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REVIEW

Oncology Nursing Considerations for Liposomal and Nanoparticle-Based Systemic Therapies in Breast Cancer: A Narrative Review of Patient Assessment, Education, and Toxicity Management

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Abstract

Introduction: Liposomal and nanoparticle-based systemic therapies can alter drug solubility, circulation, distribution, infusion requirements, and the pattern or severity of treatment toxicities in breast cancer. These formulation effects can shift where nursing surveillance should be most intensive and how patients should be prepared for treatment at home. **Methods:** The review used a clinically focused, purposive synthesis organized around the patient journey and formulation-specific care needs; SANRA domains were used as a self-appraisal framework for narrative-review reporting. **Results:** Pegylated liposomal doxorubicin (PLD) and nanoparticle albumin-bound paclitaxel (nab-paclitaxel) provide the clearest formulation-specific nursing examples. With PLD, priorities include infusion tolerance, hand-foot syndrome, mucositis, myelosuppression, fatigue, and anthracycline-related cardiopulmonary vigilance. With nab-paclitaxel, cumulative peripheral neuropathy, functional change, myelosuppression, infection risk, fatigue, and treatment-day tolerance are prominent. Across formulations, high-value nursing actions include documenting a usable baseline, verifying the exact formulation, tracking symptom trajectory and functional interference, teaching formulation-relevant self-care, integrating patient-reported symptoms, and linking warning signs to explicit escalation pathways. Telenursing and digital symptom monitoring are most useful when reported information triggers a defined clinical response. **Conclusion:** Nanocarrier-based breast cancer therapy should be approached as a formulation-specific nursing problem. A standardized but flexible pathway connecting baseline risk, treatment-day verification, early toxicity recognition, patient education, serial functional assessment, and timely escalation may improve consistency while preserving regimen- and patient-specific judgment.

Keywords: Breast cancer, Oncology nursing, Nanomedicin, Liposome, Nanoparticle

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Introduction

Contemporary oncology practice is supported by evidence generated across biochemical, epidemiologic, computational, cellular, imaging, and translational research. Contextual studies spanning biochemical and resource-recovery methods, postoperative and pain-related evidence synthesis, metabolic risk assessment, infectious-disease surveillance, machine-learning classification, cellular experimentation, and human imaging illustrate how diverse evidence streams can contribute to clinical knowledge development [1-10].

Within cancer research, this translational continuum includes combination cytotoxicity, targeted nanoliposomal delivery, polymeric nanoparticle platforms, drug repurposing, integrative supportive care, selenium-containing liposomal systems, oral-cancer nanoparticle strategies, breast-cancer nanogels, and plant-derived

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antileukemic approaches [11-23]. These studies demonstrate the breadth of anticancer research, but the nursing question addressed here is deliberately narrower: which formulation-related differences alter assessment, administration, education, toxicity surveillance, functional monitoring, and escalation in patients receiving systemic therapy for breast cancer?

For this review, "nanocarrier" is used as an umbrella term for drug-delivery systems in the nanoscale or nanomedicine domain; "liposomal" and "nanoparticle" are used when a specific formulation class is intended. Breast-cancer systemic therapy is increasingly influenced not only by the pharmacology of the active drug but also by how that drug is formulated and delivered [24-26]. Liposomes, albumin-bound nanoparticles, polymeric or micellar systems, and other carrier platforms can modify solubility, circulation, tissue distribution, drug exposure, preparation, and infusion requirements. From a nursing perspective, the clinically relevant issue is not the "nano" label itself but whether a formulation changes treatment-day procedures, the timing or pattern of adverse effects, or follow-up needs [24-26]. Oncology nurses contribute across this pathway by establishing pretreatment baselines, identifying vulnerability, verifying treatment readiness, monitoring infusion tolerance, reinforcing self-management, recognizing cumulative toxicity, and coordinating referral when symptoms threaten safety or treatment continuity [27-29]. Because many toxicities emerge after patients leave the infusion unit, the focused clinical question is: how should the formulation influence what the nurse assesses, teaches, documents, and escalates before, during, and after systemic therapy? PLD and nab-paclitaxel are emphasized as contrasting clinical examples, while less established platforms are used only when they clarify a broader practice principle.

