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Patterns of Symptoms and Symptom-related Factors of Patients in the Intensive Care Unit: A Secondary Data Analysis of Electronic Medical Records

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Purpose: Patients in the Intensive Care Unit (ICU) experience a variety of symptoms. This descriptive correlational study aimed to determine the prevalence of symptoms and the physiological and situational factors associated with these symptoms in ICU patients. **Methods:** We analyzed the Electronic Medical Records (EMRs) of 1,214 cases admitted to and discharged from the ICUs of a university hospital in Seoul over a 1-year period from June to September 2022. This analysis utilized standardized instruments embedded in EMRs and a natural language analysis framework developed by the researchers. Descriptive statistics, the χ^2 test, the Fisher exact test, and multivariate logistic regression were employed to identify common symptoms and their related factors. **Results:** In total, 85.7% of the cases had at least one symptom during their ICU stay, and 36.6% experienced 2 symptoms. Pain was the most frequently experienced symptom, affecting 69.5% of cases, followed by agitation (29.7%), dyspnea (29.7%), and delirium (4.8%). Multivariate logistic regression analysis indicated that the length of ICU stay influenced pain (odds ratio [OR]=1.04; 95% confidence interval [CI], 1.02~1.06; $p<.001$), delirium (OR=1.08; 95% CI, 1.06~1.11; $p<.001$), agitation (OR=1.07; 95% CI, 1.05~1.10; $p<.001$), and dyspnea (OR=1.19; 95% CI, 1.13~1.26; $p<.001$). **Conclusion:** Pain, agitation, and dyspnea are common in ICU patients and are associated with the length of their ICU stay. Our study identifies factors related to these symptoms that could be targeted to manage and reduce their occurrence, providing a foundation for future research on various symptom assessment tools and natural language transcripts.

Key Words: Delirium; Dyspnea; Intensive care units; Pain; Psychomotor agitation.

INTRODUCTION

Patients with or suspected to have severe organ dysfunction are typically admitted to the Intensive Care Unit (ICU) [1]. Additionally, ICU admission following major surgery is considered standard treatment [2]. Given the increasing severity of critically ill patients and the demand for advanced medical interventions, the ICU plays a critical role in modern healthcare systems, and its prevalence is expanding [3]. Intensive care nurses are the first key personnel to detect and intervene upon changes and risks in patient conditions, and the level of nurse staffing has a direct impact on patient outcomes, including mortality [3].

Patients admitted to the ICU often experience a range of

painful symptoms due to complex factors [4], and the ICU experience typically includes other unpleasant symptoms [5]. While the primary goal of ICU care is to manage life-threatening conditions, the focus on pain relief and palliative care within these settings has significantly increased in recent years [6]. The experiences of disease and treatment in critically ill patients are closely linked to the symptoms they endure [5]. Effective management of these symptoms is crucial because it not only alleviates the suffering of these patients but also impacts their prognosis [7]. Moreover, previous studies have shown a correlation between high mortality rates and symptoms such as pain and shortness of breath in critically ill patients [8,9]. Furthermore, systematic assessments and management of

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pain and delirium in these patients have been associated with lower mortality rates and reduced need for mechanical ventilation [7].

Symptom evaluation is necessary to plan care for critically ill patients [5]. Although patient self-reporting is considered the most reliable gold-standard assessment due to the subjective nature of symptoms, it is often impossible for critically ill patients to report their symptoms themselves [4]. Consequently, previous studies that relied solely on patient self-reporting have excluded a significant number of critically ill patients who are unable to communicate effectively [10]. This underscores the need for research that includes both patient self-reporting and objective observation of symptoms.

Although the importance of symptom management in the ICU is widely recognized, relatively limited research has investigated this issue. Previous studies have primarily focused on individual symptoms, such as pain [11,12], delirium [13,14], dyspnea [15], and psychological symptoms like anxiety, rather than addressing the complexity of multiple concurrent symptoms. Given that critically ill patients often experience a variety of symptom complexes simultaneously [4], there is a need for comprehensive research into these frequently occurring symptoms.

