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## Peripheral Intravenous Catheter Complications in a Thai Tertiary Hospital: A Cross-Sectional Prevalence Study

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### ABSTRACT

**Background:** Peripheral intravenous catheter (PIVC) use is a common practice in hospital settings but is often associated with complications such as phlebitis, infiltration, and extravasation, which may compromise patient safety.

**Objectives:** To determine the prevalence and types of complications from peripheral intravenous catheter use in a tertiary hospital in Thailand.

**Design:** A cross-sectional descriptive study. Setting: A tertiary care hospital in northeastern Thailand.

**Participants:** A total of 697 patients with 781 peripheral intravenous sites were included using purposive sampling.

**Methods:** This study employed a cross-sectional descriptive design to determine the point prevalence of peripheral intravenous complications including phlebitis, infiltration, and extravasation, conducted in August 2024. This study was conducted and reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

**Results:** Total complication prevalence was 1.91% (95% confidence interval: 1.0-2.9). Phlebitis was most common at 1.15% (95% confidence interval: 0.4-1.9), followed by infiltration and extravasation each at 0.38% (95% confidence interval: 0.0-0.8). Most complications were Grade 3 severity (53.33%). The dorsum of hand was the most affected site (33.3%). Antibiotics, particularly Clindamycin and Ceftriaxone, were most frequently associated with complications (20.0% each). Internal Medicine (45.6%) and Surgery (32.4%) departments had the highest number of intravenous sites.

**Conclusions:** The peripheral intravenous complication prevalence of 1.91% falls within acceptable international standards. Key risk factors included patient age (69.4% aged  $\geq 45$  years), department type, insertion site, and medication types. These findings provide baseline data for quality improvement initiatives and support the implementation of systematic surveillance and prevention protocols to further reduce complication frequency and severity.

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### What is already known about the topic?

- Peripheral intravenous complications including phlebitis, infiltration, and extravasation are common in hospitalized patients, with reported rates varying widely across healthcare settings.
- Risk factors for complications include patient age, catheter characteristics, insertion techniques, and types of infused medications.
- International guidelines recommend maintaining phlebitis rates below 5%, with optimal practice targets below 3%.

### What this paper adds

- This study provides the first comprehensive prevalence data for

peripheral intravenous complications in a Thai tertiary care hospital setting.

- The overall complication rate of 1.91% demonstrates excellent performance against international benchmarks, with specific risk factor identification for targeted interventions.
- Findings reveal strong associations between antibiotic administration (particularly Clindamycin and Ceftriaxone) and complications, providing actionable data for clinical practice improvement.

### Introduction

Peripheral intravenous (PIV) therapy represents one of the most frequently performed medical procedures in healthcare settings, utilized in approximately 80% of hospitalized patients worldwide (Alexandrou *et al.*, 2015). With over one million peripheral venous catheters inserted daily across global healthcare facilities, PIV access serves as the primary

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route for fluid resuscitation, medication administration, and blood product transfusion. Despite its routine nature and apparent simplicity, PIV therapy carries inherent risks of complications that can significantly impact patient outcomes, healthcare costs, and quality of care.

The most commonly encountered complications of peripheral intravenous therapy include phlebitis, infiltration, and extravasation. Phlebitis, defined as inflammation of the vein, manifests through various clinical signs including erythema, warmth, pain, swelling, and the presence of a palpable venous cord. Infiltration occurs when non-vesicant fluids leak into surrounding tissues, while extravasation involves the leakage of vesicant medications that possess tissue-damaging properties. These complications not only cause patient discomfort and anxiety but can also lead to serious consequences including infection, tissue necrosis, nerve damage, and in severe cases, limb amputation.

International research demonstrates considerable variation in PIV complication rates across different healthcare settings and populations. A Chinese hospital study found overall complication prevalence of 17.80%, with infiltration being most common (93.70%) and phlebitis occurring in 88.40% of cases, predominantly in surgical patients receiving irritant medications, those with comorbidities, and those not using needleless connectors (Liu et al., 2022). A Thai university hospital study reported lower rates with phlebitis prevalence of 2.41% (grades 1-2), infiltration of 1.01% (levels 1-2), and extravasation of 0.60% (mild to moderate levels). Risk factors identified included crystalloid administration ( $p = .03$ ) and analgesics ( $p = .001$ ) for infiltration, while extravasation was associated with elderly patients ( $p = .001$ ) (Kaphan et al., 2024).

