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The Effectiveness of Nursing Interventions in Preventing Medical Adhesive-Related Skin Injuries in Hospitalized Patients

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ABSTRACT: Medical adhesive-related skin injuries (MARSI) are a frequently underestimated yet clinically significant complication among hospitalized patients, encompassing mechanical trauma such as skin tears and epidermal stripping, as well as irritant contact dermatitis and tension blisters arising from the use of tapes, dressings, and securement devices. These injuries compromise skin integrity, increase the risk of infection,

prolong healing, generate avoidable discomfort, and contribute to higher care costs and extended length of stay. Because MARSI is largely preventable, nursing practice occupies a central position in risk identification and mitigation, with interventions spanning systematic skin assessment at admission, documentation of fragile or compromised skin, appropriate product selection based on skin condition and adhesive strength, and standardized removal techniques that minimize shear and traction forces. Evidence from clinical studies and quality improvement initiatives consistently demonstrates that structured nursing interventions substantially reduce the incidence of MARSI. Bundled approaches—combining staff education, standardized assessment tools, adhesive selection algorithms, skin barrier products, and correct application and removal techniques—have been associated with significant reductions in injury rates, often by half or more, alongside improved documentation and greater staff awareness of risk factors. Adherence to these protocols, however, remains variable, and sustained benefit depends on ongoing training, audit and feedback, and integration of prevention principles into routine workflows. Overall, the literature supports nursing-led prevention as a cost-effective and clinically meaningful strategy, though further rigorous studies are needed to standardize definitions and outcome measures across settings.

INTRODUCTION

Medical adhesive-related skin injury (MARSI) is defined as erythema or another cutaneous abnormality—including vesicle, bulla, erosion, or tear—that persists for 30 minutes or more after removal of an adhesive product [1]. Medical adhesives are used on nearly every hospitalized patient for vascular access securement, wound dressings, electrodes, tubing fixation, ostomy products, and monitoring devices. Because nurses select, apply, maintain, and remove most of these products, nursing practice is central to whether adhesives protect patients or injure them [1]. MARSI is therefore not a minor skin issue but a nursing-sensitive patient safety problem that affects comfort, skin integrity, infection risk, healing, length of stay, and healthcare cost [1]. The scale of the problem is substantial. In adult acute care, point prevalence estimates for any MARSI have ranged from 3.4% to 25.0%, with a mean of approximately 13% [2]. In critically ill adults, a meta-analysis of 20 studies involving 4,337 patients estimated a pooled MARSI incidence of 25.21% (95% CI 17.99–34.12) [3]. These figures are clinically important because intensive care patients often have oedema, impaired perfusion, sedation, mechanical ventilation, and a high density of adhesive devices, all of which increase skin vulnerability [3].Paediatric and neonatal populations are also heavily affected. In paediatric intensive care, MARSI has been reported in a substantial proportion of patients, and the immature skin barrier of preterm infants makes adhesive trauma especially likely [4]. In very preterm infants, adhesive application days are a practical denominator for surveillance because each dressing, electrode, and securement device represents a repeated exposure to mechanical risk [4]. This epidemiological pattern reinforces the need for prevention to begin at admission rather than after skin damage becomes visible [4]. Nursing interventions are particularly important because adhesive injury is largely avoidable. Best-practice guidance emphasizes gentle product selection, tension-free application, low-angle removal, skin protection, and the use of silicone-based adhesive removers [5]. These actions are within the direct control of bedside nurses and can be standardized through education, documentation, risk assessment, and bundled care [5]. The effectiveness of nursing interventions therefore depends not only on individual technique but also on how consistently prevention is organized at the unit level [5].

Pathophysiology and Classification of MARSI

The skin's outermost layer, the stratum corneum, consists of flattened corneocytes embedded in a lipid matrix that provides a water-resistant and mechanically resilient barrier [6]. A medical adhesive must bond strongly enough to secure a device, but the force required to break that bond during removal is transmitted directly to the stratum corneum and, in fragile skin, to deeper layers [6]. When the adhesive attachment exceeds the tensile strength of the skin, mechanical failure occurs within the skin rather than at the adhesive–skin interface [6]. This principle explains why MARSI is fundamentally an iatrogenic mechanical injury, although inflammatory and moisture-related mechanisms also contribute [1].

