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Nurses' compliance in intravenous injection among patients with extreme nutritional status: Implications for patient safety

Kepatuhan perawat dalam pemberian injeksi intravena pada pasien dengan status gizi ekstrem: Implikasi terhadap keselamatan pasien

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Abstract

Intravenous (IV) injection safety is a critical aspect of nursing practice, particularly for patients with extreme nutritional status. Nutritional imbalance can affect vascular integrity and tissue resistance, potentially reducing adherence to standard procedures. This study aimed to examine the relationship between nurses' compliance with intravenous injection procedures and patient safety among individuals with extreme nutritional conditions in a hospital setting. This cross-sectional observational study was conducted at Arifin Achmad General Hospital, Pekanbaru, between January and March 2024, and involved 60 adult patients with undernutrition (BMI < 18.5 kg/m^2) or obesity (BMI ≥ 30 kg/m^2). Compliance was measured using a checklist based on the WHO and Ministry of Health guidelines, and patient safety was assessed through IV-related complications. Data were analyzed using chi-square and multivariate logistic regression analyses. The results showed a compliance rate of 72.5% and a significant relationship between compliance and the incidence of complications (p = 0.008). Noncompliance increased the risk of complications by 2.8 times (OR = 2.8; p = 0.014). In conclusion, nurses' adherence to IV injection procedures significantly affects patient safety. Continuous training and adaptive protocols that consider patients' nutritional status are recommended to enhance nursing service quality.

Keywords: Intravenous injection, Compliance, Nutritional status, Obesity, Patient safety

Abstrak

Keselamatan injeksi intravena (IV) merupakan aspek penting dalam praktik keperawatan, terutama pada pasien dengan status gizi ekstrem. Ketidakseimbangan gizi dapat memengaruhi integritas vaskular dan ketahanan jaringan sehingga menurunkan kepatuhan perawat terhadap prosedur standar. Penelitian ini bertujuan menilai hubungan antara kepatuhan perawat terhadap prosedur injeksi IV dan keselamatan pasien pada kelompok dengan status gizi ekstrem. Penelitian observasional potong lintang dilakukan di RSUD Arifin Achmad Pekanbaru, sejak Januari-Maret 2024, terhadap 60 pasien dewasa dengan status gizi kurang (IMT < 18.5 kg/m^2) atau obesitas (IMT ≥ 30 kg/m^2). Kepatuhan diukur menggunakan daftar periksa berbasis panduan WHO dan Kemenkes, sedangkan keselamatan pasien ditentukan berdasarkan kejadian komplikasi injeksi. Analisis data menggunakan uji Chi-square dan regresi logistik multivariat. Hasil menunjukkan tingkat kepatuhan 72.5% dengan hubungan bermakna antara kepatuhan dan komplikasi (p = 0.008). Ketidakpatuhan meningkatkan risiko komplikasi sebesar 2.8 kali (OR = 2.8; p = 0.014). Kesimpulannya, kepatuhan perawat terhadap prosedur injeksi IV berpengaruh signifikan terhadap keselamatan pasien. Diperlukan pelatihan berkelanjutan dan penerapan protokol adaptif

berbasis status gizi untuk meningkatkan mutu layanan keperawatan.

Kata Kunci: Injeksi Intravenous, Kepatuhan, Status Gizi, Obesitas, Keselamatan Pasien

Introduction

Intravenous (IV) injection is one of the most fundamental and frequently performed clinical procedures in hospital settings and is applied to both acute and chronic patients. It serves as the primary route for administering medications, fluid resuscitation, blood transfusions, and total parenteral nutrition (Gorski et al., 2021; Fajar & Lisum, 2020). Although it appears routine and simple, IV administration carries substantial clinical risks if not performed according to established standards. Because it directly involves access to the circulatory system, errors in the technique may lead to severe complications such as infection, hematoma, infiltration, embolism, or anaphylactic reactions (Krishnaswamy, 2021; Bell et al., 2021). Therefore, compliance with safety protocols and standard operating procedures (SOP) for IV injections is a critical component of nursing quality and patient safety.