Materials and Methods

This article used a narrative review approach rather than a systematic or scoping-review design. MEDLINE/PubMed, CINAHL, Embase, Scopus, and Web of Science were searched for English-language literature published from January 2000 through August 2026 using combinations of ("breast cancer" OR "breast neoplasms"), ("liposomal" OR "nanoparticle" OR "nanocarrier" OR "pegylated liposomal doxorubicin" OR "nab-paclitaxel"), and ("nursing" OR "supportive care" OR "toxicity" OR "symptom monitoring" OR "patient education" OR "infusion"). Human breast-cancer studies, clinical reports, oncology-nursing studies, supportive-care guidance, and clinically applicable toxicity literature were prioritized. Preclinical, computational, non-breast-cancer, and non-nursing studies were retained only as contextual or translational examples and were not used to support direct nursing recommendations. Citation chaining and targeted journal or publisher searches supplemented database retrieval. The final narrative synthesis included 61 cited sources. Because selection was purposive and iterative rather than exhaustive, a fixed PRISMA screening denominator, PRISMA flow diagram, and duplicate independent screening were not applied. Sources were synthesized thematically across assessment, administration, education, toxicity surveillance, patient-reported outcomes, telenursing, referral, and implementation. Formal study-level risk-of-bias scoring was not undertaken because the review incorporated heterogeneous evidence types. Instead, evidence was weighted according to study design, direct applicability to breast-cancer care, relevance to oncology nursing, and consistency with established clinical guidance, with greater emphasis on clinical guidelines, randomized trials, prospective studies, and directly applicable oncology evidence. SANRA was applied solely as a self-appraisal framework for the methodological and reporting quality of this narrative review and not as a risk-of-bias tool for individual studies [30]. Figure 1 summarizes the patient-journey framework from baseline assessment through treatment, early toxicity surveillance, self-management, and escalation.

Formulation-Specific Nursing Context

Formulation-specific care begins by separating the effect of the carrier from the effect of the active drug [24, 31, 32]. A modified formulation may reduce one administration problem without eliminating the drug's intrinsic toxicities, and it may shift rather than simply reduce the adverse-effect burden [24, 31, 32]. Nurses therefore need to know the exact product being administered and should avoid assuming that formulations containing the same active agent are interchangeable in preparation, premedication, infusion practice, or toxicity expectations [25, 31, 32]. Table 1 compares representative

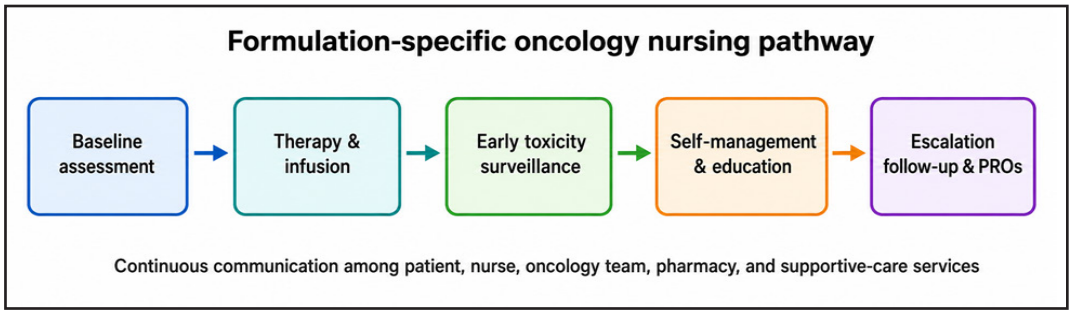

Figure 1. Formulation-Specific Oncology Nursing Pathway for Patients Receiving Liposomal or Nanoparticle-based Systemic Therapy. Color is used as a secondary visual aid; labels, box sequence, and directional arrows preserve interpretability in grayscale.

platforms in terms of the nursing questions that matter at baseline, on the treatment day, and during follow-up.

Pegylated Liposomal Doxorubicin

PLD demonstrates why formulation can change nursing emphasis [31, 33, 34]. The liposomal formulation modifies exposure compared with conventional doxorubicin, yet patients still require attention to hematologic effects, fatigue, infusion tolerance, and cardiopulmonary symptoms associated with anthracycline treatment history and patient vulnerability [31, 34, 35]. At the same time, hand-foot syndrome and mucositis become highly visible nursing priorities [31, 33, 34]. A useful pretreatment assessment therefore includes not only prior anthracycline exposure and cardiovascular history but also baseline skin integrity, plantar callus or fissuring, occupational friction or prolonged standing, oral health, hydration, and prior mucosal toxicity [31, 32, 35]. An illustrative example is a patient who works long shifts on their feet and has pre-existing heel calluses [31, 33, 34]. If the baseline is documented, new burning, erythema, or tenderness after PLD can be recognized as a change rather than being dismissed as chronic foot discomfort [31, 33, 34]. Early nursing intervention may focus on reducing heat, pressure, and friction, reinforcing gentle skin care, and arranging clinical review if pain, blistering, open skin, or loss of function develops. The same logic applies to oral symptoms: mild dryness or soreness is more actionable when the nurse also asks whether the patient can maintain fluids, nutrition, oral hygiene, and sleep [31, 33, 34].

