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REVIEW

Analysis of Barriers to Evidence Transformation and Countermeasures for MARSI Prevention in Tracheal Intubated Patients Based on the i-PARIHS Framework

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Objective: To systematically analyze the current status of evidence application for the prevention of medical adhesive-related skin injury (MARSI) in patients undergoing tracheal intubation, identify the multidimensional barriers and facilitators in the process of evidence translation on the basis of the i-PARIHS framework, and construct targeted intervention strategies.

Methods: Review indicators were developed on the basis of the 30 pieces of best evidence for the prevention of medical adhesive-associated skin injury in patients with tracheal intubation obtained from a previous study, and the review results were analyzed for barriers and facilitators by applying the Evidence Application Barrier Identification Assessment Checklist under the i-PARIHS framework.

Results: A total of 30 pieces of evidence were screened for conversion, and 24 review indicators were formulated, of which only 13 items (54.2%) had a compliance rate>60%, and 11 items (45.8%) had compliance rates<60%, with 3 key indicators (12.5%) having extremely low compliance rates (<10%). Key obstacles: Poor feasibility of change implementation: Evidence has not been transformed into easily accessible and actionable practical tools such as flowcharts and checklists; there is a lack of standardized operating procedures to guide clinical execution. Insufficient ability and cognition of change recipients, especially anesthesiologists: lack of relevant knowledge reserves; not receiving sufficient relevant training; lack of understanding and trust in the effectiveness of intervention measures. Organizational support and environmental deficiencies include a lack of effective incentive or constraint mechanisms such as performance linkages and quality feedback. The physical work environment, such as the operating space and equipment layout, has not been optimized to support new practices.

Conclusion: The best evidence for preventing MARSI in endotracheal intubation patients shows significant differences in clinical translation, with nearly half of the reviewed indicators having insufficient compliance and serious missing items (<10%). It is urgent to develop and implement strengthened intervention strategies to address the multidimensional barriers mentioned above, particularly in terms of change enforceability, anesthesiologist capabilities, organizational mechanisms, and the environment; actively promoting healthcare personnel change; and facilitating the effective clinical translation of the best evidence.

Keywords: tracheal intubation, medical adhesive-related skin injury, MARSI, evidence translation, i-PARIHS framework, barriers

In 2012, the International Skin Tear Advisory Panel (ISTAP) released a consensus reached by 23 experts at the Medical Adhesives and Patient Safety Summit, which for the first time defined skin injury following medical adhesive removal as medical adhesive-related skin injury (MARSI). Medical adhesive-related skin injury (MARSI) states that MARSI manifests as erythema of the skin lasting ≥30 minutes after removal of the adhesive, which may be accompanied by unusual symptoms such as blisters, vesicles, or lacerations.[1] The 2019 update of the International Consensus further simplified MARSI to include "skin injury caused by medical adhesive products or devices. (eg, tapes, wound dressings, stoma sumps, electrode pads, medication patches, wound suture strips, etc.)"[2] MARSI is quite common in the clinic,

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especially in critically ill patients, with an incidence rate of up to 31% in adult ICU patients, and most often involves the cheek and mandibular regions.[3] Notably, the incidence of facial MARSI is particularly prominent in patients with tracheal intubation, reaching 28.57%.[4]

Although MARSI is widely recognized in the medical literature, its impact on the management of patients under anesthesia has not been adequately appreciated.[5] Perioperative skin management often focuses on the prevention of stress injuries, with relatively little attention given to facial skin. However, in anesthesiology practice, the facial skin not only has the important function of observing the patient's condition but is also a common site for tracheal intubation catheter fixation. The lack of standardized extubation practices or insufficient awareness of protection by healthcare professionals can easily lead to facial MARSI caused by fixation tape; therefore, anesthesiology departments need to pay more attention to MARSI and take effective measures to minimize this type of preventable injury.

As a common medical skin injury, MARSI has received increasing attention in terms of risk factors and protective strategies. Existing studies have focused on specific high-risk groups, such as neonates with immature skin barrier function,[6,7] older adults with degenerative changes in skin structure,[8,9] patients with PICC catheters requiring long-term intravenous access,[10–12] and critically ill patients with complex underlying diseases.[13,14] These studies have provided an important basis for understanding the general risk factors and population-specific protection against MARSI.