In the context of nursing practice, the quality and safety of IV administration largely depend on nurses' procedural compliance, which reflects both their technical competence and professional accountability (Nickel et al., 2024). According to Donabedian's model of healthcare quality, compliance is a component of process quality that directly influences outcome quality, including patient safety outcomes. Deviation from established standards not only indicates a breakdown in procedural fidelity but also increases the likelihood of preventable complications, especially among patients with complex physiological conditions.

Patients with extreme nutritional statuses, particularly those who are malnourished or obese, represent a population that poses significant challenges for IV administration (Hoskins et al., 2023). Nutritional status affects tissue integrity, vascular structure, and body fluid composition, all of which influence the success and safety of venous cannulation. In malnourished patients, muscle atrophy, thin skin, fragile vein walls, and reduced circulating volume make venipuncture difficult and increase the risk of hematoma and tissue injury (Nickel, 2019; Ko, 2022). In contrast, obese patients have thick subcutaneous layers and deep venous access that obscure peripheral vein visualization and elevate the likelihood of infiltration, infection, or procedural failure (Jones et al., 2021). Conversely, in obese patients, thick subcutaneous layers and deep-seated veins hinder peripheral vein visualization and increase the likelihood of infiltration, infection, and improper device use (Teshome, 2019; Lau, 2024). These physiological differences require specific technical adjustments and equipment selection, such as needle gauge, insertion angle, and cannula fixation strategy.

Despite the clinical importance of these adaptations, current nursing protocols and training programs are often generalized and fail to address variations in anthropometric and nutritional characteristics (Jones et al., 2021). Most competency assessments and IV training focus on standard techniques without emphasizing physiological differences as determinants of procedural success or patient safety (Teshome 2019; Lau 2024). This gap between standardization and clinical individualization results in a disconnection between theory and practice, where procedures intended to be therapeutic may inadvertently cause iatrogenic harm (Choi & Jeong, 2020). From a patient safety perspective, inappropriate IV administration in patients with extreme nutritional status can lead to both localized and systemic consequences. Complications such as phlebitis, nosocomial infections, soft tissue abscesses, and embolism can provoke systemic inflammatory responses, prolong hospital stays, and increase healthcare costs (Liang & Yan, 2023). In teaching and referral hospitals, such as the Arifin Achmad Regional Hospital in Riau, Indonesia, these events also add to nurses' workload, reduce service efficiency, and affect the institutional reputation. However, most of these complications are preventable through appropriate pre-procedural assessment, proper technique application, and procedural adaptation based on patients' nutritional and physiological conditions (Barnard-Kelly et al., 2021; Dagdelen et al., 2018).

However, research specifically examining the relationship between nurses' compliance with IV injection standards and patient safety

outcomes among patients with extreme nutritional statuses remains scarce, particularly in Indonesia. Previous studies have primarily evaluated general compliance without considering nutritional status as a moderating or risk factor that influences clinical outcomes (Clark et al., 2019). This represents a critical knowledge gap that limits the development of evidence-based and patient-specific safety interventions.

Therefore, this study aimed to assess nurses' compliance with IV injection standards among malnourished and obese patients, identify procedural deviations related to extreme nutritional conditions, and analyze the relationship between nurses' compliance and the occurrence of IV-related complications as indicators of patient safety. These findings are expected to serve as a scientific basis for developing adaptive clinical protocols, evidence-based training modules, and nursing policies that are more responsive to the nutritional status of patients as a determinant of procedural safety and clinical outcomes.

Methods

Design and Approach

This study employed a quantitative approach with a cross-sectional analytical observational design (Rezigalla, 2020). This design was chosen to evaluate the appropriateness of intravenous injection practices among undernourished and obese patients within a defined time period and to analyze the relationship between nurses' procedural adherence and the occurrence of clinical complications related to patient safety (Wang & Cheng, 2020).

To strengthen the analytical validity, potential confounding variables, such as nurses' years of experience, workload, shift schedule, and patient comorbidities, were identified and controlled statistically during the analysis. Data were collected using standardized instruments and cross-checked with patient records to minimize any bias. The inclusion of these controls ensured that the observed associations between compliance and complications reflected the true procedural effects rather than external influences.

Research Location and Time

The study was conducted in the adult inpatient wards of RSUD Arifin Achmad Pekanbaru, a type B provincial referral hospital in Riau, Indonesia, which also functions as a teaching hospital affiliated with the Politeknik Kesehatan of the Ministry of Health, Riau. This hospital was selected because it has a high volume of intravenous nursing procedures and provides care to diverse patient populations, making it a suitable setting for this study. Data were collected between January and March 2024.

