



# Keyword Network Analysis of Infusion Nursing from Posts on the Q&A Board in the Intravenous Nurses Café

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**Objectives:** Portal sites have become places to share queries about performing nursing and obtain expert know-how. This study aimed to analyze topics of interest in the field of infusion nursing among nurses working in clinical settings. **Methods:** In total, 169 user query data were collected from October 5, 2018 to December 25, 2021. This exploratory study analyzed the semantic structure of posts on the nurse question-and-answer board of an infusion nursing-related internet portal by extracting major keywords through text data analysis and conducting term frequency (TF) and term frequency-inverse document frequency (TF-IDF) analysis, N-gram analysis, and CONvergence of iteration CORrelation (CONCOR) analysis. Word cloud visualization was conducted utilizing the “wordcloud” package of Python to provide a visually engaging and concise summary of information about the extracted terms. **Results:** “Infusion” was the most frequent keyword and the highest-importance word. “Infusion→line” had the strongest association, followed by “vein→catheter,” “line→change,” and “peripheral→vein.” Three topics were identified: the replacement of catheters, maintenance of the patency of the catheters, and securement of peripheral intravenous catheters, and the subtopics were blood sampling through central venous catheter, peripherally inserted central catheter management, evidence-based infusion nursing, and pediatric infusion nursing. **Conclusions:** These findings indicate that nurses have various inquiries in infusion nursing. It is necessary to re-establish the duties and roles of infusion nurses, and to develop effective infusion nursing training programs.

**Keywords:** Intravenous, Vascular Access Devices, Nurses, Data Mining, Information Services

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## I. Introduction

Advances in science and medical technology have led to many changes in infusion nursing. Various infusion nursing equipment has been developed to ensure the safety of patients and healthcare professionals and to facilitate the convenience of healthcare professionals, and several new devices are being introduced and used in clinical settings. There include closed-system drug transfer devices to minimize exposure to chemotherapeutic agents [1], artificial intelligence automatic infusion pumps with remote infusion monitoring, and power-injectable central catheters that can be adminis-

tered with contrast medium during computed tomography or magnetic resonance imaging scans [2,3].

Infusion nursing refers to all intravenous-related nursing practices, from selecting venous catheters to removing them, for intravenous infusion patients [4]; these tasks are high-frequency and high-importance nurse duties. The requirements for infusion nursing differ depending on the administered drug, and in particular, since peripheral venous catheterization is a nursing practice that affects the maintenance time and risk of complications depending on the type of drug, the injection location, the injection method, and the patient's condition, evidence-based practice is emphasized [5].

The demand for nurses' specialized knowledge and proficient skills in infusion nursing and their role as professionals who are responsible for the entire process of intravenous infusion therapy is increasing. Medical institutions prepare guidelines for intravenous infusion therapy for nurses and provide periodic training to ensure patient safety and reduce the length of hospital stays, as well as carrying out various activities to prevent infection and improve the satisfaction of patients and caregivers through standardized intravenous management [6]. Institutional protocols mainly follow the nursing practice guideline for intravenous infusions published by the Hospital Nurses Association in Korea [7] and the infusion therapy standards of practice of the Infusion Nurses Society in the United States [5].

The Hospital Nurses Association in Korea has held educational courses for nurses who practice infusion nursing since 2007. The curriculum includes the anatomy and physiology of blood vessels, water-electrolyte imbalance, chemotherapeutic agents, blood transfusion therapy, antibiotic therapy, parenteral nutrition, pediatric intravenous infusion therapy, central venous catheter types and nursing, patient education, peripherally inserted central catheter (PICC) nursing, the role of infusion nurses, nursing processes for various situations in intravenous infusion therapy, and quality management activities in intravenous infusion nursing [8]. These courses provide an opportunity to engage in mutual exchange and learn the latest information on infusion nursing. Several medical institutions have used these courses as an orientation training curriculum for intravenous team nurses to help them obtain knowledge, skills, and attitudes before starting to work with the team. New nurses can also receive intravenous infusion therapy training, which consists of lectures and observation-oriented practical training. After nurses are assigned to a ward, methods to solve the problems that arise in the process of working independently are

sought.

Although medical institutions each provide training, as described above, based on the practice guidelines for infusion nursing to help nurses perform evidence-based infusion nursing, there are limitations to resolving queries in work performance due to new drugs and the diversity of patients.

