



Research Progress on Risk Factors and Preventive Nursing Strategies of Pressure Injuries in Hospitalized Patients

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ABSTRACT

Pressure injuries (PIs) are serious hospital-acquired soft-tissue adverse events induced by sustained pressure, shear stress and frictional force. Across global acute-care medical institutions, hospital-acquired pressure injuries continue to impose heavy clinical and socioeconomic burdens, particularly within intensive-care, geriatric, oncological, cardiac-surgical and long-term rehabilitation hospital wards (Coleman et al., 2024). Patients suffering from newly-developed pressure injuries face elevated risks of local soft-tissue necrosis, secondary bacterial infection, biofilm formation, sepsis, prolonged hospital stay, functional decline, palliative-care burden and all-cause mortality (Moore et al., 2023; Gillespie et al., 2022). Sub-clinical deep-tissue damage without visible epidermal breakage is easily missed during routine ward assessment, contributing to silent progression toward full-thickness pressure injury (Black et al., 2025). The updated NPIAP-EPUAP-PPPIA 2025 international clinical guideline revises core definitions, risk-assessment workflows, differential-diagnosis algorithms for deep-tissue pressure injury, device-related injury classification and evidence-based preventive nursing bundle components, providing updated consensus for global clinical nursing practice (Black et al., 2025). Emerging research has explored circulating biological markers, artificial-intelligence-assisted skin image recognition, and subgroup-tailored prevention protocols for cardiac-surgical, prone-position ventilated and frail older-adult inpatients (Pereira et al., 2024; Li et al., 2023). This narrative review comprehensively elaborates non-modifiable and modifiable risk dimensions of pressure injuries for adult hospitalized patients, summarizes multi-dimensional evidence-based preventive nursing interventions, discusses implementation obstacles existing in real-world clinical nursing settings, reviews emerging innovative preventive approaches, and puts forward targeted improvement suggestions. This work intends to supply high-quality theoretical reference for front-line clinical nurses to implement standardized pressure-injury prevention workflows and lower the incidence of hospital-acquired pressure injuries.

Keywords: *hospitalized patients; pressure injury; risk factors; preventive nursing; evidence-based nursing; care bundle; hospital-acquired pressure injury*

1. Introduction

The formal definition of pressure injury published by NPIAP-EPUAP-PPPIA (2025) describes localized damage of skin and subcutaneous soft-tissue structures, mostly occurring over bony prominences, or directly associated with compression from medical therapeutic devices; tissue damage originates from prolonged or intense mechanical pressure combined with shear and frictional loading (Haesler et al., 2024). Compared with the 2021 guideline iteration, the 2025 version strengthens clinical recognition of intact-skin deep-tissue pressure injury (DTPI), optimizes diagnostic description for medical-device-related pressure injuries (MDRPI), establishes clear differential-diagnosis pathways to distinguish pressure injury from incontinence-associated dermatitis (IAD), and emphasizes the conceptual boundary between unavoidable pressure injury and preventable hospital-acquired cases (Clark et al., 2025; Bee et al., 2022).

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Multi-national cross-sectional epidemiological investigations demonstrate that pooled global prevalence of hospital-onset pressure injury among adult acute-care inpatients ranges between 7.2%-18.6%, and the incidence climbs sharply to 22.3%-34.1% for mechanically ventilated critically-ill subgroups (Papanikolaou et al., 2022). Special clinical subgroups exhibit distinctly higher vulnerability: cardiac-surgical postoperative patients receiving prolonged intraoperative compression show 19.4%-27.8% hospital-acquired pressure-injury risk; patients managed in prone-position ventilation for acute respiratory distress syndrome possess particularly high MDRPI and sacral DTPI incidence (Silva et al., 2024; Yang et al., 2023). Advanced age, immobility, organ-function impairment and multiple comorbidities jointly render elderly and critically-ill populations the highest-risk patient subgroups (Santos et al., 2023).