However, studies focusing on MARSI in the specific scenario of tracheal intubation catheter fixation are still insufficient. Although a variety of adhesive tapes are used in clinical practice, little is known about the relative likelihood of adhesives producing injury among patients under general anesthesia.[15] The existing systematic studies on the occurrence characteristics, independent risk factors, and targeted protective measures for MARSI in patients undergoing tracheal intubation are relatively limited. Some studies failed to analyze the weight of tracheal intubation fixation as an independent risk factor in depth either because of an insufficient sample size or design limitations.[16]

On the basis of the i-PARIHS framework (Integrated Promoting Action on Research Implementation in Health Services framework),[17] our research team integrated the 30 best pieces of evidence for MARSI prevention through systematic evaluations, conducted a baseline review to identify gaps between clinical practice and evidence-based recommendations, proposed the best evidence-based prevention of medical adhesive-associated skin injuries in patients undergoing tracheal intubation from 3 aspects, namely, change, recipients and the organisational environment,[18] identified and analyzed barriers on the basis of the results of the review, developed a series of coping strategies, promoted smooth translation of the best evidence, and provided lessons for practitioners to carry out clinical translation of the evidence.

Information and Methods

General Information

The baseline review was conducted on surgical patients and anesthesiologists, nurse anesthetists, pharmacists and purchasing staff from July–August 2024. 1 This study was conducted on patients of all ages who had undergone tracheal intubation. ① Patient inclusion criteria: tracheal intubation patients of all ages and family or personal consent to participate in this study. The exclusion criteria were patients who had already had MARSI at the time of admission, patients with skin diseases, and patients whose skin assessment was difficult. The exclusion criterion was withdrawal midway or death. Forty patients—23 males and 17 females—were enrolled; their ages ranged from 2--82 (42.25±25.01) years. ② Inclusion criteria for doctors and nurses: registered anesthesiologists and registered anesthesia nurses; engaged in clinical work; and working in the anesthesia department for ≥6 months. The exclusion criteria were further training, rotation, and leave. There were 12 doctors, aged 23–46 (32.42±7.11) years, with 2–23 years of working experience; 16 nurses, aged 26–53 (35.65±5.28) years, with 4–33 years of working experience; 2 pharmacists, aged 33–36 (34.50±2.12) years, with 12–16 years of working experience; and 1 purchasing officer, aged 38 years, with 6 years. There were 3 people with a college education, 107 people with a bachelor′s degree or above, 34 people with junior titles, 49 people with intermediate titles, and 27 people with senior titles. The study was approved by the Clinical Research and Laboratory Animal Ethics Committee of Zhongshan People′s Hospital (Approval No. KY2024-086).

Methods

Formation of an Evidence-Based Team

The evidence-based team members consisted of seven members. One deputy nurse manager (PhD, deputy chief nurse) was responsible for the development, coordination and overall planning of this project; one deputy nurse manager of the surgical anesthesia department (Bachelor's degree, chief nurse) was responsible for the implementation of the project, project coordination, and correspondence with the experts; two nursing team leaders (Bachelor's degree, deputy chief nurse) were responsible for the application of the evidence, data collection and analysis; and three core members of the evidence-based team (all Master's degrees, two deputy chief nurses, and one chief nurse practitioner) were responsible for project guidance, literature quality assessment, and evidence summarization. Team members formed review indicators on the basis of the evidence, conducted a review of the indicators, analyzed their barriers, and developed targeted strategies on the basis of the results of the analysis. The process is shown in Figure 1.

Determining the Applicability of the Best Evidence and Constructing Review Indicators

The evidence-based team has completed the best evidence summary in the preliminary stage, including the identification of risk factors, skin assessment, the selection and use of medical adhesives, skin care, the application of skin protection products and deadhesives, pain management, and education and training in seven areas, and has refined 30 key evidence. An expert panel meeting was held with five experts who participated in the evaluation of the clinical application of the best evidence of medical adhesive-related skin injury in patients with tracheal intubation, and the experts conducted a review of the evidence on the basis of the principles of validity, credibility, and measurability. If one of the items was contrary to the other, the evidence was excluded as a means of determining the evidence for clinical application, and the 30 pieces of the best evidence for each of