Currently, there is no professional association related to intravenous infusion therapy in Korea, and infusion nursing information is obtained from experienced professionals or found in online communities [6]. These are called blogs or online cafés, where those who are interested in infusion nursing share posts and engage in social learning through interaction. Cafés for nurses are personally or publicly run, using the "café" format provided by Naver, the predominant online platform in Korea.

The IV nurses café has been run since 2018 by an organization that supports the infusion nursing community. The members of the café are about 2,500 nurses who are working at hospitals. They voluntarily share their experiences in infusion nursing and have the opportunity to receive new information. The platform has become a place to post queries about performing infusion nursing, obtain expert know-how, and share lived experiences. The IV nurses café is characterized by bidirectional communication regarding infusion nursing in the question-and-answer (Q&A) board. In order to receive answers from experts, community members ask questions related to infusion nursing that arise in a clinical setting. Therefore, posts on the Q&A board of the IV nurses café are considered to reflect representative keywords regarding infusion nursing. There is no limit on the word count of posts on the Q&A board in the IV nurses café, and the posts are written in Korean.

This study aimed to analyze interests in the field of infusion nursing among nurses working in the clinical setting and the findings would help to prepare fundamental data for developing infusion nursing training programs and identifying directions for policy improvement. The specific objectives were as follows: (1) to extract frequent and essential keywords from the infusion nursing questions and understand the content; (2) to identify meaningful questions by analyzing the strength of connections between terms among the infusion nursing questions; and (3) to analyze the main topics by determining the structural connections between the keywords comprising the topics.

## II. Methods

### 1. Study Design

This exploratory study analyzed the semantic structure by extracting major keywords through text data analysis from posts on the Q&A board in the IV nurses café through keyword network analysis in order to understand the associations among keywords.

### 2. Subjects and Data Collection

The subjects were posts on the Q&A board in the IV nurses café related to infusion nursing. For data collection, a web crawler was developed that collected posts on Naver [9] using the “selenium” package of Python 3.9.3 version (Pycon, Python Software Foundation, Delaware, USA). Data were collected from posts created by users who consented to the Personal Information Protection Act regulations at the time of membership sign-up. Data with low relevance, such as posts that were unrelated to Q&A or had no user opinions, were excluded. Through this process, a total of 169 user query data were collected from October 5, 2018 to December 25, 2021. The posts were written in Korean and ranged in length from 15 to 150 words. This study received an approval ex-

emption permit from the Asan Medical Center Institutional Review Board (No. 2020-0189).

### 3. Data Analysis

#### 1) Data preprocessing

In data preprocessing, morphemes were segmented and stopwords were removed to analyze the collected unstructured query text data, including verbs and nouns [10]. The posts were written in Korean, although technical jargon was conveyed through a mixture of Korean and English. The extracted Korean texts were translated into English based on the context, and the translated texts were verified by one professor who had expertise in IV nursing and two skilled IV nurses.

For user query data, a morphological analysis was performed using the Okt module of the “konlpy” Python package, which is widely used in natural language processing, and then tokenization was performed to extract major nouns, adjectives, and verbs. Text preprocessing was then conducted to remove stopwords and special characters (Figure 1, Table 1).