Although a small fraction of pressure injuries is classified as unavoidable among end-stage, severely oedematous or heavily haemodynamically unstable patients, overwhelming majority of hospital-acquired pressure injuries can be avoided through systematic risk screening, timely risk stratification and standardized nursing preventive interventions (García-Fernández et al., 2022). Nevertheless, multiple real-world clinical barriers hinder prevention effectiveness: insufficient nursing workforce allocation, incomplete risk-assessment execution, inconsistent adherence to bundle-care protocols, inadequate nutritional intervention, lack of standardized skin-care protocols for moisture-exposed patients, gaps in special-subgroup targeted protocols, and insufficient training for newly-recruited nursing staff (Jackson et al., 2024). Furthermore, traditional manual visual skin assessment has intrinsic limitations for detecting early deep-tissue injury under intact skin (Pereira et al., 2024). Therefore, systematic comprehension of multi-layered risk factors and mastery of latest evidence-based preventive nursing strategies together with emerging digital-nursing tools are essential for advancing nursing quality-control management. This review sorts out domestic and international latest research literatures, integrates 2025 international guideline recommendations, analyzes risk-factor dimensions and preventive nursing measures in-depth, discusses practical challenges of clinical implementation and future research directions.

2. Multidimensional risk factors for pressure injuries in hospitalized patients

Risk factors for hospital-acquired pressure injuries are commonly divided into non-modifiable patient-intrinsic factors and modifiable extrinsic clinical-treatment-related factors (Papanikolaou et al., 2022). Non-modifiable intrinsic factors cannot be intervened by clinical nursing measures, yet they are critical baseline signals for risk stratification. Modifiable extrinsic factors constitute the primary targets for nursing preventive interventions. It should be emphasized that risk factors exert synergistic interactive effects, rather than isolated independent actions (Banks et al., 2023). For instance, advanced ageing skin atrophy will amplify tissue damage induced by shear force and malnutrition. Single clinical indicator cannot reliably predict pressure-injury onset; multi-item comprehensive risk-assessment scales remain core screening instruments for clinical practice (Coleman et al., 2024). The Braden Scale retains first-line recommendation status within the NPIAP-EPUAP-PPPIA 2025 guideline; Norton Scale and Waterlow Scale serve as supplementary assessment tools for geriatric, palliative-care and long-term-care populations (Haesler et al., 2024). Even validated scales possess definite false-negative rates in ICU prone-position and cardiac-surgical populations; clinical nurses must combine scale results with holistic clinical judgement instead of mechanically relying on scoring outcomes (Silva et al., 2024). Table 1 summarizes the classification, concrete content, pathological mechanism and clinical characteristics of major pressure-injury risk factors for hospitalized patients.

Table 1 Summary of major risk factors for pressure injuries among hospitalized patients

Risk factor category	Specific items	Pathological mechanism	Clinical feature
Non-modifiable patient-related factors	Advanced age ≥ 75 years	Cutaneous atrophy, reduced subcutaneous adipose tissue, peripheral microcirculation autoregulation decline	Bed-ridden elderly patients exhibit significantly elevated risk (Santos et al., 2023)
	Terminal illness / palliative care status	Systemic catabolic metabolism, multiple-organ function decline	Higher probability of unavoidable pressure injury (García-Fernández et al., 2022)
	Genetic tissue susceptibility	Connective-tissue structural difference, impaired tissue repair capacity	Individual variance in equivalent mechanical pressure exposure (Banks et al., 2023)
	Mobility-activity limitation / bedridden state	Sustained local tissue compressive load, impaired spontaneous position change	Highest-risk factor for hospital-acquired pressure injury (Moore et al., 2023)
Modifiable intrinsic patient-related factors	Malnutrition, hypoalbuminaemia	Decreased interstitial colloidal osmotic pressure, tissue oedema, weakened tissue repair	Serum albumin less than 30 g/L corresponds to markedly increased risk (Jackson et al., 2024)
	Skin moisture exposure: incontinence, sweat, wound exudate	Cuticle maceration, reduction of skin barrier mechanical resistance	Incontinence patients show higher superficial-injury risk (Bee et al., 2022)
	Chronic medication: glucocorticoids, sedatives, neuromuscular blocking agents	Cutaneous tissue thinning, reduced spontaneous movement, sensory blunting	Common risk among ICU mechanically ventilated patients (Clark et al., 2025)
	Anaemia, hypoperfusion status	Peripheral tissue oxygen supply insufficiency	Tissue tolerance to mechanical pressure decreases significantly (Papanikolaou et al., 2022)
Extrinsic clinical-environmental factors	Sustained pressure, shear force, friction	Capillary occlusion, ischaemic tissue injury, epidermal abrasion	Bony prominence locations are high-incidence sites (Black et al., 2025)
	Medical-device compression: mask, catheter, fixation band	Localized compressive damage directly caused by therapeutic apparatus	Independent high-risk injury category defined in 2025 guideline (Haesler et al., 2024)
	Insufficient repositioning frequency, inappropriate support surface	Persistent tissue mechanical load without effective decompression	Major preventable cause of ward-acquired pressure injury (Coleman et al., 2024)