MARSI is conventionally classified into mechanical injuries, dermatitis, and other adhesive-related events [1]. Mechanical injuries include skin stripping, tension injury or blister, and skin tear [6]. Dermatitis includes irritant contact dermatitis and allergic dermatitis, while other events include folliculitis and maceration [1]. Skin stripping is consistently the most frequently

reported subtype; in critically ill patients, skin stripping has accounted for a large majority of cases [3]. This predominance is clinically important because skin stripping is almost entirely preventable through correct removal technique and appropriate product selection [5].

Epidemiology and Clinical Impact

MARSI is common across every hospitalized population in which it has been systematically measured [7]. In adult intensive care, scoping review evidence shows that prevalence and incidence vary widely because of differences in case definition, surveillance intensity, and population risk [7]. Even so, the consistent pattern is that patients with higher adhesive exposure and greater physiological vulnerability have higher rates of injury [2]. The variation in reported rates should not be interpreted as uncertainty about whether MARSI occurs; rather, it reflects differences in how actively clinicians look for it [7].

The clinical consequences of MARSI extend well beyond the visible skin defect [2]. Patients commonly experience pain, burning, and irritation during and after adhesive removal [3]. Damage to the skin barrier increases the risk of local infection, and in the presence of an indwelling device, local infection can progress to bloodstream infection [7]. Healing is delayed, and new wounds may require additional dressings—which in turn require further adhesives, creating a cycle of iatrogenic harm [2]. The psychological burden is also significant: patients, particularly children and older adults, may develop anxiety and fear around dressing changes [4].

Economically, MARSI consumes additional nursing time, dressing materials, and analgesia, and it may prolong hospitalization [7]. These costs are often invisible in routine accounting because they are distributed across nursing shifts, dressing supplies, and infection-control resources [2]. When MARSI is measured as a nursing-sensitive quality indicator, however, its burden becomes visible and actionable [7]. Prevention is therefore not merely a skin-integrity issue but a determinant of hospital efficiency, patient flow, and patient experience [3].

Risk Factors and Risk Assessment

Effective prevention begins with recognizing which patients are most vulnerable [8]. Risk assessment is informed by predictive models, although most published MARSI prediction models have methodological limitations and require external validation before they can be used as stand-alone decision tools [8]. Even so, these models consistently identify advanced age, skin fragility, oedema, moisture, impaired mobility, and adhesive exposure as important predictors [8]. Risk assessment should therefore structure clinical judgment rather than replace it [8].

MARSI-specific instruments have been developed for hospitalized adults [9]. A risk assessment scale comprising multiple items across domains of skin condition, physiology, and treatment exposure has demonstrated content validity and acceptable predictive validity, with lower scores identifying low-risk patients and higher scores identifying high risk [9]. In neonates, structured skin condition and risk tools are used to stratify risk and trigger preventive bundles [4]. The practical nursing implication is that every patient with adhesives should have a documented risk status that is reviewed when the device is applied, checked, and removed [9].

Risk factors can be divided into intrinsic patient characteristics and extrinsic care-related exposures [10]. Intrinsic factors include extremes of age, dry or fragile skin, oedema, malnutrition, dehydration, impaired mobility, altered cognitive status, and a history of previous MARSI or skin allergy [10]. Extrinsic factors include the type and dwell time of adhesive products, repeated application and removal at the same site, improper removal technique, and the intensity of adhesive use characteristic of critical care [10]. Table 1 summarizes these factors and their implications for nursing practice.

Table 1. Major Risk Factors for MARSI in Hospitalized Patients

Domain	Representative risk factors	Clinical implication for nursing
Demographic and constitutional	Age over 60 years; prematurity; low body weight; dehydration; malnutrition	Prioritize fragile-skin protocols at admission
Skin condition	Dry skin; oedema; moist skin; history of MARSI; allergy history	Inspect and document skin at every adhesive site

Physiological status	Fever; impaired perfusion; lower Braden score; hypoalbuminaemia	Integrate MARSI risk into routine risk assessment
Treatment exposure	Mechanical ventilation; sedatives; intravenous fluids; antibiotics; prolonged length of stay	Increase surveillance frequency in high-exposure patients
Adhesive practices	Repeated application at same site; strong acrylic adhesives; rapid or high-angle removal; tension during application	Standardize selection, application, and removal technique

Core Nursing Preventive Interventions

The evidence base for MARSI prevention converges on a set of interrelated nursing actions: skin assessment, judicious adhesive selection, skin protection, correct application, atraumatic removal, and the use of adhesive removers [11]. These are not isolated tasks but components of a coherent preventive philosophy in which every adhesive encounter is treated as a potential injury event [11]. Nurse-led intensive care models have demonstrated that when these actions are organized systematically, MARSI incidence falls and patient outcomes improve [11].