We reviewed previous studies to identify significant symptoms that frequently occur in critically ill patients and potentially affect their prognosis. While studies investigating multiple symptoms reported a variety of symptoms, pain, dyspnea, and anxiety were consistently noted as common and highly prevalent in this patient group [16, 17]. Notably, pain and shortness of breath were identified as the most distressing of these symptoms [16]. Although anxiety is a critical symptom in critically ill patients and has been the focus of several studies, its highly subjective nature poses challenges for objective assessment. Therefore, in this study, we investigated agitation, which can be objectively evaluated by nurses, as an alternative to anxiety. Additionally, we included delirium, which is known to significantly impact the prognosis of critically ill patients [13], thereby expanding our analysis to four symptoms.

Moreover, studies that have attempted to comprehensively investigate various symptoms have excluded a significant number of ICU patients who are unable to self-report, resulting in notable limitations [16,17]. To address the communication barriers faced by patients in the ICU, a qualitative study [18] was conducted using retrospective interviews after their discharge. Although this qualitative study explored the experiences of patients in ICUs, it did not quantify the symptoms or symptom-related factors

that these patients experienced during their ICU stay [18].

A study comparing trends in domestic and international research in intensive care nursing highlighted a lack of quantitative research on the symptoms experienced by patients in intensive care within the South Korean context [19]. To address these gaps, this study aimed to quantify the prevalence of, and factors related to, symptoms experienced by patients in the ICU, regardless of their ability to communicate. This study utilized both patient self-reports and objective observations by analyzing Electronic Medical Record (EMR) data, which includes natural language processing and tools used in EMR analysis. The specific goal of this study was to examine the patterns of symptom occurrence, including pain, agitation, dyspnea, and delirium, as well as the degree of physiological and situational factors associated with these symptoms in critically ill patients. It also aimed to identify the risk factors influencing the occurrence of each symptom.

METHODS

1. Study Design

This descriptive correlational study aimed to identify the symptoms and its related factors experienced by patients in the ICU through a retrospective EMR data review.

2. Study Population

The required sample size was calculated using G*Power 3.1.9.7. Due to the limited number of prior studies that identified multiple symptoms and related factors in critically ill patients, references from studies focusing on individual symptoms were used. Considering the significant differences in effect size and explanatory power reported in previous research, a small effect size and explanatory power were employed for this sample size calculation. With an effect size of 0.1, a power of .80, a confidence level of .05, and 15 independent variables, the required sample size was determined to be 139. To account for missing values in EMR data and annual variations in ICU admissions, we reviewed the medical records of patients admitted to the ICU over a 1-year period.

We analyzed the EMRs of adult patients aged 18 and older who were treated and discharged from the ICU at a university hospital in Seoul, South Korea, over a one-year period from June 2021 to May 2022. Patients with a Glasgow Coma Scale (GCS) score of 3 or less (indicating abnormal flexion response) or a Richmond Agitation Sedation Scale (RASS) score of -4 or less (indicating deep sedation)

were excluded from the study because their symptoms could not be assessed through verbal and non-verbal responses. Additionally, we excluded records of patients with missing data related to inclusion and exclusion criteria or symptom values to minimize errors in the statistical analysis. Specifically, cases lacking ICU admission or discharge records, GCS scores, RASS scores, and Confusion Assessment Method for Intensive Care Unit (CAM-ICU) records were also excluded. Regarding pain assessment, we excluded cases that lacked records for both the Numeric Rating Scale (NRS) and the Critical Care Non-verbal Pain Scale (CNPS). For dyspnea evaluation, cases were excluded if they did not include both the “respiratory pattern” item from the clinical observation record and a natural language description in the nursing records. During the study period, there were 2,532 admission records; 1,318 were excluded based on the exclusion criteria, leaving 1,214 records included in the study. Of the 1,214 records reviewed, 327 were repeat entries for patients who had been previously admitted during the study period. After accounting for these repeats, a total of 999 patients were included in the study. To analyze differences in symptoms based on ICU readmission, each admission record of a patient was treated as a separate case when multiple admissions occurred.

3. Measurements and Validations

1) Symptoms

Based on previous studies [11-17], four symptoms frequently observed in critically ill patients—pain, delirium, agitation, and dyspnea—were selected for analysis due to their possible relation to patient prognosis.