Note: Risk-assessment scales should be reassessed upon patient condition deterioration, operation transfer, ward-transfer events (NPIAP-EPUAP-PPPIA, 2025). Clinical holistic judgement cannot be replaced by scale scores alone (Silva et al., 2024).

2.1 Non-modifiable intrinsic risk factors

Advanced age represents one well-documented baseline risk factor. After the age of 75 years, human skin epidermis and dermis layers undergo progressive atrophy, subcutaneous fat padding decreases, dermal collagen-fibre arrangement becomes loose, and peripheral microvascular autoregulatory capacity declines (Santos et al., 2023). Even under identical mechanical-pressure conditions, aged soft tissue sustains ischaemic damage far more easily compared with young-adult tissue. Frailty deserves separate emphasis among older subgroups: frail elderly patients exhibit sarcopenia-related muscle mass loss, which further eliminates soft-tissue cushioning effect over bony prominences (Brown et al., 2022). Terminal-stage disease and palliative-care patients present persistent systemic catabolic metabolism, multiple-organ function recession; even if nursing preventive measures are fully implemented, part of these patients will develop unavoidable pressure injuries (García-Fernández et al., 2022). Genetic connective-tissue susceptibility also generates inter-individual outcome differences: certain patients possess weaker connective-tissue anti-shear capacity, and tissue injury emerges under relatively low mechanical load (Banks et al., 2023). It must be emphasized that non-modifiable factors do not directly produce

pressure injuries; they only elevate overall vulnerability of patients, requiring enhanced intensity of subsequent preventive nursing measures (Jackson et al., 2024).

2.2 Modifiable patient-intrinsic risk factors

Mobility and activity-level limitation is the strongest modifiable risk factor for hospital-onset pressure injuries (Moore et al., 2023). Patients who cannot independently complete body repositioning are exposed to uninterrupted compressive stress over bony-prominence sites. Special attention should be paid to patients restrained for therapeutic reasons, for example trauma orthopaedic immobilization, which artificially abolishes spontaneous positional adjustment (Gillespie et al., 2022). Nutritional disturbance occupies critical status: hypoalbuminaemia, insufficient protein and energy intake induce interstitial oedema and impair soft-tissue repair potential. Clinical observational research indicates serum albumin below 30 g/L correlates with 2.7-fold elevated pressure-injury risk (Jackson et al., 2024). Beyond albumin, pre-albumin, transferrin and sarcopenia-related biochemical markers also serve as auxiliary warning indicators (Brown et al., 2022). Skin moisture damage caused by urinary or faecal incontinence, perspiration and wound exudate leads to stratum-corneum maceration, weakening epidermal mechanical-barrier function; moist skin sustains friction-related injury far more readily (Bee et al., 2022). Pharmacological exposures also exert notable influence: long-term glucocorticoid application induces dermal thinning; sedatives and neuromuscular-blocking agents depress consciousness and spontaneous physical movement, frequently encountered within ICU populations (Clark et al., 2025). Anaemia and systemic hypoperfusion reduce peripheral tissue oxygen delivery capacity, lowering tissue tolerance threshold for mechanical pressure (Papanikolaou et al., 2022). In cardiac-surgical patients, intraoperative hypotension further aggravates peripheral tissue ischaemic susceptibility (Silva et al., 2024).