Nanoparticle Albumin-Bound Paclitaxel

Nab-paclitaxel provides a different nursing profile [32, 36, 37]. Peripheral neuropathy, myelosuppression, fatigue, musculoskeletal symptoms, and functional change are central concerns. The formulation may alter administration characteristics compared with solvent-based paclitaxel, but it does not justify relaxing infusion observation or assuming that hypersensitivity is impossible [32, 36, 37]. Before treatment, the nurse should establish whether numbness, tingling, painful neuropathy, balance problems, diabetes-related nerve symptoms, prior taxane exposure, or limitations in fine motor tasks are already present [32, 36, 38]. Functional questioning makes serial assessment more clinically meaningful [36-38]. A patient with stable diabetic tingling who can walk normally and use their hands without difficulty has a different baseline from a patient who already has gait instability. During treatment, a change from occasional tingling to dropping objects, avoiding stairs, waking at night with pain, or nearly falling is a trajectory that should be communicated promptly [36- 38]. Repeating the same short functional questions at each cycle makes subtle deterioration easier to recognize and gives the prescriber more useful information than a single yes/no neuropathy question.

Other Liposomal, Micellar, and Investigational Nanoparticle Platforms

Other liposomal, micellar, and targeted nanoparticle formulations may be clinically evaluated or used in specific settings, but their nursing profiles cannot be inferred safely from the carrier class alone [24, 39]. The active drug, surface modification, dose, schedule, combination regimen, infusion instructions, and local product information all matter [24, 39]. For an unfamiliar formulation, the safest nursing approach is to verify product-specific preparation and monitoring requirements, identify expected toxicities of both the drug and formulation, document unexpected patterns carefully, and avoid assuming that experience with PLD or nab-paclitaxel automatically applies to the new platform [24, 39].

Nursing Care Across the Treatment Continuum

Pretreatment Assessment: Creating a Usable Baseline

A pretreatment nursing assessment should create a baseline that can be reused at later cycles [40, 41]. Laboratory eligibility is important, but a clinically useful baseline also records organ symptoms, function, skin and oral status, neurologic symptoms, infection risk, medication use, prior reactions, psychosocial barriers, and the patient's ability to recognize and report change [40, 41]. For PLD, this may include exertional dyspnea, edema, prior anthracycline exposure, palm and sole condition, oral lesions, and nutritional intake [31, 33, 35]. For nab-paclitaxel, it should include sensory symptoms, pain, gait, falls, fine-motor tasks, work demands, and pre-existing conditions such as diabetes that may complicate attribution [32, 36, 38]. Baseline vulnerability should influence follow-up intensity [40, 41]. Older adults, patients with frailty or polypharmacy, people with limited mobility, those who live far from the treatment center, and patients with limited health literacy or social support may need more structured contact even when the drug regimen is identical [40-42]. The purpose is not to label these patients as automatically high risk; it is to anticipate where a modest toxicity could create a disproportionate functional or safety consequence [40-42]. A small increase in numbness, for example, is more consequential in a patient already using a walking aid than in a patient with no balance limitation [36, 38, 40].

Treatment-Day Verification and Infusion Monitoring

Safe treatment-day nursing begins with verification of the exact formulation rather than only the generic drug name [31, 32, 43]. The nurse should confirm the product, dose, cycle and day, route, infusion duration, required laboratory criteria, venous access plan, and formulation-specific preparation or premedication instructions according to the local protocol [31, 32, 43]. This step is particularly important when conventional and modified formulations of a drug coexist because dosing or administration assumptions can be unsafe when transferred from one product to another. Before infusion, patients should be told which new sensations must be reported immediately [31, 32, 43]. During administration, observation should include new flushing, rash, dyspnea, chest or back discomfort, dizziness, blood-pressure change, anxiety associated with evolving symptoms, and

Table 1. Representative Nanocarrier-based Systemic Therapies and Formulation-Specific Nursing Priorities in Breast Cancer Care