The EMRs included data on symptom assessments using both standardized and non-standardized instruments. Standardized tools, such as the 11-point NRS and CNPS for pain, CAM-ICU for delirium, and RASS for agitation, were employed. Pain was considered present if either the NRS or CNPS yielded a score of ≥ 1 . When evaluated with the NRS, patients were asked to rate the intensity of their pain on a scale from 0 to 10. The inter-rater reliability of the CNPS ranged from 0.83 to 0.88. [20] Additionally, there was a strong correlation between the CNPS and the self-reported pain scale ($r=0.71$) [21]. The CAM-ICU is a delirium assessment tool noted for its high sensitivity and specificity, with inter-rater reliability ranging from 0.79 to 0.95 [22]. Agitation was defined as a RASS score between +1 (restless) and +4 (combative). The RASS is highly reliable for inter-rater assessments and is used to evaluate sedation, consciousness, and agitation in critically ill patients [23].

For dyspnea, no records of measurements made using standardized tools were available. Therefore, data were extracted from natural language descriptions in the EMRs. To ensure the reliability of the natural language processing, two or more capable nurses conducted cross-checking in each step. The criteria for nurses' abilities were set according to a previous study that developed a clinical ladder system model for staff nurses working in tertiary care hospitals in South Korea [24]. According to this study, clinical experience of 3 years and 7 years were suggested as the minimum clinical experience cut-off point for the “competent” and “expert” levels, respectively [24]. Adapting this clinical experience criterion, nurses with the necessary level of competence at each stage established three lists of index words—possible index words, index words, and index keywords—and reviewed the records. First, two nurses with >3 years of experience in the ICU, including the researchers, independently analyzed 10 EMRs and created a list of 20 possible index words. This list was reviewed for content validity by seven experts, including a nursing professor, a head nurse in the ICU, an educational nurse in the ICU, and four ICU nurses with >7 years of experience. Items with a content validity index value of $\leq .78$ were removed. After the expert content validity evaluation, 16 index words remained: “difficulty in respiration,” “uncomfortable respiration,” “difficult to respire,” “hard to breathe,” “stuffy breath,” “breathing hard,” “shortness of breath,” “hard to breathe,” “Hard to respire,” “shortness of breath,” “accessory muscle,” “dyspnea,” “irregular breath,” “labored breath,” “respiratory distress,” and “shortness of breath.” Because the phenotypes of the index words were highly diverse, there was a risk of missing natural language records with different endings if we searched for only one representative phenotype. Therefore, six index Keywords - “respiration,” “breathing,” “accessory muscle,” “breath,” “dyspnea,” and “respiratory” - were re-selected and nursing notes were searched.

Even though this list of index keywords was created from index words used to detect dyspnea in the EMRs, the appearance of an index keyword only meant that there was an evaluation of dyspnea. An individual record review was required to confirm whether these cases represented actual dyspnea. For example, if the word “breath” appears in an EMR, the individual records should be checked to distinguish whether it occurs in the context of “shortness of breath” or “no trouble breathing”. In total, 1,832 natural language records for 561 cases were identified through the primary keyword search. The researchers reviewed the records to determine whether the

search results corresponded to the 16 index words, and it was confirmed that 884 records for 288 cases involved dyspnea.

Additionally, the "respiratory pattern" item on the clinical observation record was utilized to assess dyspnea. At the hospital where the research took place, the respiratory pattern was documented with one of four descriptors: easy, shallow, deep, or labored. In this study, any choice other than "easy" was classified as dyspnea.

2) Physiological factors

This study was based on the theory of unpleasant symptoms, which explores the experience of multiple unpleasant symptoms and their influencing factors [25]. We reviewed previous studies to identify the specific symptoms and related factors to be analyzed in this research. The physiological factors considered were age, sex, primary diagnosis, illness severity, and level of consciousness. Primary diagnoses were categorized according to the 10th International Statistical Classification of Diseases and Related Health Problems. Illness severity was evaluated using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score. APACHE II scores were categorized using a threshold of 23, identified as the optimal predictive cut-off point for mortality in ICUs [26]. The level of consciousness was assessed with the GCS, with scores classified at a threshold of 12. A score of 12 or lower indicates a moderate brain injury [27].