2.3 Extrinsic clinical-environmental risk factors

The core extrinsic physical forces driving pressure-injury generation are pressure, shear stress and friction (Black et al., 2025). Sustained pressure compresses local capillaries, obstructing tissue blood perfusion; shear force distorts subcutaneous microvascular architecture, even when surface pressure appears moderate. Shear-force injury is especially prominent in patients with elevated head-of-bed position, prone-ventilation patients and postoperative sedated patients (Yang et al., 2023). Medical-device-related pressure injury receives prominent emphasis in the 2025 guideline, including injuries induced by non-invasive ventilation masks, endotracheal-tube fixators, drainage catheters and adhesive securing dressings (Haesler et al., 2024). MDRPI may appear in non-classic anatomical sites such as nasal bridge, auricle, cheek, limbs, which are easily neglected during routine skin inspection (Clark et al., 2025). Substandard nursing workflows such as insufficient repositioning frequency and mismatched support-surface selection constitute major preventable reasons for ward-acquired pressure injuries (Coleman et al., 2024). It is worth noting that even high-grade dynamic pressure-redistribution mattresses cannot completely offset harm produced by excessive shear force.

3. Evidence-based preventive nursing strategies for hospitalized patients

NPIAP-EPUAP-PPPIA (2025) advocates multi-component preventive nursing bundles rather than isolated single-measure interventions. A pressure-injury preventive care bundle integrates risk assessment, skin surveillance, repositioning protocol, appropriate support-surface deployment, skin moisture protection, nutritional collaborative intervention, medical-device-pressure-reduction management and health education (Haesler et al., 2024). Multiple systematic-review meta-analysis studies confirm standardized bundle-nursing implementation can lower hospital-acquired pressure-injury incidence by 40%-62% (Smith et al., 2023). Nevertheless, generic universal bundles cannot fully satisfy the requirement of special high-risk subgroups, such as prone-position ARDS patients, cardiac-surgical postoperative patients and frail palliative-care inpatients (Yang et al., 2023; Silva et al., 2024). Therefore, subgroup-modified bundle adjustment has gradually become research hotspot in recent years. Besides conventional manual nursing measures, digital-assisted preventive approaches including AI-driven skin image analysis, smart mattress pressure-mapping monitoring and electronic-system repositioning reminder modules have shown preliminary application value in pilot ward settings (Pereira et al.,

2024; Li et al., 2023). Table 2 lists each core module of pressure-injury preventive nursing bundle, concrete operational points and evidence-level annotation.

Table 2 Core modules of pressure-injury preventive nursing bundle for hospitalized patients

Bundle module	Key operational points	Evidence level (2025 guideline)
Timely risk reassessment	Complete Braden-scale screening upon admission; reassess after condition change, surgery, ward transfer; combine clinical holistic judgement	High (Haesler et al., 2024; Silva et al., 2024)
Systematic skin surveillance	Full-body skin inspection each shift; focus on bony prominences and device-contact skin; identify early DTPI warning signs; record skin status	High (Black et al., 2025)
Standardized patient repositioning	Reposition bed-ridden patients at least every 2-3 hours; avoid 90-degree lateral position; use 30-degree side-lying tilt; formulate individual plan for haemodynamically unstable patients	High (Coleman et al., 2024)
Individualized support-surface selection	High-risk patients deploy dynamic or high-specification static pressure-redistribution mattresses; regular inspection of support-surface function; recognise mattress cannot eliminate shear injury	Moderate-High (Moore et al., 2023)
Incontinence-associated skin protection	Timely cleansing after soiling; apply barrier skin-protection products; minimise prolonged skin-moisture exposure; differentiate IAD versus PI	Moderate (Bee et al., 2022)
Multidisciplinary nutritional intervention	Collaborate with clinical dietitians; optimise protein-energy supply; monitor serum-albumin, pre-albumin and body-weight dynamic change	Moderate (Jackson et al., 2024; Brown et al., 2022)
Medical-device pressure-reduction management	Rational fixation technique; regularly adjust device position; place protective padding between device and skin; inspect hidden skin beneath equipment	High (Clark et al., 2025)
Patient-caregiver health education	Explain pressure-injury risk knowledge; teach correct position-changing skills for family caregivers	Moderate (Santos et al., 2023)

Note: Bundle measures should be adjusted according to patient haemodynamic stability, pain tolerance and individual physical-condition limitation; special-subgroup modification is required for prone-ventilation and cardiac-surgical patients (NPIAP-EPUAP-PPPIA, 2025; Yang et al., 2023).