Skin Assessment and Surveillance

Systematic skin assessment is the foundation upon which all other interventions depend [12]. Nurses should inspect the skin beneath and around every adhesive device at each dressing change and at least once per shift in high-risk patients, documenting temperature, colour, moisture, integrity, and any early signs of erythema or stripping [12]. In neonatal intensive care, the shift from reactive wound care to prospective prevention has been achieved precisely through periodic, structured skin surveillance using validated condition scores [12]. Assessment must include not only the skin under the current adhesive but also previously exposed sites, because repeated application at the same location substantially increases risk [10]. Documentation of baseline skin condition and of each adhesive application creates a longitudinal record that allows early detection and continuous quality monitoring [9].

Selection of Appropriate Adhesives

Not all adhesives are equivalent in their potential to injure skin [5]. Acrylic adhesives generally provide stronger, more sustained adhesion, whereas silicone adhesives offer lower peel force and are less likely to strip the stratum corneum on removal [5]. For patients with fragile or dry skin, silicone-based tapes and soft silicone wound contact layers should be preferred when securement requirements permit [5]. Adhesive selection should also match the clinical purpose: a dressing intended to remain undisturbed for several days requires different adhesive characteristics from an electrode that will be repositioned hourly [5]. Breathable, stretchable, and conformable products reduce tension and moisture accumulation, particularly over joints and oedematous areas [6]. The principle is to use the least aggressive adhesive that will reliably perform the required task, and to avoid strong adhesives where a gentler alternative is clinically adequate [5].

Skin Protection and Barrier Products

When a strong adhesive is unavoidable—for example, to secure a central venous catheter or an endotracheal tube—the skin can be protected with an alcohol-free liquid barrier film before adhesive application [12]. Barrier films polymerize into a thin, transparent interface that reduces the adhesive–skin bond while preserving adhesion to the device [5]. In preterm neonates, an alcohol-free, non-sting silicone-based barrier spray has been used to create a mechanical protective layer between the skin and the adhesive, with measurable reductions in MARSI [12]. Skin protectants should be applied to clean, dry skin and allowed to dry completely before the adhesive is applied; otherwise, adhesion may be compromised and the device may become insecure [5]. Barrier products are particularly indicated for patients with dry, erythematous, or previously injured skin and for those requiring repeated adhesive application at the same site [10].

Application Technique

Many MARSI events begin at the moment of application rather than removal [6]. Adhesives should be applied without tension [5]. Stretching a tape or film during application stores elastic energy that later pulls on the skin as the patient moves or as oedema resolves, producing tension blisters and shear injury [6]. The adhesive should be laid down gently and smoothed with firm, even pressure to ensure contact without creating wrinkles or gaps that can concentrate mechanical stress [5]. Hair should

be clipped rather than shaved at adhesive sites to avoid creating micro-abrasions that weaken the skin–adhesive interface [10]. Where possible, adhesives should be secured to intact skin rather than over bony prominences, and device securement should distribute force over a broader area rather than concentrating it at a single point [5].

Removal Technique

Removal is the highest-risk moment in the adhesive lifecycle [13]. The evidence consistently supports a "low and slow" approach: the adhesive should be peeled back parallel to the skin surface, at a low angle, while the opposite hand supports the skin at the peel line [13]. Pulling an adhesive at a perpendicular or high angle transmits traction directly to the epidermis and sharply increases the risk of stripping [13]. Removal should proceed in the direction of hair growth and should be paused if resistance is encountered, rather than accelerated [13]. For adherent products, stretching the adhesive parallel to the skin can reduce its peel strength and facilitate gentler detachment [5]. The skin should never be allowed to tent or lift during removal; if the adhesive does not release easily, an adhesive remover should be used rather than force [13].

Adhesive Removers

Silicone-based adhesive removers have emerged as a key nursing tool for atraumatic removal [14]. These products diffuse beneath the adhesive edge and reduce the bond between the adhesive and the skin, allowing the product to be lifted without traction [14]. Unlike alcohol or acetone-based solvents, silicone removers are non-irritating, do not sting, and are suitable for fragile, neonatal, and paediatric skin [14]. Clinical evaluations have reported that silicone removers prevent further MARSI episodes, reduce existing skin damage, and decrease pain and anxiety during dressing changes [14]. A randomized trial comparing a silicone-based remover with an isopropanol-based solution is underway, and preliminary expectations suggest a substantial reduction in MARSI incidence with the silicone product [15]. Adhesive removers should be used routinely for high-risk patients and for any adhesive that does not release easily, rather than reserved as a rescue measure after injury has occurred [14].