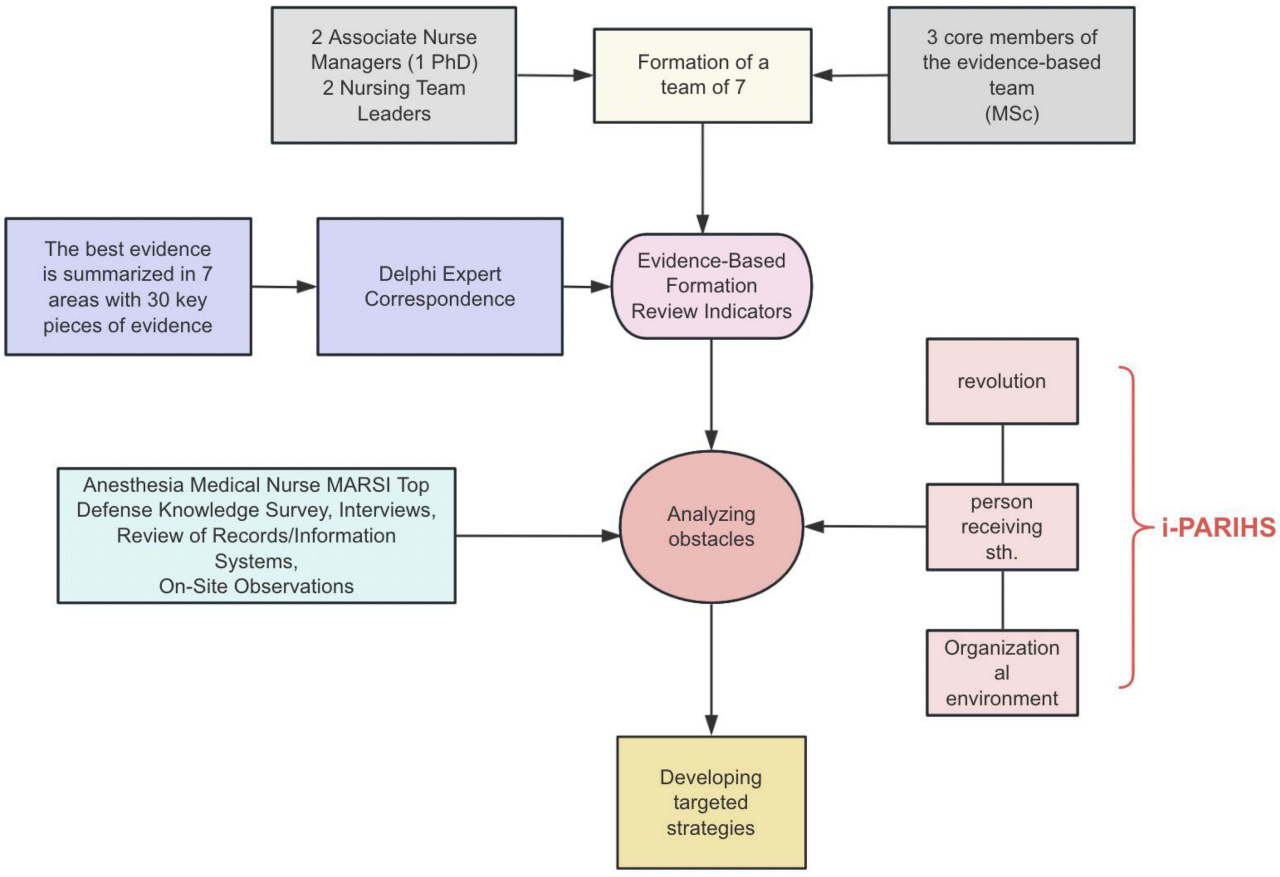

Figure 1 Evidence-based Team Composition and Workflow.

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the seven aspects were finally obtained. The 30 pieces of best evidence were converted into 24 quantifiable review items through the Delphi expert correspondence method, covering the dimensions of risk assessment, operational practices, and education and training. The best evidence review indicators are shown in Table 1. The criteria are shown in Table 1.

Baseline Review Data Collection

(1) Questionnaire. Anesthesia medical and nursing MARSI prevention knowledge survey: An electronic MARSI prevention knowledge questionnaire was distributed to anesthesiologists and anesthesia nurses by 2 researchers. The