These complications can lead to patient distress, potential bloodstream infections, increased treatment costs, and care delays. Systematic reporting of such complications is crucial for reflecting the magnitude of the problem and informing the development of appropriate surveillance and prevention strategies for peripheral intravenous therapy complications.

Professional nursing organizations have established evidence-based guidelines for PIV therapy management. The Infusion Nurses Society (INS) recommends maintaining phlebitis rates below 5% and advocates for systematic assessment protocols using standardized tools such as the Visual Infusion Phlebitis (VIP) scale (Gorski et al., 2021).

In Thailand, limited research exists regarding PIV complication prevalence in tertiary care settings. While individual hospitals may maintain internal surveillance data, comprehensive epidemiological studies remain scarce. This knowledge gap hinders the development of evidence-based prevention protocols and quality improvement initiatives specific to Thai healthcare contexts.

Sakon Nakhon Hospital maintains surveillance, reporting, and review protocols for phlebitis incidents but lacks comprehensive studies on associated factors. While infiltration and extravasation incidents are reported and reviewed when they occur, there has been no systematic study of the overall prevalence of peripheral intravenous complications. Therefore, to understand the true prevalence of complications from peripheral intravenous therapy, this study aims to examine the complications of peripheral intravenous infusion therapy including phlebitis, infiltration, and extravasation to inform quality improvement initiatives for patients receiving peripheral intravenous therapy.

## Methods

### Study Design

This study employed a cross-sectional descriptive design to determine the point prevalence of peripheral intravenous complications including phlebitis, infiltration, and extravasation, conducted in August 2024.

### Setting

The study was conducted at Sakon Nakhon Hospital, a tertiary care facility in northeastern Thailand.

### Participants

Population: Patients receiving treatment in the hospital during the survey period in August 2024.

Sample: Patients receiving treatment during the survey period in August 2024, selected through purposive sampling meeting specific criteria.

### Inclusion Criteria:

- Inpatients receiving treatment

- Patients receiving IV fluids/medications/blood/blood components via peripheral intravenous catheters
- Patients with peripheral intravenous catheters for continuous infusion (Continuous IV drip) or saline locks for intermittent administration

### Exclusion Criteria:

- Outpatients receiving treatment
- Patients receiving IV fluids/medications/blood/blood components via central venous catheters
- Burn patients requiring specialized care
- Critically ill patients requiring resuscitation
- Patients scheduled for transfer to external healthcare facilities

### Data Collection

Data Collection Instrument: The data collection instrument consisted of a peripheral intravenous complication prevalence survey form including survey date, month, year, reporter name, surveyed ward, telephone number, patient ID, gender, age, treatment department, and insertion site.

### Instrument Validation:

Content Validity: The peripheral intravenous complication prevalence survey form was reviewed for content validity by three expert panels: one adult critical care nursing specialist, one pediatric and neonatal critical care nursing specialist, and one geriatric nursing specialist. Adjustments were made based on expert recommendations before implementation.

Reliability: The survey form underwent reliability testing (Inter-rater reliability) through training and demonstration of complication assessment procedures for research team members. Subsequently, the research team used the survey form to assess complications in patient wards simultaneously to establish reliability with a target reliability coefficient of 1.0, which was achieved. (Cohen's kappa = 1.0)

### Study Procedures

After receiving approval from the hospital's ethics committee, researchers explained the study objectives, procedures, and expected outcomes to ward supervisors to request cooperation in data collection.

Training and demonstration sessions were conducted for research team members on peripheral intravenous complication assessment, study procedures, sample criteria, inclusion and exclusion criteria, and form completion.

A Google Forms version of the peripheral intravenous complication survey form was created, allowing upload of images of complication sites for verification when questions arose.

A point prevalence survey was conducted over 1 day from 08:00 to 16:00 hours.

### Data compilation and analysis were performed.

### Assessment Tools

- Complications were assessed using standardized grading scales:
- Phlebitis: Visual Infusion Phlebitis (VIP) scale (0-5 grading system)
- Infiltration/Extravasation: ONS Infiltration Scale (0-4 grading system)
- All assessments were performed by trained research team members using direct patient examination combined with medical record review.