#### 2) Simple frequency analysis

This study calculated term frequency (TF) and term fre-

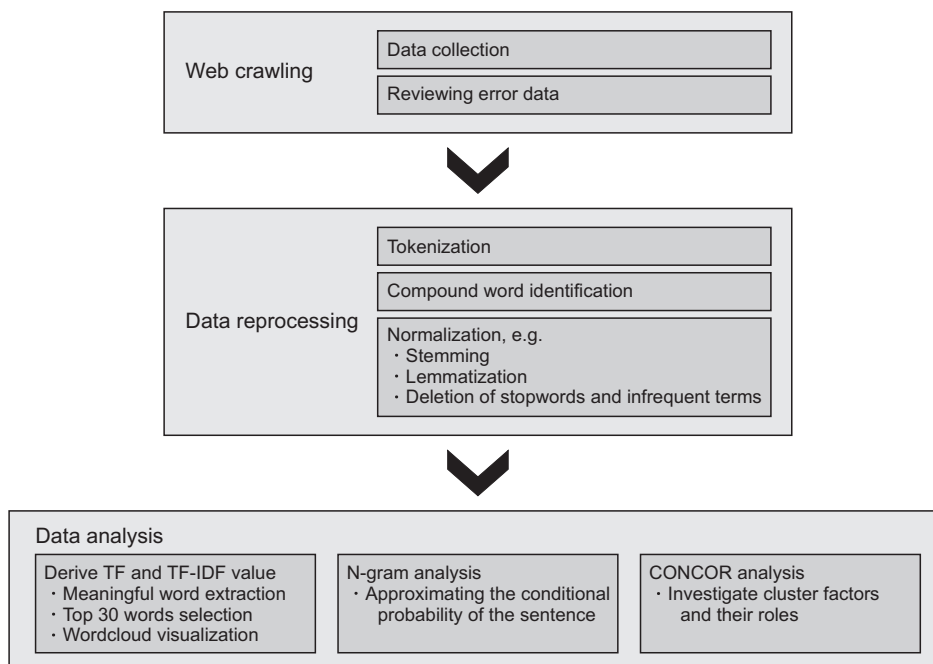


Figure 1. Analysis process. TF: term frequency, IDF: inverse document frequency, CONCOR: CONvergence of iteration CORrelation.

Table 1. List of corrections and deletions of stopwords and infrequent terms

Deletion (complete deletion of the term)	Correction (deletion and correction of parts of the term)
Unidentified terms (single-syllable character): and, latter, in	Elimination of postposition: Tegaderm also→Tegaderm, Plaster on→Plaster
Low relevance terms: extra, about, for, through	

quency-inverse document frequency (TF-IDF) analysis to extract keywords after text preprocessing. TF-IDF provides statistical data indicating the importance of a specific term within a specific document when there is a document group consisting of several documents, and this method is widely used for morphological analysis [11]. The TF-IDF value increases when the number of documents in which a term appears among the entire document set is low, but the number of times in a specific document is high. The TF-IDF determines the relative frequency of words in a specific document compared to the inverse proportion of that word over the entire document corpus. Intuitively, this calculation determines how relevant a given word is in a particular document. Words that are common in a single or a small group of documents tend to have higher TF-IDF numbers than common words such as articles and prepositions. Therefore, the TF-IDF only considers the frequency of words, and it does not relate to regularization [12].

This study derived the TF and TF-IDF of 30 terms by using CountVectorizer and TfidfVectorizer modules in the scikit-learn package of Python. In addition, word cloud visualization was conducted utilizing the “wordcloud” package of Python to provide a visually engaging and concise summary of information about the extracted terms.

### 3) N-gram analysis

N-gram analysis calculates and visualizes sequences of N words as a probabilistic number, allowing the frequency of syllables or words located after a particular word in a large document volume to be expressed as a quantitative value [13]. N-grams can be used to analyze large-volume unstructured text documents to quantify the frequency of syllables or words placed after a particular word with a strength score. Arrows visually indicate the direction of the connection between words, and the thickness of the arrows represents the connection strength [14]. In this study, the degree centrality indices of co-occurring words were derived and visualized using an N-gram network graph. Accordingly, the preprocessed query data were analyzed based on word segmentation units (word A–word B) using the N-gram network analysis tool provided by Textom (The IMC, Daegu, Korea). Textom is a big data analysis solution that can analyze large and complex text data. It can process unstructured big data from data collection to refinement, matrix, sentiment analysis, and visualization using crawling and natural language processing.

### 4) Keyword network analysis

CONvergence of iteration CORrelation (CONCOR) analysis is an analytical method of grouping highly correlated word nodes based on an analysis of intertextual correlations [15]. CONCOR analysis allows an intuitive understanding of the network structure between words and enables easy identification of the characteristics of a specific group by deriving meaningful word groups [16].

Therefore, this study conducted CONCOR analysis utilizing UCINET6.753 (Analytic Technologies, Nicholasville, KY, USA) after extracting data applied with a 1-mode matrix (50×50) through Textom to derive detailed study areas. In a visualization based on CONCOR analysis, a larger node indicates a higher word frequency, and a thicker connection line between nodes indicates a greater inter-word association strength.

## III. Results

### 1. Keyword Derivation

The TF analysis showed that “infusion” (124 times) was the most frequent keyword, followed by “IV” (84 times), “use” (71 times), “line” (64 times), and “hospital” (58 times) (Table 2). Similarly, the TF-IDF analysis results also showed that “infusion” had the highest importance (275.9569), followed by “IV” (210.8157), “use” (199.5942), “line” (187.454), and “hospital” (165.8411). The terms showed slight differences in ranking between 1 and 30 between TF and TF-IDF.