Table 1 Best Evidence Review Indicators

	Quality Review Indicators	Object of Review	Review Methodology	Implementation Rate per cent
1	MARSI risk assessment of patients before admission to theatre and tracheal intubation, during PACU admission and extubation using the "Risk Assessment Form for Medical Adhesive Related Skin Injury to the Face" Healthcare professionals	Medical staff	Observed on site	43.64
2	Assess the integrity, skin color and skin tone of the skin under and around the endotracheal tube every 4–6 h. Low-birth-weight infants and preterm infants should be assessed every 2 hours, and patients should be assessed for the use of topical skin and adhesives during the shift changeover.	Medical staff	Observed on site	73.53
3	High risk patients issued with MARSI high risk card	Patients	Observed on site	1.47
4	When skin injury occurs, assess wound location, size, degree of necrosis, type and amount of exudate and integrity of surrounding skin	Patients	Observed on site	83.33
5	Adhesives are applied according to manufacturer's instructions		Observed on site	98.85
6	Selection of the most appropriate medical adhesives	Patients	Observed on site	98.85
7	Use anti-allergenic dressings for dressing allergies; switch to sterile gauze coverage for patients with skin tension injuries; choose silicone-based dressings for fragile skin	Patients	Observed on site	12.07
8	Prepare the skin before applying medical adhesive, apply adhesive correctly, and secure the tracheal tube appropriately.	Medical staff	Observed on site	96.43
9	Use proper removal techniques to remove medical adhesives, avoiding rapid, vertical pulling forces.	Medical staff	Observed on site	100
10	Use adhesive removers: silicone-based removers for children with particularly fragile skin; mineral oil, petroleum jelly in special cases.	Medical staff	Observed on site	43.42
11	Promote patient comfort, assess and record pain after extubation using visual analog scales or numeric rating scales	Medical staff	Observed on site	75.90
12	Provide good skin care: keep skin clean; keep skin moist; avoid rubbing dry skin, avoid sharp objects; avoid clothing that irritates skin	Patients	Interview	81.48
13	Observe the skin every 2 hours from intraoperative to extubation, including color, temperature, moistness, integrity, fragility of the adhesive site, and palpate if necessary; observe the integrity of the adhesive bond and determine whether there are any signs of loosening or friction against the skin.	Medical staff	Observed on site	71.43
14	Skin cleansing Choose appropriate cleanser or warm water; after cleansing, apply nutritious moisturizer, skin repair lotion, or skin protectant to the skin or choose a neutral, natural skin emollient to be applied to the skin twice daily.	Patients	Interview	25.42

(*Continued*)

Table 1 (Continued).

	Quality Review Indicators	Object of Review	Review Methodology	Implementation Rate per cent
15	Early extubation to reduce time with tube; and extubation adhesive removal feedback on the facial medical adhesive-related skin injury risk assessment form	Medical staff	Observed on site	90.48
16	Use of skin barrier products in high-risk patients prior to application of medical adhesives	Medical staff	Observed on site	20.63
17	Use of sterile skin barrier products for patients at high risk of infection	Medical staff	Observed on site	10.34
18	After wiping the facial skin clean, apply skin protection film to the patient's face and perioral skin where adhesive tape is to be applied	Medical staff	Observed on site	38.89
19	Physicians, nurses, procurement staff and pharmacists are educated on MARSI, skin preparation, medical adhesive application and removal methods, and the use of skin barrier products and or medical adhesive removers.	Healthcare professionals Purchasing staff and pharmacists	Access to records	64.55
20	Patients and families aware of MARSI occurrence	Patients	Interviews	5.50
21	Sound MARSI education and training assessment system, MARSI knowledge training programme, including "Overview of MARSI knowledge", "Managing dry skin", "Protecting fragile skin", "Protecting fragile skin", "Protecting fragile skin", "Protecting fragile skin", "Protecting fragile skin", "Protecting fragile skin", "Protecting fragile skin". "Dressing knowledge", "Correct handling practices", "Correct choice of adhesive".	Medical staff	Access to records	84.55
22	MARSI Conservative treatment ineffective for 7d or wound deterioration occurs, consult a wound care specialist or dermatologist	Patients	Access to information System	100
23	All MARSI should be recorded in the patient's medical record and reported	Medical staff	Query Information System	8.62
24	Develop strategies to prevent MARSI. Develop a stratified risk based care programme based on risk assessment	Medical staff	Query Information System	43.40

questionnaire was based on the best evidence to form the entries and was modified and improved by correspondence with 2 anesthesia nurses and wound specialists. The content validity index (I-CVI) of the questionnaire at the level of the entries was 0.89, and it contained a total of 27 entries, each of which was a single-choice question divided into 4–5 options. (2) Interview method. Ten doctors, nurses, awake patients and family members each and one pharmacist and one purchaser each were sampled and interviewed by two researchers about their perceptions of the best evidence of MARSI, factors affecting the dissemination and application of the evidence, suggestions for this evidence translation project, and the observed behavior of nurses at work. (3) Access to records/information systems. Patient care transcripts, medical records, specialist nursing systems and electronic information systems were accessed by 2 researchers to determine nurses' MARSI reporting, record keeping, nursing actions taken and information on expert consultations. (4) Onsite observation. (1) Observation of the implementation of preventive measures: Two trained nurse anesthetists observed the operation process without the operator's knowledge.② Observation of the correct operation of personnel: The assessment criteria for medical adhesive pasting and removal were developed on the basis of the best evidence, and the head nurse conducted onsite observation, with a score of 100 points and a passing score of ≥90 points. (5) Other information. (1) Two researchers were responsible for collecting patients′ general information and recording the occurrence of MARSI after patients′ admission to the department, including patients′ general

information, whether MARSI occurred during the admission period, the site and type of occurrence, and the medical adhesive agent that caused MARSI.