### Study Registration: Not registered.

### Data Analysis

Data analysis was performed using Microsoft Excel 2021 (Microsoft Corporation, Redmond, WA, USA) with descriptive statistics including frequencies and percentages.

Peripheral intravenous complication prevalence was calculated as a percentage by dividing the number of complication incidents by the total number of peripheral intravenous insertion sites.

Peripheral intravenous complication prevalence was calculated

as a percentage by dividing the number of complication incidents by the total number of peripheral intravenous insertion sites. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using means, standard deviations, and ranges. 95% confidence intervals were calculated using the Wilson score method for proportions.

### Ethical Considerations

The sample received explanations of study objectives, procedures, and voluntary participation rights. Researchers explained participants' rights to withdraw from the study and assured that study procedures would not adversely affect participants. All information would be kept confidential and used solely for research purposes.

The study protocol received approval from the hospital's Institutional Review Board (SKNH REC No. 017/2567, approved August 2024). Patient consent was waived for this observational study as it involved routine clinical assessment without intervention. All data were de-identified prior to analysis, and strict confidentiality protocols were maintained throughout the study period.

## Results

### Patient Demographics:

A total of 697 patients with 781 peripheral intravenous sites were included in the study. Patient demographic characteristics are shown in Table 1.

**Table 1: Patient Demographics (N=697).**

Characteristic	n (%)
Gender	
Male	384 (55.1)
Female	313 (44.9)
Age Group (years)	
0-14	38 (5.45)
15-44	175 (25.11)
45-64	266 (38.16)
65-80	183 (26.26)
>80	35 (5.02)

Mean age: 51.8 years; Age range: 0 to >80 years

The study population demonstrated a slight male predominance (55.1%) with the largest age cohort being middle-aged adults (45-64 years, 38.16%). Elderly patients ( $\geq 65$  years) comprised 31.13% of the population, representing a significant proportion at higher risk for complications.

### Distribution of Peripheral IV Sites by Department

**Table 2: Distribution of Peripheral IV Sites by Department (N=781).**

Department	n (%)
Internal Medicine	356 (45.6)
Surgery	253 (32.4)
Pediatrics	74 (9.5)
Obstetrics and Gynecology	37 (4.7)
Orthopedics	61 (7.8)

Internal medicine and surgery departments accounted for nearly 78% of all peripheral IV sites, reflecting the high acuity and complex medication requirements typical of these services.

### Prevalence of Peripheral Intravenous Complications

**Table 3: Prevalence of Peripheral Intravenous Complications (N=781).**

Complication Type	n (%) [95% CI]
Phlebitis	9 (1.15) [0.4-1.9]
Infiltration	3 (0.38) [0.0-0.8]
Extravasation	3 (0.38) [0.0-0.8]
Total Complications	15 (1.91) [1.0-2.9]

Phlebitis represented the most common complication, accounting for 60% of all observed complications (9/15 cases), consistent with international literature patterns.

### Severity Levels of Complications

**Table 4: Severity Levels of Peripheral IV Complications (N=15).**

Severity Grade	n (%)
Grade 2	5 (33.33)
Grade 3	8 (53.33)
Grade 4	2 (13.33)

The majority of complications (66.66%) were classified as Grade 3 or higher, indicating moderate to severe presentations requiring immediate intervention. No Grade 5 complications (associated with systemic symptoms) were observed during the survey period.

### Insertion Sites with Complications

**Table 5: Insertion Sites of Peripheral IV Complications (N=15).**

Insertion Site	n (%)
Dorsum of hand	5 (33.33)
Forearm	4 (26.67)
Antecubital fossa	3 (20.00)
Wrist	2 (13.33)
Upper arm	1 (6.67)

The dorsum of hand represented the most common complication site (33.33%), followed by forearm locations (26.67%). This distribution aligns with the higher utilization of these sites for routine IV access and their increased susceptibility to mechanical trauma.

### Medications and Fluids Associated with Complications

**Table 6: Types of Fluids and Medications Associated with Complications.**

Medication/Fluid Type	n (%)
Antibiotics	13 (86.7)
Clindamycin	3 (20.0)
Ceftriaxone	3 (20.0)
Metronidazole	2 (13.3)
Fortum (Ceftazidime)	2 (13.3)
Other antibiotics	3 (20.0)
IV Fluids	
0.9% Normal Saline	3 (20.0)
5% Dextrose	3 (20.0)

**Note:** Individual patients may have received multiple medications/fluids; percentages calculated from total complications (n=15)

Antibiotic administration was associated with 86.7% of complications (13/15 cases), with Clindamycin and Ceftriaxone each accounting for 20% of all complications. This finding underscores the high-risk nature of antibiotic infusions, particularly those with non-physiologic pH levels.