Population and Sample

The target population consisted of adult inpatients who received intravenous injections during the study period. The inclusion criteria were patients aged ≥18 years with undernourished status (BMI < 18.5 kg/m^2) or obesity (BMI ≥ 30 kg/m^2) and those who were not in terminal or intensive care conditions. Patients with severe coagulation disorders, massive edema, or burns that interfered with vascular access were excluded.

A purposive sampling technique was employed to ensure that participants represented the two target groups, malnourished and obese, relevant to the study's objectives. Although purposive sampling may limit external validity and introduce potential selection bias, it was deemed appropriate given the specific clinical characteristics required for comparison. To mitigate bias, sampling was conducted across multiple wards and shifts to capture patient variability and reduce the contextual influence of specific nursing teams or time periods.

The final sample consisted of 60 eligible patients (30 malnourished and 30 obese). Although this sample size was relatively small for inferential analyses such as logistic regression, a power analysis was performed to confirm the minimum adequacy for detecting moderate effect sizes (Cohen's d ≥ 0.5) at a 95% confidence level. The results should be interpreted with caution, focusing on the observed trends and practical significance rather than on population-level generalization.

Research Instruments

Compliance with intravenous injection procedures was evaluated using a structured observation checklist developed based on the Standard Operating Procedures (SOP) of the Ministry of Health of the Republic of Indonesia and World Health Organization (WHO) guidelines. The instrument consisted of ten

procedural indicators, including vein identification, aseptic technique, equipment selection, documentation accuracy, and monitoring of local adverse effects. Each indicator was scored dichotomously (1 = compliant, 0 = non-compliant), with higher scores reflecting greater adherence to the standard procedure.

To ensure content validity, the instrument was reviewed by three panel members representing clinical nursing practice, academic nursing education, and patient safety. Content Validity Ratio (CVR) values for individual items ranged from 0.78 to 1.00, with an overall Content Validity Index (CVI) of 0.92, indicating excellent content relevance and clarity. Reliability testing was performed using an inter-rater reliability analysis, yielding a Cohen's kappa coefficient of 0.83, which reflects a high consistency between observers (Altmiller, 2019).

Prior to data collection, all observers participated in a standardized training session to ensure uniform interpretation of procedural indicators and minimize observation bias. The training included joint video-based reviews, pilot observations of five non-sample patients, and calibration discussions to align the judgment criteria for the same. Periodic inter-observer comparisons were conducted throughout the data collection period to maintain reliability and prevent drift in scoring behavior of the observers.

Research Variables

This study used the level of adherence to the intravenous injection procedure as an independent variable, reflecting the conformity of nurses' actions with operational standards. The incidence of local side effects, such as hematoma, infiltration, pain, and edema, were used as dependent variables to represent the safety aspect of the patient. The relationship between the two was analyzed to assess the effect of procedural adherence on the risk of clinical complications.

Nutritional Status Measurement

Nutritional status was assessed using Body Mass Index (BMI), calculated from direct body weight and height measurements, following WHO classification: undernutrition (BMI < 18.5 kg/m^2), normal (18.5–24.9 kg/m^2), and obesity (≥ 30 kg/m^2) (WHO, 2020). To improve accuracy, Mid-Upper Arm Circumference (MUAC) and serum albumin levels were used as supportive indicators to validate BMI findings. Although the main analysis focused on undernourished and obese patients, data from participants with a normal BMI were analyzed descriptively as a baseline comparison to contextualize group differences.

Data Collection Procedure

Observations were made directly by two research nurses during intravenous injection. Each injection event was recorded on the same observation sheet, accompanied by a recording of adverse events within 30 min to 1 h post-surgery. All observations were performed noninvasively, in accordance with the rules of nursing ethics (Keogh et al., 2017).

Data Analysis

Data were analyzed using SPSS version 25. Descriptive statistics were used to summarize the participant characteristics and compliance distributions. Bivariate analyses using the chi-square test were used to examine the association between compliance levels and adverse events. Multivariate logistic regression was employed to identify predictors of patient safety outcomes, with adjustment for potential confounders, such as age, comorbidities, and duration of hospitalization. Bonferroni correction was applied to control for multiple testing, and statistical significance was set at $p < 0.05$.

