptance of palliative pathways.

The absence of a unified systems-based model that accounts for these interactions highlights a significant gap in current veterinary oncology practice. The findings of this review underscore the need for a comprehensive, integrated framework capable of aligning clinical risk governance, safety culture, and palliative care to support safer, more consistent, and more compassionate management of canine mammary tumors.

DISCUSSION

The synthesis of 46 articles reveals that challenges in managing canine mammary tumors (CMTs) stem from persistent clinical variability, safety limitations, and inconsistent integration of palliative principles. This pattern becomes clearer when the literature is examined chronologically. Early foundational veterinary pathology and epidemiology studies highlighted substantial heterogeneity in tumor presentation and staging practices, with [Rasotto et al. \(2017\)](#) and [Campos et al. \(2020\)](#) noting frequent late-stage diagnoses and inconsistent use of imaging modalities. These early findings already pointed to the need for structured diagnostic pathways, but subsequent studies continued to report similar patterns, indicating limited systemic improvement by the late 2010s and early 2020s ([Benavente et al., 2022](#); [Ramos et al., 2023](#)).

The theme of clinical risk governance also evolved chronologically. Foundational safety science research outside veterinary medicine had already established that clinical variability and diagnostic inconsistency were deeply tied to system weaknesses rather than individual clinician error. This systems-oriented perspective provides the theoretical basis for prioritizing clinical risk governance within the proposed framework. Within the UNAIR

corpus, *Nenobais et al. (2019)* contributed early insight from nursing and caregiving contexts by describing how emotional burden increases significantly when clinical information is unclear or inconsistent, reinforcing the notion that communication lapses directly intensify caregiver distress. This theme aligns with early veterinary oncology work, which similarly demonstrated that owners of dogs with CMT often misunderstood prognosis or treatment burden due to unclear communication (*Beauvais et al., 2012*). Together, these findings support the interpretation that deficiencies in clinical risk governance particularly in communication, accountability, and feedback mechanisms amplify both clinical risk and caregiver distress.

As the literature progressed into the 2020s, attention shifted toward organizational and cultural factors influencing clinical risk. *Oxtoby et al. (2020)* demonstrated that fear-based cultures and punitive responses to error hindered reporting and organizational learning in veterinary practice. This was followed by increasingly refined discussions of safety leadership, such as those articulated by *Syaiful and Dwiyantri (2022)* within UNAIR's occupational safety research, which emphasized that leadership behavior is central in shaping communication patterns, adherence to protocols, and team psychological safety. By the mid-2020s, veterinary-specific studies confirmed that structured communication tools and standardized perioperative checklists reduced anesthesia-related incidents (*Ljungvall et al., 2023*), providing empirical support for safety culture mechanisms previously described in broader healthcare research. These findings collectively indicate that effective clinical risk governance in CMT care is inseparable from the presence of a positive, learning-oriented safety culture.

The evolution of palliative care research followed a similar chronological expansion. Earlier veterinary oncology discussions highlighted unmet needs in pain assessment and quality-of-life monitoring for dogs with CMT (*Spitznagel, 2019*). Complementary work within UNAIR's nursing literature contributed conceptual grounding around caregiver roles, with *Ulfiana et al. (2017)* demonstrating that structured home-based palliative models enhanced caregiver autonomy and competency. These concepts were adapted in the present review to the human-dog caregiving context, recognizing the unique ethical dimensions of surrogate decision-making and euthanasia in veterinary medicine. Later veterinary oncology studies increasingly emphasized early, anticipatory palliation to prevent crises such as uncontrolled pain, tumor ulceration, or emergency euthanasia (*Goldberg et al., 2021; Lavelle et al., 2022*). This convergence supports reconceptualizing palliative care in CMT management as a longitudinal, risk-mitigating process initiated alongside diagnostic and therapeutic planning rather than as a terminal-stage intervention.

The integration of clinical risk governance and safety culture became more explicit in newer literature. *Indarwati et al. (2023)* demonstrated that improvements in safety culture require coordinated structural interventions, including staff orientation, continuing education, environmental redesign, and formal incident-reporting pathways. These findings align with veterinary studies documenting that surgical errors, chemotherapeutic complications, and monitoring failures persist when governance structures lack standardized communication and reporting mechanisms. Furthermore, *Kartikasari et al. (2025)* showed that strong safety culture substantially increases adverse drug reaction reporting evidence highly relevant to CMT management, where chemotherapy, analgesics, and antibiotics are central therapeutic components requiring careful oversight. Within this context, palliative care emerges not only as a compassionate intervention but also as a downstream clinical risk mitigation strategy, reducing unmanaged symptoms, emergency presentations, and ethical distress.

By connecting earlier and later findings, a clear progression emerges. Earlier studies documented diagnostic and therapeutic variability; mid-stage literature identified systemic and cultural contributors to these problems; and recent work demonstrates that safety leadership, structured communication, and early palliative integration are feasible and impactful responses. Across all periods, however, a critical gap persists: No study proposes or evaluates a unified, systems-based framework that explicitly integrates clinical risk governance, safety culture, and palliative care for canine mammary tumor management.