Therapy / platform	Why formulation matters for nursing	Main nursing-relevant concerns	Baseline & treatment-day priorities	Between-cycle education and follow-up
Pegylated liposomal doxorubicin (PLD) [31, 33, 34]	Liposomal anthracycline formulation shifts the prominence of selected toxicities and has product-specific infusion requirements.	Infusion reaction, hand-foot syndrome, mucositis, myelosuppression, fatigue, cardiopulmonary symptoms in the context of anthracycline exposure.	Review prior anthracycline/cardiac history; document palms/soles and oral status; assess function and nutrition; verify exact product and infusion instructions; observe closely during infusion.	Teach friction/heat reduction and gentle skin/oral care; monitor walking/hand function and intake; reinforce infection warnings; review new dyspnea, edema, palpitations, or marked fatigue promptly.
Nanoparticle albumin-bound paclitaxel (nab-paclitaxel) [32, 36, 37]	Albumin-bound taxane formulation changes administration characteristics but retains taxane-related cumulative toxicity.	Peripheral neuropathy, myelosuppression, fatigue, musculoskeletal symptoms, functional decline; infusion hypersensitivity remains possible.	Document baseline sensory symptoms, gait, falls, fine-motor function, diabetes or prior neuropathy; review blood counts and infection symptoms; confirm regimen and infusion readiness.	Track numbness/pain plus ADL impact; teach fall prevention and protection of reduced-sensation areas; reinforce fever/contact instructions; escalate progressive gait or hand-function change.
Other liposomal cytotoxic formulations used or evaluated in oncology, including non-pegylated liposomal anthracycline formulations and, in broader oncology practice, liposomal irinotecan or liposomal vincristine [24, 31, 34]	Different liposomal products are not interchangeable: lipid composition, active drug, dose, schedule, and infusion instructions can alter distribution, administration, and toxicity priorities.	Product-specific infusion reactions, mucosal or hematologic toxicity, organ-specific effects, and active-drug toxicities; breast-cancer relevance must be confirmed for each product.	Check product-specific preparation, access, premedication, laboratory criteria, allergies/reaction history, and organ-specific risk.	Use formulation-specific education; avoid extrapolating a PLD profile to every liposome; document unexpected timing or toxicity patterns and clarify escalation thresholds.
Micellar / polymeric taxane platforms [32, 39]	Solubilization strategy and excipient profile may differ from conventional taxane products, potentially altering administration and tolerability.	Taxane-related neuropathy and myelosuppression plus formulation-specific infusion considerations.	Confirm exact formulation, premedication requirements, infusion duration, neurologic baseline, and blood-count criteria.	Follow cumulative neuropathy and function; reinforce infection and fall-prevention education; compare new symptoms with the documented pre-treatment baseline.
Targeted or combination nanoparticle platforms under clinical evaluation [24, 39]	Novel carrier, targeting ligand, or drug combination can create unfamiliar toxicity and workflow demands.	Potential overlap of active-drug toxicity, infusion events, organ toxicity, skin/neurologic effects, adherence and outpatient monitoring burden.	Use protocol-specific instructions; define expected versus unknown risks; establish detailed baseline and contact pathway; coordinate closely with pharmacy/research team.	Capture patient-reported experience and unexpected events; avoid class-wide assumptions; use low threshold for protocol clarification when symptoms do not fit the expected pattern.

Abbreviations: PLD, pegylated liposomal doxorubicin; nab-paclitaxel, nanoparticle albumin-bound paclitaxel; ADL, activities of daily living.

local infusion problems [31, 32, 43]. Documentation should capture meaningful deviations such as infusion interruption, rate modification, rescue medication, or new symptoms rather than recording only that treatment was completed. A mild event that resolves on one cycle may become important when the same pattern recurs or intensifies on the next cycle [31, 32, 43].

Between-Cycle Surveillance and Cumulative Toxicity

Between-cycle nursing surveillance should focus on trajectory, function, and the patient's ability to maintain self-care [27-29]. Many toxicities become clinically important because they are progressive: neuropathy accumulates, oral pain begins to limit intake, hand-foot symptoms interfere with walking, or fatigue gradually reduces activity and independence [33, 38, 44]. Structured telephone review, clinic assessment, or patient-reported symptom tools can be used to ask the same core questions repeatedly so that change is visible over time [27-29]. The nurse should distinguish three broad action levels: mild and stable symptoms that can be managed with reinforced education and planned reassessment; symptoms that require same-day clinical review because they are progressing or interfering with function; and urgent symptoms that may indicate infection, severe infusion toxicity, cardiopulmonary compromise, dehydration, major bleeding, or another acute problem [28, 38, 43]. This logic is developed in the toxicity-to-action model below and can be adapted to local protocols without turning nursing judgment into an inflexible checklist [28, 43].

Toxicity-to-Action Management

Figure 2 converts symptom surveillance into an action sequence. The process begins with detecting a symptom or sign, grading its severity and trajectory, linking it to likely treatment toxicity or an alternative cause, and then choosing an appropriate response [28, 38, 43]. The lower branch emphasizes that the action should reflect risk: education and reinforcement for low-risk stable findings, same-day clinical review for moderate or function-limiting change, and urgent escalation when severe or rapidly evolving features are present [28, 38, 43]. This structure helps prevent two common problems: under-reacting to a symptom because its name sounds familiar, and over-reacting without considering severity, trajectory, and functional impact.

Hand-Foot Syndrome and Dermatologic Toxicity

With PLD, assessment of the palms and soles should include erythema, swelling, burning, tingling, tenderness, fissures, peeling, blistering, and interference with hand use or walking [31, 33, 34]. Functional impact is essential because the same visible redness may have very different clinical significance in a patient who walks normally compared with one who cannot tolerate shoes. Education can emphasize reducing heat, friction, and pressure; maintaining gentle skin care and moisturization; and reporting new painful or open areas early [31, 33, 34]. Atypical or unilateral lesions should prompt consideration of infection, fungal disease, contact irritation, or another dermatologic process rather than automatic attribution to treatment.