Research Ethics

This study was approved by the Health Research Ethics Committee (KEPK) of Politeknik Kesehatan, Ministry of Health Riau, Pekanbaru (registration number LB.02.03/6/01/2024). All participants provided written informed consent, and patient confidentiality was maintained in accordance with the bioethical principles.

Result and Discussion

Respondent Characteristics

Sixty patients participated in this study, comprising two nutritional status groups: 30 patients with malnutrition (BMI < 18.5 kg/m^2) and 30 patients with obesity (BMI ≥ 30 kg/m^2). The majority were female (58.3%), and the participants' ages ranged from 19 to 65 years (mean age, 44.2 ± 11.6 years). The normality of

the continuous data was confirmed using the Shapiro–Wilk test ($p > 0.05$), allowing the use of parametric tests.

Preliminary comparisons between groups using the independent t-test for continuous variables and chi-square test for categorical variables showed no statistically significant differences in age ($p = 0.32$) or sex distribution ($p = 0.68$). Although the differences were not significant, patients in the malnutrition group tended to be slightly younger (mean age 42.8 ± 12.1 years) than those in the obesity group (mean age 45.6 ± 11.0 years). Although such small numerical variations are not statistically significant, they may still have clinical implications in terms of vascular elasticity and tissue integrity, potentially influencing intravenous access performance.

Table 1. Demographic characteristics of patients by nutritional status

Characteristics	Malnutrition (n = 30)	Obesity (n = 30)	Total (n = 60)	p-value
Gender, n (%)				0.680*
Male	13 (43.3%)	12 (40.0%)	25 (41.7%)	
Female	17 (56.7%)	18 (60.0%)	35 (58.3%)	
Age (years)				0.320**
Mean ± SD	42.8 ± 12.1	45.6 ± 11.0	44.2 ± 11.6	
Range	19–65	22–64	19–65	–
Comorbidity (≥ 1 diagnosis), n (%)	11 (36.7%)	13 (43.3%)	24 (40.0%)	0.590*
Length of hospital stay (days) Mean ± SD	4.6 ± 1.8	4.9 ± 2.1	4.8 ± 1.9	0.540

Notes: * Chi-square test; ** Independent t-test.
Normality was verified using the Shapiro–Wilk test ($p > 0.05$). No significant baseline differences were observed between the groups.

The demographic characteristics presented in Table 1 demonstrate a balanced distribution between the malnutrition and obesity groups (all $p > 0.05$), indicating comparability for subsequent inferential analyses. Although not statistically significant, the malnutrition group tended to include slightly younger patients, whereas comorbidities were marginally more frequent among obese patients than among non-obese patients. These minor variations were controlled for in the multivariate logistic regression model to ensure an unbiased estimation of the association between nutritional status, nurse compliance, and IV-related complications.

Overall, the demographic composition suggests that both undernourished and obese patients represent clinically relevant populations with increased vulnerability to intravenous injection complications. These findings highlight the need for adaptive nursing approaches that consider physiological variations related to nutritional status, particularly in the management of vascular access and prevention of injection-related complications.

Compliance Rate with Intravenous Injection Procedures

Of the 60 intravenous (IV) injection procedures observed, the overall nurse compliance with the standard IV protocols was 72.5%, indicating moderate-to-high adherence. When analyzed according to patients' nutritional status, nurses demonstrated higher compliance during procedures performed on malnourished patients (75.3%) than on obese patients (69.6%). The normality of the compliance score was confirmed using the Shapiro–Wilk test ($p > 0.05$), and group differences were analyzed using an independent t-test. Although the mean difference was not statistically significant ($p = 0.074$), the observed trend suggests that body morphology may influence procedural ease and adherence consistency.