3.1 Risk screening and whole-body skin assessment

Risk assessment acts as the starting point for all preventive work. According to 2025 guideline requirements, all newly-admitted hospitalized patients must receive risk-scale screening within several hours after admission; reassessment must be triggered by clinical events including condition deterioration, surgical intervention, ward transfer, sedative-medication initiation (Haesler et al., 2024). Nurses should complete comprehensive full-body skin inspection for high-risk patients in each nursing shift. Inspection sites cover occiput, ear, shoulder, sacrum, ischial tuberosity, greater trochanter, heel, malleolus and all skin areas contacting medical devices (Black et al., 2025). Special attention ought to be paid to early warning manifestations of deep-tissue pressure injury: local skin purple-maroon discoloration under intact epidermal surface, local tissue hardness or tenderness, even without epidermal breakage (Clark et al., 2025). It is critical to carry out differential diagnosis between pressure injury and incontinence-associated dermatitis: IAD distributes within skin folds and perineal area without strictly corresponding to bony-prominence location (Bee et al., 2022). Abnormal skin findings need accurate documentation within nursing records. At present, near-infrared spectroscopy and artificial-intelligence skin image recognition are being explored as auxiliary tools for detecting sub-clinical deep-tissue damage, yet large-scale clinical popularization still requires further validation (Pereira et al., 2024).

3.2 Position-repositioning and pressure-redistribution support-surface management

Repositioning remains the cornerstone physical intervention for pressure-injury prevention (Coleman et al., 2024). For haemodynamically stable bed-ridden patients, repositioning frequency is recommended at minimum every 2-3 hours. The guideline explicitly discourages rigid 90-degree side-lying posture; 30-degree oblique lateral tilt is preferred, lowering shear-force load over

trochanteric region (Haesler et al., 2024). For patients suffering unstable haemodynamics who cannot tolerate frequent turning, multidisciplinary team discussion is required to formulate individualised decompression plans, and fully document rationale for adjusted repositioning intervals (NPIAP-EPUAP-PPPIA, 2025). Support-surface mattresses cannot substitute regular repositioning operations. High-risk patients should be allocated pressure-redistribution mattresses matching patient body-weight range; nursing staff regularly check mattress inflation status and functional integrity (Moore et al., 2023). Heel decompression deserves extra clinical attention; suspend heels off bed-surface when conditions permit to eliminate direct compressive load (Banks et al., 2023). For special subgroups such as prone-position ventilation patients, repositioning logic must be adjusted according to respiratory-support parameters to balance lung-protective ventilation goals and pressure-injury prevention (Yang et al., 2023).

3.3 Moisture-associated skin care and multidisciplinary nutritional intervention

Faecal or urinary incontinence, sweat and wound exudate produce skin maceration, raising superficial-pressure-injury risk (Bee et al., 2022). Contaminated skin receives gentle cleansing using mild pH-balanced cleaning agents; abrasive scrubbing must be avoided. Appropriate skin-barrier protective products are applied to decrease moisture-related epidermal damage. Nutritional support is multidisciplinary collaborative work: clinical nurses identify risk signals, initiate consultation requests for clinical dietitians, optimise protein and energy intake for at-risk patients, monitor dynamic changes of body-weight, serum albumin and pre-albumin (Jackson et al., 2024; Brown et al., 2022). Malnourished patients obtain individualised nutritional formulation; oral nutritional supplements are applied when oral intake remains insufficient. For sarcopenic frail elderly patients, adequate protein supply simultaneously improves muscle mass and soft-tissue cushioning capacity, forming dual protective effects against pressure injury (Brown et al., 2022).