Mucositis and Nutritional Consequences

Oral toxicity should be assessed as both a mucosal problem and a potential threat to hydration, nutrition, sleep, and medication adherence [31, 34, 44]. Nurses can ask about soreness, ulcers, dry mouth, bleeding, dysphagia, altered taste, oral coating, and the amount the patient is actually able to eat and drink. Gentle oral care, hydration, and avoidance of irritating foods or products may be reasonable self-management for mild symptoms, but same-day review is more appropriate when pain is escalating, intake is falling, or lesions are extensive [31, 34, 44]. Fever, suspected infection, uncontrolled bleeding, or inability to maintain fluids requires a higher level of concern [44, 45].

Peripheral Neuropathy and Functional Safety

Neuropathy surveillance with nab-paclitaxel should move beyond asking whether tingling is present [36-38]. Repeated assessment can include sensory change, painful neuropathy, weakness, gait instability, falls or near-falls, sleep disturbance, and difficulty with tasks such as writing, fastening buttons, preparing meals, using a phone, or driving. Self-management advice may include fall prevention, appropriate footwear, protection of areas with reduced sensation, and caution with hot objects [36-38]. Progressive symptoms that affect gait, hand function, sleep, or occupational safety should be communicated promptly because functional deterioration may be more clinically important than symptom intensity alone.

Myelosuppression, Infection, Fatigue, and Systemic Decline

Blood-count abnormalities remain relevant regardless of delivery platform [32, 37, 45]. Nursing assessment should combine laboratory information with symptoms such as fever, chills, bleeding, bruising, dyspnea, palpitations, profound weakness, or rapidly declining activity tolerance [32, 37, 45]. Patients need clear instructions about which infection symptoms require immediate contact and how to reach the oncology service outside routine clinic hours [32, 45]. Fatigue should be interpreted in context rather than treated as an isolated expected symptom; worsening fatigue may reflect anemia, infection, dehydration, pain, sleep disruption, poor intake, mood disturbance, or deconditioning [32, 37, 45]. Cardiopulmonary change also deserves explicit surveillance, particularly in patients receiving anthracycline-containing treatment or those with pre-existing cardiac disease [31, 35, 46]. New exertional dyspnea, orthopnea, edema, palpitations, chest symptoms, unexplained cough, or abrupt loss of activity tolerance should not be normalized as routine fatigue. Table 2 brings these domains together and links early findings to focused assessment, patient self-management, same-day review, and urgent escalation.

Table 2. Practical Nursing Surveillance, Self-Management, Clinical Review, and Escalation Domains for Nanocarrier-based Systemic Therapy

Toxicity domain	Early findings and focused nursing assessment	Patient self-management / education	Same-day clinical review triggers	Urgent escalation triggers
Infusion reaction [31, 43]	Flushing, rash, chest/back discomfort, dyspnea, dizziness, or blood-pressure change; document onset and infusion timing plus temperature, blood pressure, heart rate, respiratory rate, and oxygen saturation before and during the event and after intervention, according to local protocol.	Explain possible symptoms before infusion and instruct the patient to report them immediately rather than waiting for worsening.	Persistent or recurrent symptoms after initial management; need for rate change, interruption, or rescue medication according to protocol.	Severe respiratory symptoms, hemodynamic instability, rapidly progressive reaction, altered consciousness, or other emergency features.
Hand-foot syndrome / skin toxicity [31, 33, 34]	Burning, erythema, swelling, tenderness, fissures, peeling, or blistering; assess walking, shoe tolerance, hand use, occupational friction, and functional interference, and document CTCAE grade when the service uses CTCAE grading.	Reduce heat, pressure and friction; gentle cleansing and moisturization; inspect skin; report painful or open areas early.	Increasing pain, functional interference, significant fissuring/ blistering, or uncertain diagnosis such as possible infection.	Rapidly progressive skin injury with systemic illness, severe infection concern, or inability to mobilize safely.
Mucositis / oral toxicity [31, 44]	Soreness, ulcers, dry mouth, bleeding, dysphagia, altered intake; examine impact on fluids, nutrition, oral hygiene, sleep, and medication use.	Gentle oral care, hydration, avoid irritating products/foods when symptomatic, report lesions early.	Escalating pain, extensive lesions, reduced intake, weight loss concern, or symptoms requiring prescription supportive care.	Inability to maintain fluids, fever with oral lesions, suspected severe infection, uncontrolled bleeding, or acute airway/swallowing concern.
Peripheral neuropathy [36, 37, 38]	Numbness, tingling, pain, weakness, fine-motor difficulty, gait change, falls/near-falls; compare with baseline and prior cycle.	Fall prevention, suitable footwear, protect areas with reduced sensation, caution with hot/sharp objects, report progression.	Progressive or painful neuropathy; new ADL limitation; sleep disruption; difficulty driving, working, or using stairs.	Acute major weakness, repeated falls with injury risk, rapidly evolving neurologic deficit, or another neurologic emergency pattern.
Myelosuppression / infection / fatigue [32, 37, 45]	Fever, chills, bruising/bleeding, dyspnea, palpitations, profound weakness; combine symptoms with laboratory trends and treatment timing.	Use infection precautions; know the program's fever/contact instructions; maintain hydration/nutrition where possible; report bleeding or marked decline.	New fever or infection symptoms requiring oncology assessment; worsening bruising/bleeding; fatigue causing meaningful reduction in function.	Sepsis-like illness, severe bleeding, syncope, severe dyspnea, confusion, or other signs of acute instability.
Cardiopulmonary or systemic deterioration [31, 35, 46]	New exertional dyspnea, orthopnea, edema, cough, palpitations, chest symptoms, dizziness, rapid activity decline; consider dehydration and other causes.	Track new symptoms and activity tolerance; avoid normalizing abrupt decline as "expected fatigue"; know when to call.	New persistent cardiopulmonary symptoms, edema, sustained palpitations, dehydration or marked weight/intake change.	Severe dyspnea, chest pain, syncope, acute neurologic change, or rapidly worsening cardiopulmonary compromise.