Figure 2 shows a word cloud visualization based on the TF and TF-IDF of the top 30 terms. The word cloud on the left is the result of using frequent terms, and the word cloud on the right is the result of using the importance of terms.

### 2. Inter-word Association Strength

The N-gram analysis of the strength of inter-word associations showed that “infusion→line” (23) had the strongest association, followed by “vein→catheter” (19), “line→change” (11), and “peripheral→vein” (10) (Table 3, Figure 3).

Six clusters of sequential terms and one core cluster containing “infusion” with the highest number of sequential terms (39) were derived. In the core cluster including “infusion.” The “infusion→line→change” sequence was relatively strong, as was “hospital→pediatric→IV→site.”

### 3. Topic Derivation

Three topics and four subtopics were derived by analyzing the queries related to infusion nursing on the posts of the Q&A board in the IV nurses café by topic through CON-



**Table 3. Strength of word associations**

	Word A	Word B	Strength
1	infusion	line	23
2	vein	catheter	19
3	line	change	11
4	peripheral	vein	10
5	iv	site	9
6	pediatric	iv	9
7	adhesive	plaster	8
8	hospital	nurse	8
9	contrast	agent	8
10	nurse	association	7

iv: intravenous.

COR analysis by grouping highly associated terms (Figure 4).

The first area (G1) of the three topics was “replacement of catheters.” In this topic, “infusion,” “line,” “change,” and “patient” were terms that appeared frequently, and were mainly related to intravenous replacement in high-risk patients. The second topic area (G2) was “maintenance of the patency of catheters,” where “use,” “flushing,” and “heparin” were terms that appeared frequently, and these terms were mainly associated with activities to prevent venous catheter occlusion. The third topic area (G3) was “securement of peripheral intravenous catheters,” in which “catheter,” “vein,” and “peripheral” appeared frequently; these terms were related to safely securing peripheral intravenous catheters.

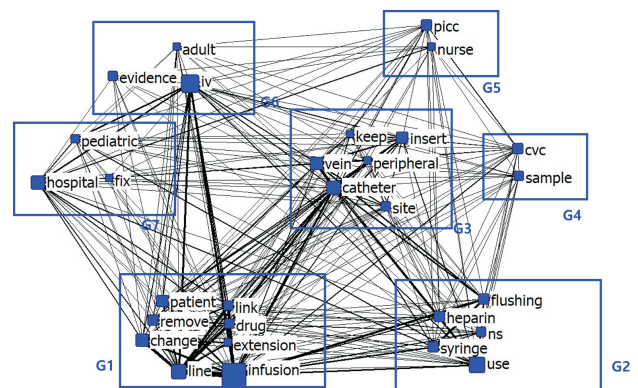
Next, the first subtopic (G4) was “blood sampling through central venous catheter,” which contained terms associated with central venous catheter and blood collection, such as “sample” and “CVC.” The second subtopic (G5) contained terms related to “PICC” and “nurse,” and the subtopic was named “peripherally inserted central catheter (PICC) management.” The third subtopic (G6) was named “evidence-based infusion nursing” based on the derived terms associated with “adult,” “IV,” and “evidence.” Lastly, the fourth subtopic (G7) was named “pediatric infusion nursing,” as it contained terms related to venous catheter securement in pediatric patients, such as “hospital,” “fix,” and “pediatric.”

## IV. Discussion

This study was conducted to identify the interests of clinical field nurses in the field of infusion nursing by analyzing posts on the Q&A board in the IV nurses café, with the aim of preparing fundamental data for developing infusion nursing training programs and identifying directions for policy



**Figure 3. Network graph using N-gram analysis.** 3way: 3-way stopcock, iv: intravenous, ns: normal saline, cvc: central venous catheter, picc: peripherally inserted central catheter.



**Figure 4. Keyword network analysis using CONvergence of iteration CORrelation (CONCOR) analysis.** iv: intravenous, ns: normal saline, cvc: central venous catheter, picc: peripherally inserted central catheter.

enhancement.