The proposed framework is therefore primarily theory-driven, synthesizing convergent evidence across domains rather than claiming direct empirical validation within CMT-specific trials. Its value lies in articulating testable propositions, including the hypotheses that (1) clinics implementing structured safety culture interventions will demonstrate more consistent diagnostic staging and earlier palliative integration in CMT cases, and (2) formalized clinical risk governance structures will be associated with reduced procedural variability and improved caregiver communication. These hypotheses provide a foundation for future empirical evaluation of the model.

In reviewing the complete chronological landscape, it becomes apparent that CMT management has evolved from a predominantly biomedical orientation toward a more holistic, systems-based understanding. Progress has been uneven, but the accumulated evidence suggests that modern CMT care requires a unified approach that simultaneously addresses organizational risk governance, safety culture, and longitudinal palliative support. Such a framework does not add complexity for its own sake; rather,

it integrates existing practices into a coherent system that may be more adoptable in resource-limited clinical settings by aligning safety, communication, and compassionate care within a single operational logic.

STUDY LIMITATIONS

This review has several limitations. First, although the search strategy was comprehensive, relevant studies published outside the selected databases or in non-English languages may have been missed. Second, because of heterogeneity in study designs, populations, and outcomes, a meta-analysis could not be performed, limiting the generation of pooled effect estimates. Third, much of the available literature on safety culture and clinical risk governance originates from human healthcare rather than veterinary settings, requiring cautious interpretation when extrapolating concepts. Fourth, several included veterinary studies had small sample sizes or limited methodological rigor, which may influence the strength of the synthesized evidence. Fifth, a proportion of the interdisciplinary literature on safety culture and caregiver burden originated from UNAIR-affiliated research. While these studies met the predefined inclusion criteria and addressed underrepresented system-level dimensions, their prominence may introduce academic bias, which was mitigated by applying uniform appraisal and synthesis criteria across all included studies regardless of institutional origin. Finally, integrating findings across the domains of clinical risk governance, safety culture, and palliative care was constrained by the absence of studies explicitly operationalizing these components within a single framework specific to canine mammary tumor management.

CONCLUSION

This review highlights that effective management of canine mammary tumors requires a systems-based approach integrating clinical risk governance, safety culture, and early palliative care. Evidence from 46 studies, including interdisciplinary insights from UNAIR-affiliated research, suggests that diagnostic variability, inconsistent surgical practices, communication gaps, and caregiver burden are driven primarily by organizational and system-level factors rather than individual clinician error. These domains function as interdependent components within complex clinical systems, and their integration could reduce preventable harm, improve clinical consistency, and enhance quality of life for both dogs and their caregivers. The proposed framework is theory-driven, synthesizing convergent evidence to provide a coherent foundation for future evaluation rather than claiming direct empirical validation in CMT-specific trials.

RECOMMENDATIONS

Future research should operationalize and empirically test integrated frameworks aligning clinical risk governance, safety culture, and palliative care in veterinary oncology. Key hypotheses include whether structured safety culture interventions improve diagnostic consistency and promote earlier palliative integration in CMT cases, and whether formal governance structures reduce procedural variability and enhance caregiver communication. Further studies should evaluate the feasibility and impact of safety tools such as checklists and incident-reporting systems across diverse veterinary settings, alongside longitudinal investigations of caregiver burden and quality-of-life outcomes. Interdisciplinary collaboration will remain essential to adapt system-level safety principles to the unique ethical and clinical context of veterinary oncology.

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NOVELTY STATEMENT

This review is the first to propose a unified, theory-informed, systems-based framework explicitly integrating clinical risk governance, safety culture, and palliative care for the comprehensive management of canine mammary tumors. While previous studies have addressed these domains independently, no prior work has synthesized interdisciplinary insights from veterinary oncology, nursing, and patient safety literature to support holistic, patient-centered, and caregiver-sensitive decision-making in CMT management. The framework provides a foundation for future empirical testing and operationalization in veterinary clinical practice.

AUTHOR'S CONTRIBUTION

SR designed the study, conducted the literature review, and drafted the manuscript. EY contributed to methodological refinement and critical review of nursing and safety content. HEN provided expertise in palliative care and supported data interpretation. S contributed veterinary clinical expertise and revised the manuscript for intellectual content. All authors approved the final version.

ETHICAL CONSIDERATIONS

As this study was based solely on the analysis of previously published literature and did not involve live animals or human participants, formal ethical approval was not required.

GENERATIVE AI AND AI-ASSISTED TECHNOLOGY STATEMENT

This manuscript was entirely written and revised by the authors. Generative AI was used only in a limited capacity to improve English sentence structure and grammar. It was not used for content creation, literature synthesis, data extraction, or scientific analysis. All interpretations, analyses, and intellectual contributions are the independent work of the authors.

CONFLICT OF INTEREST

The authors have declared no competing interests related to this work. The authors' institutional affiliations had no role in the design of the study, data selection, synthesis, interpretation, or decision to submit the manuscript for publication.

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