Further analysis of the procedural dimensions revealed notable variations between the two groups (Table 2). Among obese patients, compliance was significantly lower for vein assessment and needle size selection ($p = 0.009$ and $p = 0.004$, respectively), reflecting the anatomical difficulties associated with thick subcutaneous tissue and reduced venous visibility. These findings align with previous evidence that excess adipose tissue complicates vascular access and increases the likelihood of procedural deviations (Chung & Jarvill, 2019). In contrast, nurses caring for malnourished patients demonstrated greater overall adherence to procedural sequences but tended

to overlook final safety steps, such as needle fixation and post-injection monitoring. Although these omissions appear minor, they may increase the risk of hematoma and other local complications due to tissue fragility and impaired peripheral circulation (Annutto, 2023)(Canaud et al., 2022). Although the present study did not quantify the severity of these events, the findings emphasize that even small deviations in post-procedural vigilance warrant clinical concern in undernourished patients.

Table 2. Compliance by Procedural Dimension in Intravenous Injection According to Nutritional Status

Procedural Dimension	Malnutrition (n = 30) Mean Compliance (%)	Obesity (n = 30) Mean Compliance (%)	*Overall Compliance (%)	p-value*
Hand hygiene and aseptic technique	93.3	91.7	92.5	0.720
Patient identification and preparation	86.7	83.3	85.0	0.630
Vein assessment and palpation	78.3	66.7	72.5	0.009
Selection of appropriate needle/catheter size	80.0	61.7	70.8	0.004
Site cleaning and antiseptic application	90.0	86.7	88.3	0.540
Injection site fixation and stability	73.3	68.3	70.8	0.470
Rate of infusion and device control	71.7	68.3	70.0	0.610
Observation of vein reaction during injection	76.7	70.0	73.3	0.320
Post-injection needle removal and disposal	80.0	75.0	77.5	0.420
Immediate post-injection monitoring (15 min)	68.3	63.3	65.8	0.280
Average compliance rate	75.3	69.6	72.5	0.074**

Notes: * Chi-square test for categorical compliance indicators; ** Independent t-test for overall mean comparison. Statistical significance was set at $p < 0.05$.

As summarized in Table 2, the highest compliance rate was observed for hand hygiene and aseptic techniques (92.5%), demonstrating a strong adherence to infection control practices. Conversely, the lowest compliance was observed for post-injection monitoring (65.8%) and needle selection based on patient morphology (70.8%). These variations indicate that while foundational procedural aspects are well maintained, context-specific adaptations to patients' body characteristics remain suboptimal.

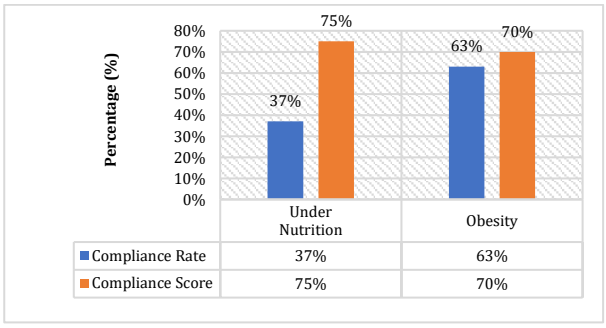

Figure 1. Comparison of Compliance Score and Compliance Rate between Undernourished and Obese Patients

The comparison presented in Figure 1 further illustrates the differential compliance patterns between nurses performing intravenous (IV) injections in patients with different nutritional statuses. Although the overall adherence rate was relatively satisfactory, the divergence between the malnourished and obese groups indicates that a uniform procedural approach may be insufficient in clinical settings. In obese patients, technical barriers, particularly those related to vein accessibility and needle selection, were significantly associated with reduced compliance with procedural dimensions (Table 2). Conversely, in malnourished patients, omissions in the final stages of IV administration, such as needle fixation and post-injection observation, may compromise procedural safety.

These findings suggest that nutritional status is a contextual determinant of procedural performance and safety. The observed differences are not merely statistical but have tangible clinical implications, as decreased compliance in specific steps can increase the risk

of infiltration, hematoma, and local discomfort. This aligns with previous literature reporting that variations in body morphology directly influence the success of vascular access and the technical accuracy of nursing interventions (Chung & Jarvill, 2019). From a patient safety perspective, the results emphasize the need for competency development that extends beyond routine protocol training to include hands-on practice. Integrating simulation- and scenario-based learning modules tailored to patients with malnutrition or obesity may enhance nurses' adaptability to anatomical variations and reduce preventable complications in the future. Institutional support, such as providing adjustable equipment (e.g., longer catheters and ultrasound-guided vein finders) and implementing periodic skill reassessment programs to ensure consistent adherence to IV safety standards, is equally important.