Bundled Care Approaches

Single interventions produce modest effects; bundled, multimodal programmes produce substantial and sustained reductions in MARSI [16]. The SECURE care bundle—Skin assessment, secure fixation without injury, adhesive selection, correct application and removal, use of a silicone-based remover, and documentation/evaluation—was designed for paediatric central venous catheter fixation and has been associated with reduced MARSI incidence and delayed onset of injury [16]. In adult intensive care, a prevention bundle grouped into skin assessment, risk identification, product selection, skin preparation, application technique, removal technique, and continuing education has been developed and validated [17]. Implementation of a nurse-led evidence-based bundle in an adult ICU reduced MARSI incidence from 20.21% to 3.19% [17]. A quality improvement programme in a neonatal intensive care unit reduced median MARSI rates from 30 to 21.2 events per 1,000 adhesive application days after the first PDSA cycle, and further reductions followed subsequent cycles [18]. In another quality improvement project, MARSI incidence fell from 17.4% to 0% following implementation of a prevention programme [19]. A further pilot programme in gynaecological patients demonstrated that a structured enhancement programme can improve adhesive practices and reduce injury [20]. These results demonstrate that the effectiveness of nursing interventions is amplified when they are delivered as a coordinated bundle rather than as isolated practices [16].

Table 2. Components of a Nursing MARSI Prevention Bundle and Supporting Evidence

Bundle component	Key nursing actions	Evidence of effect
Structured skin assessment	Inspect adhesive sites every shift; document erythema, moisture, integrity; use validated risk/condition scores	Early detection and targeted prevention in ICU and NICU
Risk stratification	Apply MARSI-specific or neonatal risk tools; flag high-risk patients	Validated scales identify high-risk adults and neonates
Adhesive selection	Choose silicone or gentle adhesives when possible; match product to purpose and dwell time	Silicone adhesives reduce stripping on removal
Skin protection	Apply alcohol-free barrier film or spray before strong adhesives	Barrier spray reduced MARSI in preterm infants

Application technique	Apply without tension; smooth with firm pressure; clip hair	Tension-free application reduces blister and shear risk
Removal technique	Remove low and slow, parallel to skin, supporting the peel line	Low-angle removal reduces epidermal stripping
Adhesive remover	Use silicone-based remover for adherent products and fragile skin	Silicone removers reduce pain and further injury
Education and audit	Train staff; audit compliance; feed back MARSI rates	Education improves knowledge and reduces incidence

Education and Training of Nursing Staff

The effectiveness of any preventive bundle depends on the knowledge and skill of the nurses who deliver it [21]. Surveys consistently reveal gaps in MARSI awareness and practice [21]. In one quality improvement initiative, pre-intervention nursing knowledge was 68%, and MARSI incidence was 0.33 per 1,000 patient days; after targeted education and protocol revision, knowledge rose to 95% and incidence fell to 0.18 per 1,000 patient days [21]. In another programme, staff unfamiliarity with MARSI decreased from 32% to 10%, and reported use of silicone-based adhesive remover increased from 38% to 70% following education [21]. Education should cover skin physiology and fragility, risk assessment, product selection, application and removal technique, recognition and reporting of MARSI, and the correct use of barrier films and adhesive removers [22]. Practical, hands-on training—using adhesive samples, removal simulations, and audit with feedback—is more effective than didactic instruction alone [22]. Embedding MARSI prevention into nursing orientation and annual competency programmes ensures that knowledge is sustained beyond the lifespan of a single quality improvement project [21].

Special Populations

The principles of MARSI prevention are universal, but their application must be adapted to populations whose skin is developmentally, structurally, or physiologically different from that of healthy adults [4]. Neonates and preterm infants have a thin, poorly keratinized stratum corneum, immature barrier function, and a high ratio of body surface area to weight, making them exquisitely vulnerable to adhesive trauma [4]. Adhesive selection should favour silicone-based products, barrier films should be used liberally, and removal should be performed with particular patience and, where necessary, a silicone remover [12]. Paediatric patients present additional challenges related to device securement, movement, and the emotional distress of dressing changes; the SECURE bundle was developed specifically for paediatric central venous catheter fixation [16]. Older adults frequently have dry, fragile, inelastic skin, often compounded by malnutrition, polypharmacy, and cognitive impairment; barrier films, gentle adhesives, and meticulous removal technique are particularly important [10]. Critically ill adults occupy the highest-risk category because they combine physiological instability, oedema, impaired perfusion, and an exceptionally high density of adhesive devices [3]. In all special populations, the intensity of surveillance and the threshold for using protective products should be higher than in general ward patients [9].