3) Situational factors

Situational factors, including the route of ICU admission, ICU readmission, length of ICU stay, and treatment, were investigated. The route of admission was categorized into three groups: postoperative admission, transfer from a general ward, or admission through the emergency room, with or without subsequent surgery. ICU readmission was defined as any instance where a patient was admitted to the ICU more than once during the study period. The length of ICU stay was determined by reviewing the admission records from the ICU. Treatment factors, such as Continuous Renal Replacement Therapy (CRRT), ventilator use, and the administration of general anesthetics, painkillers, and sedatives, were examined using clinical observation records and prescription histories.

4. Data Collection

Data collection commenced on June 23, 2022, following Institutional Review Board (IRB) approval, and continued until September 2022. The data were gathered by

reviewing both the Clinical Data Warehouse system and EMRs. In the hospital where the study took place, pain and agitation assessments were conducted on a pre-determined schedule (every 4~8 hours). In contrast, delirium and dyspnea assessments were performed by medical staff as needed, without a fixed schedule, adhering to the hospital's guidelines. As a result, the assessment cycles for each symptom varied. Additionally, since patients' EMRs often contain multiple entries related to symptoms and associated factors, it was crucial to establish criteria for selecting and analyzing these records. This study established criteria to determine the prevalence of symptoms, the number of cases, and the days on which symptoms were noted. Initially, all symptom assessment records from each patient's ICU stay were reviewed. Any patient who exhibited any of the symptoms at least once during their stay was considered a symptomatic case. The frequency of such cases was then analyzed for each symptom, with results presented as the number of cases where symptoms were noted at least once. Moreover, the total number of symptoms per case was calculated by summing the occurrences of each symptom at least once. The proportion of symptomatic days to the total number of days in the ICU was analyzed for each symptom. Each day that symptoms were noted was designated as a symptomatic day. The results were expressed as the ratio of symptomatic days to the total duration of the ICU stay. The onset time of each symptom was documented to track the patterns of symptom emergence over time. Additional data collection criteria were defined based on the unique characteristics and related factors of each symptom.

Before data collection, two nurses, one of whom was a member of the research team reviewed 10 EMRs to confirm the inter-rater reliability of the analysis. As clinical experience plays a crucial role in developing professional competency [28], nurses with >3 years of ICU experience were selected to review the EMRs in this study.

5. Statistical Analysis

The symptoms and symptom-related factors were analyzed using descriptive statistics. The χ^2 test was employed to assess differences in symptom occurrence according to symptom-related factors. When the expected frequency was ≤ 5 in $\geq 20\%$ of the subcategories, Fisher's exact test was utilized. Factors that showed significant differences based on the χ^2 test or Fisher's exact test were included in stepwise multivariate logistic regression.

6. Ethical Consideration

This study was reviewed and approved by the IRB of S university hospital, where the study was conducted (IRB No. H-2206-111-1333). The IRB determined that informed consent was not required because the risk to the study subjects was very low.

RESULTS

1. Symptom Prevalence

Of the 1,214 cases, 1,025 (84.4%) exhibited at least one of the four symptoms, while 422 (34.8%) experienced more than one symptom, as shown in Table 1. The frequency of each symptom—pain, delirium, agitation, and dyspnea—is also detailed in Table 2. Pain was the most common symptom, observed in 844 cases (69.5%), whereas delirium was the least frequent, appearing in only 58 cases (4.8%). When analyzing the proportion of days symptoms were present during the ICU stay, pain was noted on 2,184 days (33.0%), followed by agitation (12.3%), dyspnea

(12.1%), and delirium (1.2%).

2. Pain

NRS pain evaluation records were available for 1,107 cases (91.2%), CNPS records for 567 (46.7%), and both NRS and CNPS records for 460 (37.9%). Of the 1,107 cases evaluated using the NRS, 743 (67.1%) exhibited pain. Similarly, of the 567 cases assessed with the CNPS, 261 (46.0%) demonstrated pain.