Abbreviation: ADL, activities of daily living.

Patient Education, Patient-Reported Outcomes, Telenursing, and Special Contexts

Patient education is most effective when it tells the patient what to notice, what they can do safely, how urgent the symptom may be, and whom to contact [42, 47, 48]. Health literacy should be assessed pragmatically rather than assumed: nurses can ask patients to explain in their own words what the medicine is for, which warning signs require contact, and how they would obtain help after hours, followed by teach-back to confirm understanding [42, 47, 48]. Education should use plain language, short action-oriented instructions, interpreter support when needed, and culturally appropriate examples rather than relying only on written material. For PLD, education can pair early palm or sole burning with friction-reduction and skin-care strategies while clearly identifying blistering, open skin, major pain, or functional loss as reasons for clinical review [33, 47, 48]. For nab-paclitaxel, education should distinguish stable mild tingling from progressive numbness, gait difficulty, falls, or loss of hand function [36, 38, 47]. Patient-reported outcomes (PROs) can strengthen this process because neuropathy, fatigue, oral discomfort, and hand-foot syndrome are partly subjective and may be underestimated during brief clinic encounters [28, 49, 50]. Repeated short questionnaires or structured prompts are most useful when they trigger a defined response rather than becoming a separate documentation exercise [28, 49, 51]. Telenursing can be targeted to early treatment cycles, previous infusion reactions, new or changing toxicities, dose changes, or situations in which travel distance and social barriers complicate unscheduled review [27, 29, 52]. A structured contact can review fever, oral intake, skin symptoms, neuropathy, pain, falls, bowel function, fatigue, medication use, and ability to perform usual activities [27, 29, 52]. Older adults, patients with diabetes or cardiac disease, people with limited mobility or digital access, rural or remote patients, and those with language, financial, or social barriers may require adapted follow-up [35, 40-42]. Equity requires offering non-digital alternatives and ensuring that escalation pathways remain usable regardless of language, geography, technology access, or health literacy.

Emerging Digital and Translational Perspectives
Emerging Digital Perspectives

Digital and artificial-intelligence studies outside breast-cancer nursing are retained here only as contextual examples of methods that may eventually support symptom surveillance or decision support after disease-specific validation. Probabilistic neural-network classification in thyroid disease illustrates structured diagnostic classification [53]. A hybrid ResUNet-Transformer model for liver-tumor segmentation illustrates automated image analysis [54]. Wavelet- and neural-network-based X-ray denoising highlights the dependence of downstream analysis on input-data quality [55]. A random-forest treatment-response classifier with biomarker identification in ulcerative colitis provides an adjacent example of multivariable response prediction [56]. None of these studies is treated as direct evidence for current breast-cancer nursing practice; their relevance is limited to the design principles of validated data capture, interpretable outputs, and clinically defined response pathways.

Emerging Translational Perspectives

Selected translational references are likewise retained as contextual examples rather than nursing evidence. Integrated 2D and PEGDA microwell-based 3D colorectal-cancer models show how model architecture can alter the interpretation of KRAS-associated drug response before clinical translation [57]. Computational study of a boron-nitride nanocone as a lomustine nanocarrier and sensor represents an earlier-stage carrier-drug modeling example requiring experimental and clinical validation [58]. Eco-friendly synthesis and biological evaluation of pyrrolonaphthyridine compounds represents candidate-development work that precedes human administration and toxicity characterization [59]. Model-organism approaches illustrate how mechanistic findings require careful translation before they can inform patient-specific decisions [60]. Accordingly, these four sources are not used to justify nursing recommendations; they define the boundary between emerging translational research and evidence appropriate for clinical nursing action.