Evidence Baseline Review

A review of the current state of clinical practice was carried out for medical and nursing staff and patients in the operating theatre using the onsite view method, onsite interview method, review of nursing documents, and follow-up view. Adherence results were calculated for each review indicator (adherence rate [number of cases implemented/total number of cases investigated × 100%).

Analysis of Barriers

Based on the review results, the review indicators for the implementation rate were analyzed for barriers and facilitators in terms of change, recipients, and the organisational environment through evidence-based team discussions and based on the Barriers to Application Identification of Evidence under the i-PARIHS framework assessment checklist as a research tool, and corresponding action strategies were developed. The assessment checklist consists of 33 entries in the three dimensions of change, change recipients, and organisational environment, and each entry is assessed as "yes", "partially yes", or "no". "Assessed" if the result of each entry is "Yes", "Partial Yes", "No", or "Not Assessed" if no result is seen.[19]

Statistical Methods

The data were analyzed descriptively via SPSS 22.0 software, with measurements expressed as ($\bar{x} \pm s$) and counts expressed as frequencies and percentages (%).

Results

Results of the Baseline Review of Evidence

Among the 24 review indicators, 13 indicators had a compliance rate of >60%, and 11 indicators had a compliance rate of <60% (3 indicators had a compliance rate of <10%). The results of the review indicate a large gap between the clinical status quo and the application of evidence.

Occurrence of MARSI

In the 50 patients included in the analysis, 9 (18.00%) developed MARSI, with contact dermatitis accounting for the highest proportion (6, 66.67%).

Survey Findings on Healthcare Professionals' Awareness and Practice of MARSI

This study employed a questionnaire to assess the awareness level and clinical practice of MARSI among healthcare personnel involved in managing intubated patients in the Department of Anaesthesia and Surgery at Zhongshan People's Hospital (n=17, comprising 6 anaesthetists and 11 anaesthesia nurses). 17.65% (3/17) of respondents were unaware of MARSI-related content. Among anaesthetists (n=6), a significant 50.00% (3/6) indicated they were "unfamiliar" with MARSI, and 66.67% (4/6) reported having received no formal training on MARSI-related knowledge. Among those who had received training (n=9), the primary learning pathways were "guidance from senior colleagues" (35.29%) and "department-organised training" (29.41%). Principles for adhesive product selection (47.06% good knowledge rate), MARSI classification (52.94%), application techniques for special sites (oedema/joints) (52.94%), and removal techniques (64.71%). High-risk patient identification and protection: 11.76% of respondents consistently identified high-risk patients, while 11.76% consistently applied protective measures prior to use in high-risk individuals. Precise product selection: 41.17% consistently or frequently selected the most appropriate product based on multiple factors (purpose, location, environment, characteristics). Technical skills: Catheter fixation (high-hold, high-lift method, high compliance rate of 58.82%), correct removal (64.71%). Detailed data is presented in Table 2. Analysis of the Barriers to and Facilitators of Evidence Translation for MARSI Prevention in Tracheally Intubated Patients and Strategies for Action are Shown in Table 3.

Table 2 Summary of the Core Results of the MARSI Cognitive Level and the Clinical Practice Behavior of Medical Staff (n=17)