Table 2 illustrates the onset of symptoms after ICU admission. It indicates that 719 (85.2%) of the 844 cases that experienced pain reported its occurrence within the first 24 hours of ICU admission.

3. Delirium

Delirium was the least common symptom. Of the 58 cases who exhibited delirium, it first occurred within 24 hours of admission in only 17 cases (29.3%). This suggests that delirium was less likely to manifest in the early stages of admission than other symptoms (Table 2).

Table 1. The Number of Symptoms in Each Case

(N=1,214)

Variable	No symptoms	One	Two	Three	Four
	n (%)	n (%)	n (%)	n (%)	n (%)
The number of cases	189 (15.6)	603 (49.7)	285 (23.5)	119 (9.8)	18 (1.5)

Table 2. The Number of Cases and Days with Symptoms

(N=1,214)

Variables	Categories	Pain	Delirium	Agitation	Dyspnea
		n (%) or days (%)	n (%) or days (%)	n (%) or days (%)	n (%) or days (%)
Number of cases that experienced symptoms at least once		844 (69.5)	58 (4.8)	360 (29.7)	340 (28.0)
Number of cases in which symptoms were confirmed with the specific symptom assessment tools	NRS	743 (67.1) [†]			
	CNPS	261 (46.0) [‡]			
	Natural language analysis				288 (84.7)
	Respiratory pattern items				152 (44.7)
Timing of initial symptom occurrence after ICU admission (hour)	< 24	719 (85.2)	17 (29.3)	229 (63.6)	183 (53.8)
	24~< 48	37 (4.4)	6 (10.3)	35 (9.7)	41 (12.1)
	48~< 72	22 (2.6)	5 (8.6)	24 (6.7)	27 (7.9)
	≥ 72	66 (7.8)	30 (51.7)	72 (20)	89 (26.2)
Number of days with symptoms, days (%)		2,184 (33.0)	79 (1.2)	817 (12.3)	799 (12.1)

Total number of cases=1,214, Total number of days in intensive care unit=6,616.

CNPS=critical care non-verbal pain scale; ICU=intensive care unit; NRS=numeric rating scale; [†]Since some cases used only one method of recording the symptoms (NRS or CNPS), the number of cases evaluated by NRS and CNPS does not match the total number of analyzed records. Therefore, the incidence of pain among the patients evaluated using each tool was indicated separately. NRS pain evaluation records were available for 1107 cases, of which 743 showed pain of 1 point or more in NRS; thus, 67.1% of cases that were evaluated by NRS tool showed pain; [‡] CNPS records were found in 567 cases, of which 261 cases showed pain, resulting in 46.0% of patients who received CNPS evaluation showing pain.

4. Agitation

Table 2 indicates that agitation was observed in 360 cases (29.7%) and occurred during 12.3% of the total patient stay period. According to the same table, 229 cases (63.6%) experienced agitation for the first time on the first day of ICU admission.

5. Dyspnea

We investigated dyspnea by analyzing natural language and clinical observation records that covered respiratory patterns. Our findings revealed that dyspnea occurred in 340 cases (28.0%), with 84.7% (288 cases) confirmed through natural language symptom records and 44.7% (152 cases) identified in respiratory pattern items. Dyspnea was observed during 12.1% of the total stay. Table 2 shows that more than half of the cases (183 cases, 53.8%) with dyspnea developed the symptom on the first day of ICU admission.

6. Symptom-related Factors

The physiological and situational factors associated with the symptoms are detailed in Table 3. The cases had an average age of 63.39 years, with 51.8% being 65 years or older. Among the various diagnoses, neoplasms, denoted by the C code, were the most prevalent, accounting for 38.2%.

The most common reasons for admission were post-operative transfers from the general ward (595 cases, 49.0%) and the emergency room (443 cases, 36.5%). The average stay in the ICU was 5.45 days, with a median duration of 3 days. There were 327 cases (26.9%) involving patients who were readmitted to the ICU at least once during the study period. Additionally, 14.1% of the cases required CRRT at least once, and the majority (62.8%) involved ventilator treatment.