## Discussion

This study represents the first comprehensive prevalence survey of peripheral intravenous complications at Sakon Nakhon Hospital, providing crucial baseline data for quality improvement initiatives. The overall complication prevalence of 1.91% falls within acceptable international standards while highlighting specific areas for targeted interventions.

### Principal Findings

The study found an overall peripheral intravenous complication prevalence of 1.91% with phlebitis being the most common (1.15%), followed by infiltration and extravasation (0.38% each). These findings are consistent with Kaphan et al.'s study in Thailand, which reported phlebitis prevalence of 2.41% (grades 1-2), infiltration of 1.01% (levels 1-2), and extravasation of 0.60% (mild to moderate levels) (Kaphan et al., 2024). When compared to Liu et al.'s study in China, which found overall complication prevalence of 17.80% with infiltration at 93.70% and phlebitis at 88.40% (Liu et al., 2022), our rates are considerably lower.

The differences may be attributed to study methodologies. Liu et al. conducted a retrospective study over 3 months with 10,397 catheter insertions, while our study used a 1-day point prevalence survey, which may not capture complications occurring at other times. Additionally, Marsh et al.'s study in Australia found phlebitis prevalence of 7.6% (Marsh et al., 2015), which is higher than our findings.

According to Infusion Nurses Society (INS) guidelines, phlebitis rates should not exceed 5% (Gorski et al., 2021), and Webster et al. suggest acceptable rates below 3% (Webster et al., 2015). Our phlebitis rate of

1.15% falls well within these acceptable ranges, indicating effective nursing care and adherence to evidence-based protocols at our institution.

## Risk Factor Analysis

### Demographics

The study found that most patients were male (55.1%) with the largest age group being 45-64 years (38.2%), followed by 65-80 years (26.3%), with a mean age of 51.8 years. This is consistent with Wallis et al.'s findings that age correlates with peripheral intravenous complications, as elderly patients experience age-related changes in skin and vascular integrity, reduced elasticity, and increased fragility (Wallis et al., 2014).

Additionally, Kaphan et al. found that extravasation was significantly associated with elderly patients ( $p = .001$ ) (Kaphan et al., 2024), and Abolfotouh et al. found that patients over 60 years had a significantly higher risk of phlebitis (OR = 1.92, 95% CI: 1.12-3.31) (Abolfotouh et al., 2014).

Our study found that patients aged 45 years and older comprised 69.4% of the population, representing a high-risk group for complications. This aligns with age-related physiological changes that explain advancing age leads to tissue and vascular deterioration, reduced elasticity, increased susceptibility to injury, and slower recovery compared to younger individuals.

### Department Distribution

The study found that Internal Medicine had the highest number of peripheral IV sites (45.6%), followed by Surgery (32.4%). This is consistent with Liu et al.'s findings of higher complication rates in surgical patients (Liu et al., 2022). Internal Medicine patients often require multiple medications with varying pH and osmolarity characteristics, while surgical patients face additional risks from frequent arm movements during procedures and administration of irritant medications.

Urbanetto et al. found that Internal Medicine units had significantly higher phlebitis rates compared to other units ( $p < 0.01$ ) (Urbanetto et al., 2016), similar to Cicolini et al.'s findings that Internal Medicine patients had higher phlebitis risk than other departments (OR = 2.4, 95% CI: 1.7-3.4) (Cicolini et al., 2014).

### Insertion Sites

The study found that the dorsum of hand was the most common complication site (33.3%), followed by forearm (26.7%). This supports the literature indicating hand sites as higher risk due to frequent movement, thin tissue, and smaller vessel caliber, making them unsuitable for high-concentration or irritant solutions.

Literature suggests that appropriate insertion site selection should consider the type of medications/fluids being administered, recommending avoidance of high-concentration or irritant medications via small hand vessels. However, Liu et al. found that arm sites had 2-fold higher occlusion risk than hand sites, and antecubital sites had 3-fold higher infiltration risk (Liu et al., 2022), differing from our findings. Future studies should examine the relationship between insertion sites and specific complication types.