Implementation Framework

A practical nursing pathway should be standardized enough to make important risks visible but flexible enough to remain formulation- and patient-specific [27-29]. Five repeating checkpoints are used: before the first cycle, each treatment day, the early post-treatment interval, the pre-cycle cumulative-toxicity review, and the end-of-treatment or transition period [27, 28, 49]. Figure 1 functions as the workflow timeline, while Table 3 operationalizes the same checkpoints into a minimum nursing data set, focused questions, an action/output, and the most likely team linkage. At each checkpoint, the nurse should produce a documented disposition proceed, reinforce education, arrange same-day review, request supportive-care input, or escalate urgently rather than recording symptoms without an action [27, 28, 43]. Standardized documentation should capture severity, functional interference, timing, trajectory, advice given, patient understanding, escalation, and follow-up response [28, 49, 52]. This creates a longitudinal nursing record that can be interpreted consistently across clinicians and cycles.

Future Study

The major research gap is not simply the need for more toxicity descriptions; it is the need to test whether structured nurse-led approaches improve patient-important and treatment-important outcomes [27, 29, 61]. Future studies should evaluate whether formulation-specific surveillance reduces unplanned acute-care use, detects toxicity at an earlier stage, improves treatment continuity, preserves function, or improves patient confidence and quality of life [28, 49, 61]. Comparative designs could test routine follow-up against structured nursing pathways that integrate symptom trajectory, function, PROs, and

Table 3. Suggested Checkpoints for a Standardized Nursing Pathway Across the Treatment Course

Checkpoint	Minimum nursing data set	Example focused questions	Action / output	Likely team linkage
Before first cycle [40-42]	Baseline organ symptoms with explicit examples: cardiopulmonary (dyspnea, edema, palpitations, chest symptoms), gastrointestinal/oral (nausea, intake limitation, mucosal symptoms), neurologic (numbness, weakness, balance), and urinary/renal changes; also record skin and functional status, medications/allergies, prior reactions, psychosocial factors, and access barriers.	"Any numbness or balance problem now?" "Any mouth sores or painful palms/soles?" "What activities would be hardest to lose?"	Individualized risk profile; formulation-specific education plan; baseline against which later change can be judged.	Oncology prescriber, pharmacy; cardio-oncology, nutrition, rehabilitation, dentistry or social support when indicated.
Each treatment day [31, 32, 43]	Exact formulation, dose, cycle/day, labs, venous access, new symptoms, prior-cycle toxicity, infusion readiness.	"What changed since the last treatment?" "Any fever, new rash, breathing problem, fall, oral pain, or worsening numbness?"	Proceed, clarify, delay, or escalate according to protocol; document infusion deviations and new baseline-relevant findings.	Prescriber and pharmacy; acute response team if infusion toxicity develops.
Early post-treatment interval [27, 28, 49]	Infusion sequelae, fever, oral intake, skin symptoms, neuropathy, pain, bowel symptoms, fatigue and ability to perform usual activities.	"Are symptoms stable, improving, or getting worse?" "Can you eat, drink, walk safely, and use your hands normally?"	Reinforce self-care, arrange same-day review, or trigger urgent escalation depending on trajectory and function.	Telephone/telenursing service, oncology clinic, urgent care/ emergency pathway, interpreter service, or non-digital contact pathway as locally defined.
Before subsequent cycles [33, 36, 37]	Trend in toxicity; ADL impact; falls; cumulative neuropathy; hand-foot syndrome; mucositis; fatigue; unresolved infection; and persistent organ-specific symptoms such as dyspnea/edema, gastrointestinal intake problems, neurologic change, or urinary/renal complaints.	"Compared with the previous cycle, what is harder to do?" "Did any symptom prevent sleep, walking, eating, work, or self-care?"	Provide longitudinal toxicity summary; support dose/timing discussion; initiate supportive-care referral when needed.	Prescriber, pharmacy, rehabilitation, dermatology, nutrition, pain/palliative/ supportive care.
End of treatment / transition [35, 41, 46]	Persistent neuropathy, skin or oral effects, cardiopulmonary symptoms, fatigue, functional recovery, self-management needs and follow-up ownership.	"Which treatment effects are still limiting you?" "Who will follow this symptom if it persists?"	Document unresolved effects; create handover and survivorship plan; ensure patient knows future contact route.	Survivorship/primary care, rehabilitation, cardio-oncology, pain/supportive care or other specialty follow-up.

Abbreviation: ADL, activities of daily living.