3.4 Medical-device-related pressure injury targeted prevention

Device-associated pressure injury is an independent high-risk category highlighted within the 2025 guideline (Black et al., 2025). Clinical devices such as non-invasive ventilation masks, tracheal-tube fasteners, pulse-oximetry probes and drainage tubes can produce local compressive tissue damage. Nurses select appropriately-sized medical apparatus; avoid over-tight fixation; insert soft protective padding between device and skin whenever clinically permissible; periodically adjust contact location of fixed equipment (Clark et al., 2025). During each nursing shift, inspect skin underneath all fixed medical devices; do not omit skin assessment due to difficulty of device removal. For non-invasive ventilation patients, mask-fit adjustment and prophylactic foam dressing application over nasal bridge are core preventive steps (Peng et al., 2023).

3.5 Emerging digital-nursing auxiliary preventive approaches

Digital nursing tools gradually provide supplementary support for pressure-injury prevention workflow (Pereira et al., 2024). Smart pressure-mapping mattresses can reflect real-time local pressure distribution, helping nurses judge decompression effectiveness. Hospital information-system embedded automatic reposition-reminder modules reduce human-caused missed-reposition events (Li et al., 2023). AI-based skin image recognition assists nurses to capture subtle early skin colour changes which human eyes may ignore. It should be emphasised that digital tools serve only as auxiliary means and cannot replace nurses' comprehensive clinical assessment. At present, cost constraints and equipment compatibility restrict large-scale promotion in grassroots medical institutions (Pereira et al., 2024).

4. Barriers to clinical implementation of preventive-nursing bundles and optimisation suggestions

Even though abundant high-level evidence exists supporting pressure-injury preventive bundles, real-world clinical execution still encounters multiple practical obstacles (Smith et al., 2023). We can subdivide barriers into four dimensions: human-resource-related barriers, knowledge-competence barriers, material-resource barriers, and patient-condition-dependent barriers.

First, human-resource-related barriers include insufficient nursing staffing ratio, heavy clinical bedside workload, frequent shift hand-over information loss, and high nurse turnover rate (Jackson et al., 2024). Under high-workload circumstances, risk reassessment, detailed full-body skin inspection and strict repositioning schedules are prone to be compressed or omitted. Second,

knowledge-competence barriers: partial clinical nurses possess incomplete understanding of deep-tissue pressure injury and MDRPI diagnostic criteria; some staff over-estimate the protective effect of high-end mattresses and underestimate the irreplaceable value of manual repositioning (Banks et al., 2023). Knowledge gaps are especially prominent among newly graduated nurses and temporary staff. Third, material-resource barriers: insufficient allocation of pressure-redistribution mattresses, shortage of prophylactic protective dressings, lack of digital auxiliary equipment in primary-level hospitals restrict intervention execution. Fourth, patient-condition-dependent barriers: refractory agitation, poor cooperation from patients and family caregivers; clinical limitations such as haemodynamic instability, severe traumatic injury, painful surgical wounds make standard bundle-measures hard to fully implement (García-Fernández et al., 2022). Some clinical departments mechanically copy universal bundle protocols without carrying out targeted modification for prone-ventilation, cardiac-surgical postoperative subgroups (Yang et al., 2023).

Targeted optimisation proposals are summarised as follows. First, medical institutions should organise regular standardised training targeting pressure-injury prevention knowledge for nursing staff, including new-nurse orientation and periodic refresher education, with special modules for DTPI and MDRPI identification and special-subgroup prevention (Santos et al., 2023). Second, construct ward-level pressure-injury quality-control groups, conduct regular ward spot-check audits, track bundle-measure implementation compliance rate, discover practical problems on-site and carry out continuous quality improvement; strengthen shift-handover standardized documentation of high-risk patients (García-Fernández et al., 2022). Third, strengthen multi-disciplinary collaboration mechanism among nurses, dietitians, physicians and wound-care specialists. Fourth, deliver systematic health education for patients and family caregivers, popularise pressure-injury-relevant risk knowledge and correct home-care position-changing skills (Moore et al., 2023). Fifth, formulate special-population flexible adjustment schemes for critically-ill, trauma, unstable-haemodynamic patients, avoid mechanically copying standard bundle protocols without individual consideration (NPIAP-EPUAP-PPPIA, 2025). Sixth, condition-permitting hospitals can appropriately introduce partial digital auxiliary nursing tools as supplementary prevention measures, without blindly pursuing high-tech equipment while ignoring basic nursing work (Pereira et al., 2024).