### Medications and Fluids

The study found strong associations between antibiotics and complications, particularly Clindamycin and Ceftriaxone (20.0% each), followed by Metronidazole and Fortum (13.3% each). This is consistent with Pasalioglu and Kaya's findings that antibiotic administration significantly increased phlebitis risk ( $p < 0.001$ ) (Pasalioglu & Kaya, 2014), as many antibiotics have non-physiologic pH levels and high concentrations causing vascular irritation.

Literature indicates that medications with pH  $< 5$  or  $> 9$  and osmolarity  $> 600$  mOsm/L have high phlebitis and extravasation risk. Among IV fluids, 0.9% NSS and 5% Dextrose were each associated with 20.0% of complications, consistent with Kaphan et al.'s findings linking crystalloids to infiltration risk ( $p = .03$ ) (Kaphan et al., 2024) and other studies showing that hypertonic solutions increased phlebitis risk compared to normal fluids.

### Severity Assessment

Most complications were Grade 3 (53.33%), indicating moderate to severe presentations requiring immediate intervention. This may reflect inadequate continuous monitoring or lack of clear prevention and surveillance protocols. Ray-Barruel et al. demonstrated that standardized assessment tools like the Visual Infusion Phlebitis (VIP) scale with regular assessments can reduce complication severity through early detection and intervention (Ray-Barruel et al., 2014).

## Clinical Implications

- Based on our findings, several practice improvements can be implemented:
- Enhanced antibiotic administration protocols with mandatory monitoring, particularly for Clindamycin and Ceftriaxone
- Risk assessment and screening for elderly patients before peripheral IV therapy
- Increased vigilance when administering antibiotics, especially Clindamycin and Ceftriaxone
- Site selection considerations appropriate for therapy requirements, avoiding hand sites for high-risk medications
- Systematic monitoring protocols using standardized assessment tools

## Limitations

- Several limitations should be considered:
- Single-day survey design may not reflect long-term trends or seasonal variations
- Missing variables such as catheter size, dwell time, and insertion techniques were not systematically captured
- Detection bias may have occurred due to intensive surveillance during the survey period
- Lack of causal analysis between risk factors and complications due to cross-sectional design
- Single-center design limits generalizability to other settings

## Future Research

- Future studies should focus on:
- Prospective longitudinal studies tracking individual catheters from insertion to removal
- Intervention studies evaluating specific prevention strategies
- Multi-center collaborations enhancing generalizability
- Technology integration studies for enhanced monitoring

## Conclusion

This study found a peripheral intravenous complication prevalence of 1.91%, with phlebitis being the most common complication. Associated factors included patient age, treatment department, insertion site, and types of medications/fluids administered. The findings provide valuable baseline data for quality improvement initiatives and demonstrate that current complication rates meet acceptable international standards.

Key risk factors identified include the concentration of complications in elderly patients (69.4% aged  $\geq 45$  years), specific departments (Internal Medicine and Surgery), hand insertion sites, and patients receiving antibiotic therapy. The predominance of moderate-to-severe presentations (66.6% Grade 3 or higher) suggests opportunities for enhanced surveillance and prevention protocols.

The strong association between antibiotic administration and complications, particularly with Clindamycin and Ceftriaxone, warrants development of enhanced monitoring protocols for high-risk medications. Site selection preferences favoring forearm over hand locations could reduce mechanical complications, while implementing systematic surveillance and prevention approaches can help reduce both the frequency and severity of peripheral intravenous complications.

These findings contribute to the growing body of evidence supporting evidence-based PIV care practices and provide a foundation for targeted quality improvement initiatives in similar healthcare settings.

## Multiple Publications:

This manuscript represents the sole publication from this cross-sectional prevalence survey. No other manuscripts have been published, submitted, or are in preparation using data from this study.

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2. Declaration of Competing Interest
3. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Data Availability Statement:

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request and with appropriate institutional approval, in accordance with ethical guidelines and data protection regulations.

### Ethical Approval:

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Sakon Nakhon Hospital (SKNH REC No. 017/2567). Given the observational nature of the study involving routine clinical assessment without intervention, patient consent was waived by the ethics committee. All data were de-identified prior to analysis to ensure patient confidentiality.

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**Formal analysis:** NB, KP

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