Overall, although intravenous injection is a fundamental nursing skill, the present study demonstrated that the patient's nutritional status significantly modulates procedural quality. Minor variations in compliance across specific procedural aspects highlight the practical challenges nurses face in real-world contexts, which are not always captured by global adherence measures. Consequently, improving nurse competencies should prioritize contextual adaptability reinforced through continuous education, case-based learning, and institutional policies designed to promote individualized and safe IV practices across diverse patient populations (Chung & Jarvill, 2019).

Distribution of Post-Injection Clinical Complications

A total of 60 intravenous (IV) injection procedures were performed during the study period, of which 19 (31.7%) resulted in local post-injection complications in the patient. The most frequent event was infiltration (9 cases, 15%), followed by hematoma (6 cases, 10%) and local pain or edema (4 cases, 6.7%). These findings represent short-term post-procedural effects observed within 60 min; delayed- or late-onset complications were beyond the scope of this study and were not evaluated.

The distribution of complications was uneven among the nutritional groups. Although both groups comprised equal sample sizes, 63.2% of all complications occurred in obese patients, suggesting a higher relative risk of adverse events among individuals with a body mass index (BMI) ≥ 30 kg/m^2. Physiological factors, such as increased subcutaneous tissue thickness, difficulty in venous palpation, and greater mechanical resistance to needle insertion, may have contributed to these differences. However, this interpretation should be viewed cautiously because residual confounding cannot be completely ruled out (Awuchi et al., 2020).

Table 3. Distribution of post-injection local complications by nutritional status

Types of Complications	Malnutrition (n = 30)	Obesities (n = 30)	Number of Cases	Total (%)
Hematoma	2	4	6	10
Infiltrating	3	6	9	15
Local pain & edema	2	2	4	6,7
Total Complications	7	12	19	31,7
No Complications	23	18	41	68,3

Bivariate analysis using the chi-square test revealed a significant association between nurses' compliance and the occurrence of local complications (p = 0.008). To further quantify this relationship, a logistic regression analysis was conducted, controlling for age and comorbidities. The analysis yielded an Odds Ratio (OR) of 2.81 with a 95% Confidence Interval (CI) of 1.32–6.22, indicating that patients who received injections performed with non-standard procedures were almost three times more likely to develop complications than those treated in full compliance with standard protocols.

As shown in Table 4, the logistic regression analysis identified nurse compliance as the only independent predictor of post-injection complications after adjusting for age and comorbidities (Adjusted OR 2.67; 95% CI: 1.21–5.92, p = 0.014). This indicates that non-adherent procedures increase the likelihood of local complications by nearly three-fold compared to standard-compliant practices. Nutritional status (obesity vs. malnourishment) showed a positive but statistically non-significant trend (p =

0.112), suggesting that body morphology may indirectly influence the risk of complications through technical difficulty rather than as an independent factor.

Table 4. Logistic Regression Analysis of Factors Associated with Post-Injection Complications (n = 60)

Variable	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Nurse compliance (low vs high)	2.81 (1.32–6.22)	0.008	2.67 (1.21–5.92)	0.014
Nutritional status (obese vs malnourished)	1.84 (0.92–3.66)	0.083	1.69 (0.78–3.45)	0.112
Age (≥45 years)	1.23 (0.61–2.49)	0.558	1.09 (0.54–2.22)	0.793
Gender (female)	0.94 (0.44–2.01)	0.872	0.88 (0.40–1.92)	0.751
Comorbidity (present)	1.72 (0.83–3.56)	0.143	1.61 (0.77–3.36)	0.196

In absolute terms, non-compliant procedures were associated with a 15% higher complication rate, underscoring the clinical relevance of procedural adherence as a key determinant of patient safety in the surgical field. The findings presented in Table 3 highlight the influence of nutritional status and technical factors on IV injection outcomes. In obese patients, the predominance of infiltration and hematoma suggests a mechanical mechanism related to vein depth, tissue resistance, and suboptimal needle placement. This is consistent with prior reports that identified obesity as an independent risk factor for vascular access complications during infusion therapy (Deol et al., 2020). Conversely, in malnourished patients, complications appear to result from biological fragility, reduced tissue resilience, and minimal subcutaneous protection rather than from purely technical errors. Such vulnerability increases the likelihood of hematoma formation, even when the procedures are otherwise compliant.