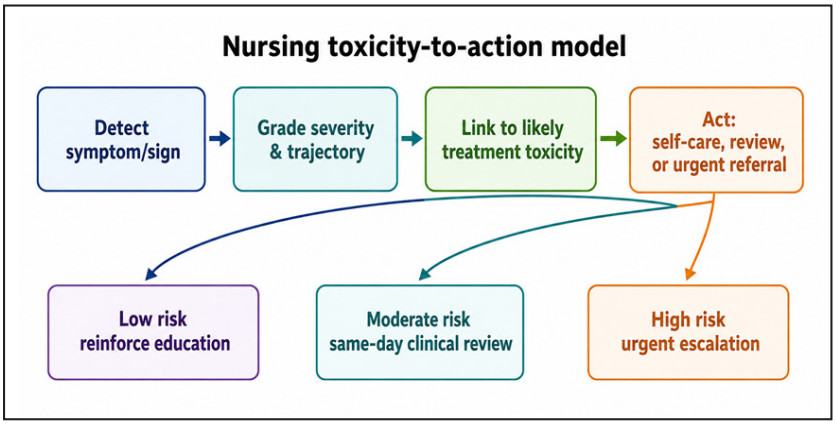

Figure 2. Nursing Toxicity-to-Action Model for Structured Symptom Surveillance and Escalation. Color is used as a secondary visual aid; labels, risk categories, and directional arrows preserve interpretability in grayscale.

explicit escalation rules [28, 49, 61]. Research should also determine which symptoms are best captured by in-person assessment, telephone contact, patient-reported tools, or digital monitoring, and how quickly each type of alert should be reviewed [49, 50, 61]. Diverse populations should be included, particularly older adults, rural patients, people with limited digital access, and patients receiving complex combinations [40, 41, 49]. Emerging nanocarrier platforms should incorporate nursing endpoints early in clinical development so that administration burden, patient experience, functional toxicity, and outpatient workflow are evaluated before supportive-care problems become routine practice issues [24, 39, 61].

Discussion

The central interpretation of this narrative review is that nanocarrier therapy should not be treated as a single nursing category [24, 31, 32]. Table 1 demonstrates why: PLD shifts surveillance toward hand-foot syndrome and oral toxicity while retaining hematologic, infusion, and cardiopulmonary concerns [31, 33, 34], whereas nab-paclitaxel places greater emphasis on cumulative peripheral neuropathy, gait and fine-motor function, myelosuppression, infection risk, and treatment tolerance [32, 36, 37]. Thus, formulation-specific nursing means changing the relative emphasis and timing of assessment rather than abandoning conventional oncology safety principles. Trajectory and function are often more informative than symptom presence alone: "mild tingling" can be clinically important when accompanied by dropping objects, avoiding stairs, or near-falls, whereas visible hand-foot erythema may have a different implication when pain and function are preserved [33, 34, 36 , 37, 38]. Figures 1 and 2 therefore serve complementary purposes: Figure 1 identifies when surveillance occurs, and Figure 2 links a detected change to severity, likely cause, and an action threshold [28, 38, 43]. Education, access, and escalation are inseparable. Self-management advice is safest when patients understand its limits, have an after-hours contact route, and can obtain timely review regardless of language, geography, digital access, or socioeconomic barriers [42, 47-49]. Telenursing and PROs can strengthen continuity only when alerts are assigned to a responsible clinical responder and non-digital alternatives remain available [28, 49, 61]. Important limitations should temper interpretation: the review used a purposive narrative rather than exhaustive search; the source-selection process may therefore be affected by selection bias; no formal study-level risk-of-bias or certainty grading was performed; nursing-specific prospective evidence is less mature than pharmacologic and toxicity evidence; and practices vary across products, combinations, institutions, and countries [27, 29, 30, 43]. The framework should consequently be used as a structure for clinical reasoning and local protocol development, not as a substitute for product-specific prescribing information, institutional policy, or individualized oncology decision-making [43, 45, 46].

In conclusion, liposomal and nanoparticle-based systemic therapies in breast cancer require nursing care tailored to the specific formulation, active drug, and individual patient vulnerability. PLD and nab-paclitaxel demonstrate that formulation can alter the timing, priority, and functional significance of toxicity surveillance while preserving the need for standard oncology safety assessment. Accordingly, an effective nurse-led pathway should integrate formulation verification, baseline risk assessment, patient education, serial monitoring of symptom trajectory and functional change, clear documentation, and timely escalation within a standardized but flexible framework. Such an approach may improve continuity and consistency of care across treatment cycles while supporting individualized clinical judgment and early recognition of clinically meaningful toxicity.

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Data Availability

Data sharing is not applicable to this article because no new datasets were generated or analyzed during the current study.

Ethics Approval

Ethical approval was not required because this review did not involve human participants, animals, or newly generated biological samples.

Consent for Publication

All authors have given consent for publication.

Conflict of Interest

The authors declare no potential conflict of interest.

Author Contributions

Soheil Balsini Gavanaroudi: Conceptualization, literature search and identification, evidence synthesis, methodology, and writing-original draft. Chero Kavian: Literature search and identification, evidence interpretation, methodology, and writing- review and editing. Ali Soheyli: Clinical and nursing interpretation, development of the nursing framework, validation of nursing-related content, and writing-review and editing. Forough Motavaf: Conceptualization, evidence interpretation, development of the review framework, and writing-review and editing. All authors critically reviewed the manuscript, approved the final version for publication, and agree to be accountable for the integrity and accuracy of the work.

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