Category	Specific Project/Item (Brief Description)	Results (Number n, Proportion %)
Basic Information	Role	Basic Information Role: Anesthesiologist: 6 (35.29%); Anesthesia nurses: 11 (64.71%)
	MARSI level of understanding	MARSI has a very good level of understanding: 3 (17.65%); have some understanding: 11 (64.71%); Not understood: 3 (17.65%)
	Received MARSI learning	9 (52.94%); No: 8 (47.06%)
	Learning pathway (n=9)	Department organized learning: 5 (29.41%); Guidance from colleagues and seniors: 6 (35.29%); Literature reading: 2 (11.76%); Academic conferences: 2 (11.76%)
Knowledge item	MARSI defines	Good cognition: 9 (52.94%); Know one thing: 8 (47.06%)
	MARSI classification	Good cognition: 9 (52.94%); Know one thing: 7 (41.18%); I do not know: 1 (5.88%)
	Scope of Adhesive Products	Good cognition: 9 (52.94%); Know one thing: 8 (47.06%)
	MARSI high-risk population	Good cognition: 13 (76.47%); Know one thing: 4 (23.53%)
	Principles for selecting adhesive products	Good cognition: 8 (47.06%); Know one thing: 7 (41.18%); I do not know: 2 (11.76%)
	Protective measures for high-risk populations	Good cognition: 9 (52.94%); Know one thing: 8 (47.06%)
	Edema/Joint Adhesive Techniques	Good cognition: 9 (52.94%); Know one thing: 8 (47.06%)
	Catheter fixation techniques	Good cognition: 9 (52.94%); Know one thing: 7 (41.18%); I do not know: 1 (5.88%)
	Patch removal technique (angle/ technique)	Good cognition: 11 (64.71%); Know one thing: 6 (35.29%)
	Removal agent usage	Good cognition: 11 (64.71%); Know one thing: 6 (35.29%)
Practice items	Identify high-risk groups for MARSI	High compliance: 2 (11.76%); Sometimes: 7 (41.18%); Rarely/Never: 2 (11.76%)
	Apply protective agents to high-risk individuals before use	High compliance: 2 (11.76%); Sometimes: 8 (47.06%); Rarely/Never: 2 (11.76%)
	Consider stimulating and selecting appropriate adhesive tape	High compliance: 8 (47.06%); Sometimes: 8 (47.06%); Rarely: 1 (5.88%)
	Replace the patch to avoid being in place	High compliance: 9 (52.94%); Sometimes: 6 (35.29%); Rarely: 2 (11.76%)
	Select the best product based on multiple factors	High compliance: 7 (41.18%); Sometimes: 9 (52.94%); Rarely: 1 (5.88%)
	Tube fixation (high and flat lifting method)	High compliance: 10 (58.82%); Sometimes: 6 (35.29%); Rarely: 1 (5.88%)
	Apply damp patches and replace them in a timely manner	High compliance: 11 (64.71%); Sometimes: 5 (29.41%); Rarely: 1 (5.88%)
	Avoid adhesive fixation during bleeding	High compliance: 9 (52.94%); Sometimes: 7 (41.18%); Never: 1 (5.88%)
	Edema/Joint Adhesive Techniques	High compliance: 10 (58.82%); Sometimes: 6 (35.29%); Rarely: 1 (5.88%)
	Removal agents/assistance for high-risk populations	High compliance: 10 (58.82%); Sometimes: 6 (35.29%); Rarely: 1 (5.88%)
	Correct removal technique (0 °/180 °, press on skin)	High compliance: 11 (64.71%); Sometimes: 5 (29.41%); Rarely: 1 (5.88%)
	Surveillance of Adhesive Site Infection	High compliance: 6 (35.29%); Sometimes: 6 (35.29%); Rarely/Never: 5 (29.41%)
	Suspected allergy, please consult with a dermatologist	High compliance: 5 (29.41%); Sometimes: 8 (47.06%); Rarely: 4 (23.53%)
	Identify different MARSI types	High compliance: 4 (23.53%); Sometimes: 11 (64.71%); Rarely: 2 (11.76%)

Table 3 Analysis of Barriers and Facilitators to Evidence Translation in MARSI Prevention in Tracheally Intubated Patients and Strategies for Action