First, an analysis of the TF of posts on the Q&A board in the IV nurses café showed that “infusion” had the highest frequency. “Infusion” is the word used in infusion nursing for “injection” or “administration,” and the ultimate goal of securing an intravenous access route is safe drug administration, explaining why this was the main topic of interest. “IV” (“intravenous”) was also derived as a high-frequency term, which is thought to be because it is used interchangeably as a term referring to the route of administration or a venous catheter. In addition, terms related to infusion nursing practice, such as “evidence,” “PICC,” and “heparin,” were also derived within the top 30. The top-ranking terms were gen-

erally related to the maintenance of venous catheters, meaning that many nurses sought information on how to perform evidence-based practice, instead of relying on the personal opinions of experts or skilled persons to solve problems in the infusion nursing field. Nurses posted on the Q&A board with questions about the practices that were commonly implemented at their medical institution and anticipating other methods. Thus, these findings can be considered a positive message for transitioning to more evidence-oriented and evidence-based practice.

In this study, the top 30 terms in terms of TF and TF-IDF had high correlations (0.9 or higher), which means that each derived term had a high probability of containing a core meaning and topic rather than being routinely used in similar texts [17].

Next, the inter-word association strength analysis showed that “infusion” and “line” had the strongest associations. A reason for the strong associations observed for “line” may be that it has two meanings (i.e., the infusion set for fluid infusion and the intravenous route). There may have been researcher intervention in separating and naming terms, which could be considered a study limitation.

This study identified that the “infusion→line→change” sequence was relatively strong in the core cluster, which included “infusion.” This finding reaffirms that the most common and important issue in infusion nursing practice is decision-making in replacing infusion-related devices or equipment. Although it was previously recommended to replace peripheral intravenous catheters regularly every 72 or 96 hours to prevent phlebitis [5,7], the current guidelines suggest removing the catheters only when there is a problem according to healthcare professionals’ clinical judgment [5,7]. The clinical judgment of healthcare professionals is based on the patient’s condition and requires information sharing. In addition, the “hospital→pediatric→IV→site” sequence was strongly connected, reflecting the fact that the operation of intravenous teams began with the need to secure an intravenous route for pediatric patients. The first intravenous team in the United States also treated pediatric patients [5,18], and most intravenous teams in Korea also work with pediatric patients, achieving successful results [19].

The topics derived from this study included the replacement of venous catheters, maintenance of the patency of the venous catheters, and securement of peripheral intravenous catheters, and the subtopics were central venous catheter blood collection, peripherally inserted central catheter management, evidence-based infusion nursing, and pediatric infusion nursing. For the replacement of catheters, the ratio-

nale for regular replacement at a particular time has lost its effectiveness, and the clinical judgment of healthcare professionals has become crucial. However, clinical judgments depend on the individual’s experience, making it imperative to share experiences and information. The most common complication associated with catheters is occlusion. Catheter occlusion is defined as a temporary or permanent inability to aspirate blood or infuse therapeutics through the lumen of a venous catheter. Occasionally, a catheter may burst when attempting to infuse with force greater than a specific pressure, or a catheter should be reinserted due to breakage. To prevent these incidents, heparin dilutions are regularly administered, and each medical institution presents the dilution concentrations and dosages in its regulations [7]. These guidelines are made based on systematic literature reviews and are recommended to be revised regularly. In particular, in the infusion nursing field, the introduction of new devices has rapidly increased with advances in science and medical technology, which often involve simultaneous studies to evaluate the effectiveness of innovations.

The Q&A board of the IV nurses café analyzed in this study is a space where nurses working at medical institutions ask questions regarding infusion nursing to skilled IV nurses selected by the team, who voluntarily participate. Expertise in infusion nursing is mainly learned through apprenticeship. The scope of infusion nursing is wide, and nurses’ roles are unclear. In particular, since the Medical Service Act places limits on independent nursing practice for invasive medical procedures [20], there is an urgent need for communicating and sharing information among nurses. Reflecting these expectations, the Q&A board of the IV nurses café related to infusion nursing has become a platform for information sharing.

A limitation of this study is that it was limited to a specific data collection period and a specific internet portal. However, this study made a significant contribution by conducting a more objective and systematic analysis that involved using a sophisticated calculation method to derive core meaningful terms through TF-IDF index analysis in addition to simple frequency analysis, thereby going beyond the methods used in similar previous studies.

It is expected that the analysis and classification of the queries addressed on the Q&A board in the IV nurses café performed in this study will provide fundamental data for re-establishing the duties and roles of infusion nurses and developing effective infusion nursing training programs. More in-depth studies can be conducted in the future by targeting various websites related to infusion nursing and a

more comprehensive range of data.

## Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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