Table 3. Population-Specific Considerations for MARSI Prevention

Population	Key vulnerabilities	Nursing priorities
Preterm and term neonates	Thin stratum corneum; immature barrier; high surface-area-to-weight ratio	Silicone adhesives; barrier spray; neonatal risk scoring; cautious removal
Paediatric patients	Movement; device securement challenges; distress	SECURE bundle; silicone removers; distraction and pain management
Older adults	Dry, fragile, inelastic skin; comorbidity; polypharmacy	Barrier films; gentle adhesives; nutritional assessment; skin emollients
Critically ill adults	Oedema; impaired perfusion; sedatives; mechanical ventilation; high adhesive density	Structured surveillance; risk-factor-based prevention; silicone removers; bundled care

Patients with previous MARSI	Altered skin barrier; sensitization; history of reaction	Avoid previously implicated products; patch testing where appropriate; early barrier protection

Quality Improvement and Implementation Science

The gap between evidence and routine practice remains the principal obstacle to MARSI prevention [23]. A best-evidence summary for patients with tracheal intubation found that much of the available evidence was derived from lower-level studies, with a relative scarcity of large randomized controlled trials [23]. Even when nurses know that low-angle removal and silicone removers reduce injury, adherence may be incomplete because of time pressure, product unavailability, habit, or lack of accountability [24]. Implementation science offers a structured approach to closing this gap [24]. The i-PARIHS framework has been used to analyse barriers to MARSI evidence translation in tracheal-intubation patients, identifying lack of accessible evidence, contextual constraints, and gaps in training as key obstacles [24].

Quality improvement methodologies—PDSA cycles, run charts, audit and feedback, and embedded electronic risk assessment—have produced measurable reductions in MARSI incidence in both adult and neonatal settings [18]. Successful programmes typically combine several elements: a standardized prevention bundle, visible leadership support, product standardization including silicone removers and barrier films, mandatory education, documentation templates, and monthly reporting of MARSI rates as a nursing-sensitive quality indicator [19]. When MARSI incidence is measured, displayed, and discussed at handover, it ceases to be an invisible complication and becomes a shared responsibility [20]. Minimizing pain during adhesive removal is also an ethical and patient-centred component of quality care, particularly for vulnerable patients who cannot advocate for themselves [25].

Gaps and Future Research Directions

Despite substantial progress, important gaps remain [23]. The quality of primary evidence is uneven, and there is a need for multicentre randomized trials of bundled interventions rather than further small observational studies [23]. Most MARSI prediction models have a high risk of bias and have not been externally validated, limiting their transportability across settings and populations [8]. The evidence base for specific product comparisons—for example, silicone versus acrylic adhesives, or different barrier film formulations—remains underdeveloped [14]. Paediatric and neonatal research is particularly sparse, despite the high vulnerability of these populations [4]. Cost-effectiveness studies are also needed to demonstrate the economic value of prevention bundles in different healthcare systems [24]. Future research should prioritize external validation of risk prediction tools, robust trials of adhesive removers, and implementation studies that test strategies for sustaining evidence-based practice beyond the life of a single quality improvement project [25].

CONCLUSION

MARSI is a common, costly, and largely preventable iatrogenic complication of hospitalization. Its pathophysiology—mechanical failure of the skin under adhesive traction—makes it uniquely amenable to nursing intervention, because nurses control the selection, application, maintenance, and removal of most medical adhesives. The evidence reviewed here demonstrates that a coherent package of nursing interventions is effective. Structured skin assessment identifies vulnerable patients before injury occurs. Judicious adhesive selection, tension-free application, barrier films, low-angle removal, and silicone-based adhesive removers each reduce the mechanical insult delivered to the skin. When these interventions are combined into bundled programmes and supported by education, audit, and visible quality monitoring, reductions in MARSI incidence of 50% or more are achievable, with corresponding improvements in patient comfort, healing time, length of stay, and satisfaction. The challenge is no longer to prove that nursing interventions work, but to ensure that they are implemented reliably, equitably, and sustainably across every clinical setting in which medical adhesives are used. Every dressing change is an opportunity either to protect the skin or to injure it; nursing practice should be organized so that the default choice is protection.

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