Content of the Assessment	Barriers	Facilitating Factors	Action Strategies
Levels of Change	1. The process of using and removing medical adhesives has not been developed. 2. Failure to cite the "Risk Assessment Scale for Medical Adhesive Related Skin Injury in the Operating Theatre". 3. The use of skin barrier products and medical adhesive removers impacts on the original adhesive application method.	1. The source of the evidence is reliable and directly usable 2. The evidence is appropriate for application in the current departmental environment and is beneficial to patients 3. The evidence can be applied to standardize MARSI preventive behavior	The members of the group jointly developed the "MARSI risk assessment record sheet", including high-risk group screening and MARSI assessment record sheet in two parts, each patient should fill in the first part of the admission, identified as high-risk patients, fill in the second part of the content, if the patient occurs skin injuries, accurately record the type of injury and the degree of each place. degree. Communicate with the hand anesthesia system engineers to make an electronic version at a later stage to facilitate collection and statistics.
Change recipients	Team: 1. Needs additional training on MARSI. 2. Has not revised nursing routines. 3. Has not developed strategies to address potential barriers to evidence application Individuals: 1. Doctors and nurses lacked knowledge of MARSI prevention. 2. Proper taping and removal techniques were not mastered. 3. A few doctors on the unit were concerned about the additional workload associated with the implementation of the change. 4. Key personnel involved in the change were not actively engaged in the discussion and implementation of the plan	1. Nursing department focuses on preventing MARSI. 2. Unit managers focus on preventing MARSI 3. Some evidence of a good foundation for original implementation.	1. The nursing department supports the project leader with human, material and financial resources at the organisational level. 2. Departmental managers are actively involved in the programme design and implementation of the project, supporting the evidence-based team members and reflecting this in their scheduling. 3. Second-line core nurses are actively involved in the learning process and driving the atmosphere in the department. Evidence-based team members develop evidence-based training programmes on MARSI knowledge, including "Overview of MARSI knowledge", "Managing dry skin", "Protecting fragile skin", "Dressing-related knowledge" and "Proper handling techniques" training courses are taught regularly, not only to nurses but also to encourage doctors, patients and their families to participate in the training. After each training, nurses are assessed on the content of the training to ensure that everyone masters it. The department's WeChat group pushes out MARSI-related knowledge and operation videos. Regular group discussions in the form of workshops encourage nurses to brainstorm, further improve the change programme and increase adherence to evidence implementation.
Organisational context	On-site environment: 1. The department lacks an evidence-based basis for the development of operational standardized processes, management systems and standards. 2. Lack of relevant training materials. 3. Lack of assessment and evaluation systems. 4. The department lacks an incentive system for the implementation of evidence-based standards.	1. The department has a good atmosphere for research and innovation learning. 2. The department has a place and equipment for training. 3. The department has had previous successful evidence translation projects and experience in introducing change. 4. Monthly QC meetings are held to provide feedback on the month's review. 5. The project has been included as a key mentoring project of the Ministry of Nursing in 2023. 6. In line with the National Nursing Career Development Plan (2021–2025) advocacy to build nursing norms based on evidence and clinical needs	1. Incidence of MARSI will be included in this year's departmental speciality monitoring indicators, and will be continuously monitored every month. 2. Feedback from monthly quality control meetings will be given to determine the improvement priorities for the following month. 3. The members of the project team will work together to formulate the "MARSI Risk Assessment Record Sheet" which should be filled in by each patient upon admission to the theatre, and will identify high-risk patients. If a patient has a skin injury, the type and extent of each injury should be recorded accurately. Communicate with the anesthesia engineers to make an electronic version at a later stage for easy collection and statistics.

Discussion

This study systematically analyzed the multidimensional barriers to evidence translation and their interaction mechanisms in the prevention of MARSI in patients with tracheal intubation on the basis of the i-PARIHS theoretical framework for evidence translation. This study validated the multidimensional interactional characteristics of the barriers to evidence translation: insufficient evidence availability (eg, lack of standardized processes), teamwork disconnection (eg, care

routines not updated), individual competence gaps (eg, lack of technical training) and lack of organisational support (eg, lack of incentives) collectively form a network of hindrances, which is in line with Grol et al's system-practitioner-evidence interaction model.[20] These factors are intertwined to form a complex dynamic network, making it difficult to effectively implement MARSI prevention measures in clinical practice. When planning complex changes in practice, potential barriers at all levels need to be addressed, and the impacts of the nature of the innovation, the characteristics of professionals and patients, society, organisations and many other factors need to be accounted for.

Complexity of Multilevel Barriers

The main barriers at the level of change are usually characterized by a lack of evidence of accessibility, changes in context, and inherent culture under attack.[21] At the evidence level, the lack of a standardized process for the use of adhesives and the failure to cite scientific assessment tools reflect the disconnect between evidence-based practice and clinical needs. Despite the existence of reliable and applicable evidence resources, their dissemination is still limited by the lack of localized operational guidelines and dynamically updated support. The gap between evidence and clinical practice is further magnified by unrevised nursing routines and inadequate training systems at the team level. Currently, many healthcare professional training courses do not include MARSI prevention,[22] and our survey on the current status of MARSI cognition and practice among medical staff revealed the following issues: there is a significant gap in overall cognition and training: 17.65% of respondents are not familiar with MARSI-related content. Notably, among the anesthesiologist community (n=6), as many as 50.00% reported "not understanding" MARSI, and 66.67% reported not having received any MARSI-related knowledge. Uneven mastery of core knowledge: Medical staff have a relatively good understanding of basic concepts such as the MARSI definition, adhesive product range, and high-risk populations (with a good cognitive rate>50%). However, there are significant deficiencies in operational knowledge points such as adhesive product selection principles, MARSI classification, special site (swelling/joint) adhesive techniques, and removal techniques. Lack of compliance in clinical practice, particularly in high-risk areas: identification and protection of high-risk populations: only 11.76% of respondents have been able to identify high-risk populations consistently, and only 11.76% have been able to apply protective measures before use in high-risk populations; more than half (>50%) execute only "sometimes" or "rarely". This is one of the weakest links in practice. Accurate product selection: Only 41.17% can "always" or "often" choose the most suitable product on the basis of multiple factors (purpose, location, environment, characteristics). Operational skills: Key operations such as catheter fixation (high lift and flat lift methods, high compliance rate of 58.82%) and correct removal (64.71%). The application frequency is acceptable, but there is still room for improvement (>35% can only be achieved "sometimes"). Anesthesiologists generally have not received relevant knowledge training, and at the individual level, medical staff have insufficient awareness and technical deficiencies in MARSI prevention, which directly weakens the effectiveness of evidence execution. Research suggests that the interaction of organisational cultural inertia (eg, lack of incentives) and individual cognitive biases (eg, negative attitudes toward change) is a central mechanism that hinders the implementation of evidence,[20] and the "lack of incentive systems in the department" and "negative attitudes of healthcare workers" found in this study corroborate this view. Inadequate management systems and incentives at the level of the organisational environment, on the other hand, constrain the sustainability of change at a systemic level. The additive effect of these barriers suggests that single-level improvements have difficulty achieving breakthroughs in evidence translation and that multidimensional synergistic interventions are needed to break the deadlock.