These observations also imply that nurses may unconsciously adjust their techniques based on the patient's body habits (Perry et al., 2018; Perry et al., 2024). In malnourished patients, more visible veins may create a false sense of procedural ease, leading to lapses in post-injection monitoring or secure fixation. In contrast, the technical difficulties encountered in obese patients can induce procedural shortcuts or fatigue-related deviations from the standard practice. This behavioral adaptation reinforces that compliance is both a cognitive and situational construct influenced by nurses' perceptions, workload, and patient anatomy.

From a safety management perspective, the strong association between noncompliance and complications underscores the preventable nature of many adverse outcomes. An odds ratio of nearly three signifies a substantial potential for harm reduction through targeted intervention. These findings support international patient safety frameworks that emphasize protocol standardization and clinical competence reinforcement as strategies for mitigating iatrogenic events.

These findings support the implementation of a dual strategy aimed at improving procedural consistency and patient safety. The first component emphasizes technical optimization, achieved through targeted training that focuses on vein localization, appropriate device selection, and post-injection care, particularly for patients with extreme BMI profiles, such as those with obesity or malnourishment. The second component involves behavioral reinforcement, which can be promoted through periodic simulation-based refresher programs, peer observations, and structured feedback mechanisms. Together, these strategies are expected to enhance nurses' adaptability, reduce technical errors, and strengthen adherence to intravenous safety standards in diverse clinical contexts.

Institutional measures, such as providing adjustable IV equipment, promoting the use of ultrasound-guided vein access for difficult cases, and implementing routine audits of IV practices, could further strengthen procedural consistency and reduce the risk of complications in diverse clinical populations.

Analysis Per Procedural Dimension

A detailed examination of ten procedural indicators of intravenous (IV) injection performance revealed substantial variation in nurses' compliance. The indicators with the lowest adherence rates were needle size

selection based on patient BMI (58.3%), accurate vein localization (61.7%), and post-procedure monitoring for ≥ 15 min (65.0%). These findings suggest that nurses encounter technical adaptation challenges when providing care to patients with extreme nutritional statuses, particularly those who are obese or malnourished (Risch et al., 2022).

In obese patients, the primary obstacles include difficulty in venous palpation, increased subcutaneous tissue depth, and frequent device misalignment, all of which contribute to the increased risk of local complications, such as infiltration and hematoma. Conversely, in malnourished patients, inadequate post-injection management, such as insufficient pressure application or limited monitoring, was more frequent and associated with hematoma formation and local pain. It is important to note that these interpretations are drawn from observational inferences rather than direct nurse feedback, underscoring the potential value of future qualitative inquiries to explore the contextual and behavioral factors influencing procedural compliance.

In contrast, the highest compliance rates were observed for hand hygiene and aseptic techniques (93.3%) and communication prior to procedure initiation (88.3%). These results demonstrate a high level of internalization of infection control and patient-centered care principles within the institutional nursing culture. However, these high adherence rates should be interpreted with caution, as observational research settings may introduce social desirability bias, wherein nurses perform better because they are aware of being observed (Lebedinskii et al., 2020).

Overall, the findings indicate that while nurses generally demonstrate strong adherence to core procedural standards, contextual adaptation to patients' physiological variability remains a major challenge. This highlights the necessity of developing case- and simulation-based training modules that emphasize procedural modifications for patients with distinct anthropometric characteristics. Integrating such adaptive training into existing competency programs, supported by continuous audits, feedback systems, and supervision, could enhance both technical precision and procedural consistency, ultimately improving patient safety and care outcomes in the future.

Conclusion

Nurse compliance with intravenous injection procedures in patients with extreme nutritional status remains below optimal standards. Noncompliance increases the risk of local complications by almost threefold compared to actions performed according to the procedure. Obese patients are more likely to experience infiltration and hematomas, whereas malnourished patients tend to experience tissue fragility and mild hematomas. Adaptive protocols should be implemented based on the nutritional status of the patient.

Furthermore, simulation-based training and regular supervision should be conducted to enhance nurses' technical skills and their procedural compliance. Institutions should strengthen patient safety policies through periodic audits and provide vein visualization tools to reduce the risk of complications.

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