5. Research gaps and future research perspectives

Current domestic-and-foreign-related research still has certain research gaps. First, most existing meta-analyses focus on general adult hospitalized populations; high-quality prospective cohort studies aiming at special subgroups including prone-position ARDS patients, cardiac-surgical postoperative patients, frail sarcopenic elderly inpatients remain relatively scarce (Silva et al., 2024; Brown et al., 2022). Uniform validated risk-assessment instruments specifically for ICU subgroups are still lacking. Second, the predictive value of circulating biochemical biomarkers (such as inflammatory cytokines, muscle-derived myokines) for early pressure-injury onset still needs further large-sample external verification; there is no widely-accepted laboratory index for clinical early warning (Pereira et al., 2024). Third, research concerning cost-effectiveness analysis of preventive bundles and digital-nursing tools is insufficient; it remains unclear which schemes possess optimal cost-benefit ratio under limited-resource primary-hospital scenarios (Li et al., 2023). Fourth, majority of existing intervention studies originate from high-and-middle-income medical centres; real-world implementation data in resource-limited grassroots medical institutions require further accumulation. Fifth, qualitative research exploring front-line nurses' real-world difficulties, psychological burden and coping strategies in pressure-injury prevention practice is relatively insufficient.

Future research directions can focus on the following aspects:

- (1) Conduct multi-centre prospective cohort studies for special high-risk subgroups, explore subgroup-specific independent risk factors, and optimise subgroup-adapted modified preventive-care-bundle schemes.
- (2) Further verify the clinical predictive efficiency of biochemical markers and non-invasive auxiliary detection techniques (near-infrared spectrum, AI skin image recognition), develop convenient early warning tools suitable for clinical ward-side application.

(3) Carry out health-economic evaluation for various prevention schemes, compare cost-effectiveness of traditional manual bundle versus digital-assisted prevention modes, provide evidence for resource allocation decision-making of grassroots medical institutions.

(4) Apply mixed-method research combining quantitative and qualitative approaches, deeply excavate practical obstacles, incentive factors of pressure-injury prevention among front-line nursing teams, so as to formulate targeted quality-improvement strategies.

(5) Strengthen research on unavoidable pressure-injury identification standard, recording specification and multidisciplinary evaluation mechanism, reduce clinical confusion in practical judgement.

6. Conclusion

Hospital-acquired pressure injury remains an important global nursing-quality-control indicator. Its occurrence results from combined action of non-modifiable patient-intrinsic vulnerability and multiple modifiable extrinsic clinical risk factors (Papanikolaou et al., 2022). Risk factors produce synergistic interaction rather than independent effects. The updated NPIAP-EPUAP-PPPIA 2025 guideline supplies updated consensus for risk screening, skin assessment including deep-tissue injury identification, repositioning strategy, support-surface selection, moisture skin-care, nutritional intervention and medical-device-related-injury prevention (Black et al., 2025). Multicomponent evidence-based preventive nursing bundles represent the optimal practice mode for reducing hospital-onset pressure-injury incidence, meanwhile bundles require flexible individualised adjustment for special clinical subgroups. Emerging digital-nursing auxiliary tools offer new auxiliary pathways for prevention workflow, but cannot replace core manual nursing work. In real-world clinical nursing practice, execution obstacles such as manpower constraints, knowledge gaps and material shortages still restrict intervention effect, which can be decomposed into human-resource, knowledge-competence, material-resource and patient-condition-related barriers. Medical institutions need to combine institutional practical conditions, strengthen staff training, build sound quality-control mechanisms, promote multidisciplinary cooperation, and realise individualised implementation of preventive-nursing strategies for different-risk-level hospitalized patients. In future, higher-quality original clinical research is still required to further optimise preventive-nursing workflows for special subgroups including mechanically-ventilated critical-care patients, cardiac-surgical postoperative patients and frail sarcopenic elderly inpatients.

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