Leverage of Facilitators

Despite these many barriers, this study also identified key facilitators that provided breakthroughs in evidence translation. For example, the importance of the nursing department and departmental management, the department's previous successes in evidence translation, and the support of policy orientations (eg, the National Nursing Career Development Plan) all provided impetus for change. The organisational context as well as organisational support and resources play important roles in evidence-based practice.[23,24] By incorporating the incidence of MARSI into specialist monitoring indicators and enabling dynamic tracking of data with the help of an electronic risk assessment tool, the department's climate of research and innovation and information technology base can be effectively utilized to promote

the penetration of evidence into practice. In addition, the common goal of medical and nursing staff for patient safety and the regular mechanism of departmental quality control meetings provide an institutional guarantee for continuous improvement.

Synergistic and Innovative Countermeasures

The literature has shown that knowledge and skills development at the individual level alone has a limited impact on the organization as a whole.[25] Therefore, the countermeasures proposed in this study reflect the integration of the "technology-people-institution" strategy to address multidimensional barriers. For example, the development and electronic modification of the MARSI risk assessment record sheet not only standardizes the risk assessment process (at the technical level) but also provides an evidence-based basis for quality improvement through data accumulation (at the institutional level). Moreover, the hierarchical, multirole training program (covering nurses, doctors, patients and family members) overcomes the limitations of traditional training and enhances teamwork and patient participation. The involvement of the nursing department in resource allocation and scheduling support provided an organisational "room for error" for change and alleviated the concerns of healthcare workers about increased workload. This systematic response strategy has resulted in closed-loop management by strengthening the operationalization of the evidence, enhancing staff capacity, and optimizing organizational support, ultimately achieving the sustainability of evidence translation.

Conclusion

There is a significant gap in the clinical translation of the best evidence for preventing MARSI in patients undergoing tracheal intubation. This study is based on the i-PARIHS framework and identifies key obstacles such as poor change feasibility, inadequate cognitive abilities of healthcare workers (especially anesthesiologists), organizational support, and environmental deficiencies. To overcome these obstacles and achieve effective evidence-based practice transformation, a systematic strategy is needed: evidence localization reconstruction, personnel empowerment training, institutional flexibility support, and technological innovation integration. This study provides a theoretical framework and preliminary path for optimizing MARSI prevention practices. Although this study proposes targeted countermeasures, potential challenges still need to be addressed: first, the development of an electronic risk assessment tool relies on interdisciplinary collaboration (eg, with information engineers), and its effectiveness needs to be verified through long-term application; second, adherence to behavioral changes in healthcare workers may decrease over time and need to be maintained through dynamic assessment and incentives; furthermore, the complexity of patient factors (eg, individual differences in the skin status of critically ill patients) is a key factor in the development of this tool. In addition, the complexity of patient factors (eg, individual differences in the skin status of patients) may affect the effectiveness of standardized measures, and individualized prevention protocols need to be further explored. Future research should explore (1) the development and application of a dynamic evidence integration platform to achieve a real-time interface between guidelines and clinical practice; (2) the construction of an artificial intelligence-based MARSI risk prediction model to improve the accuracy of preventive measures; and (3) multicenter randomized controlled trials to verify the universality and cost-effectiveness of intervention strategies.

Disclosure

The authors report no conflicts of interest in this work.

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