We aimed to explore the differences in symptom occurrence based on various related variables. The results of the χ^2 test or Fisher's exact test, which used symptom occurrence as the dependent variable and related factors as the independent variable, are summarized in Table 4. In comparing groups with and without pain, significant differences were observed in related factors such as age ($\chi^2=5.50$; $p=.019$), main diagnosis ($\chi^2=72.57$; $p<.001$), APACHE II score ($\chi^2=57.76$; $p<.001$), GCS motor score ($\chi^2=30.65$; $p<.001$), route of ICU admission ($\chi^2=276.77$; $p<.001$), ICU readmission ($\chi^2=24.76$; $p<.001$), number of days in the ICU ($\chi^2=60.05$; $p<.001$), and other treatment factors in-

cluding the application of CRRT ($\chi^2=47.32$; $p<.001$), ventilator use ($\chi^2=79.53$; $p<.001$), the use of general anesthetics ($\chi^2=177.45$; $p<.001$), the use of narcotic analgesics ($p<.001$). Delirium was related to age ($\chi^2=6.47$; $p=.011$), APACHE II score ($\chi^2=4.5$; $p=.034$), route of ICU admission ($p=.013$), ICU readmission ($\chi^2=4.81$; $p=.028$), and number of days in the ICU ($p<.001$). In a comparison between cases with and without agitation, significant differences were observed in age ($\chi^2=13.28$; $p<.001$), main diagnosis ($\chi^2=16.41$; $p=.003$), APACHE II score ($\chi^2=13.17$; $p<.001$), route of ICU admission ($\chi^2=11.96$; $p=.008$), number of days in the ICU ($\chi^2=65.99$; $p<.001$), and the utilization of CRRT ($\chi^2=7.14$; $p=.008$), ventilator use ($\chi^2=6.29$; $p=.012$), sedatives ($\chi^2=22.84$; $p<.001$), and the use of non-narcotic analgesics ($\chi^2=5.86$; $p=.016$). The cases with and without dyspnea showed significant differences in the main diagnosis ($\chi^2=49.23$; $p<.001$), APACHE II score ($\chi^2=79.49$; $p<.001$), total GCS score ($\chi^2=7.97$; $p=.047$), route of ICU admission ($\chi^2=121.77$; $p<.001$), ICU readmission ($\chi^2=12.13$; $p<.001$), number of days in the ICU ($\chi^2=267.18$; $p<.001$), and the application of CRRT ($\chi^2=45.24$; $p<.001$), ventilator use ($\chi^2=71.69$; $p<.001$), the use of general anesthetics ($\chi^2=34.33$; $p<.001$), and sedatives ($\chi^2=29.54$; $p<.001$) (Table 4).

Age was associated with the occurrence of pain, delirium, and agitation, but the relationship varied depending on the symptom. Delirium and agitation were more common in individuals over 65 years of age, whereas pain was more prevalent in those under 65. The severity of illness, as measured by the APACHE II score, was significantly linked to the incidence of all symptoms. Pain, however, exhibited a different pattern; it was more frequent when the severity of the illness was lower, whereas other symptoms increased with higher severity levels. The source of ICU admission and the length of ICU stay were significant factors influencing the occurrence of all symptoms. Each symptom had a distinct pattern depending on the source of ICU admission. Pain was more common in cases admitted following surgery, while dyspnea was more frequent in those admitted non-surgically. Delirium and agitation were least common in cases transferred postoperatively, a group that often includes pre-planned ICU admissions. Regarding the length of ICU stay, cases with longer stays exhibited a higher incidence of all four symptoms.

The factors that showed significant differences in the χ^2 test or Fisher's exact test were identified as potential risk factors for each symptom and were used as independent variables in the stepwise multivariate logistic regression analysis, with the occurrence of each symptom serving as the dependent variable. Logistic regression models for each symptom were developed stepwise to identify relevant

Table 3. Physiological and Situational Factors Related to Symptoms

(N=1,214)

Factors	Variables	Categories	n (%)	M±SD	Range
Physiological factors	Age (year)	≤ 64	585 (48.2)	63.39±14.78	18~94
		≥ 65	629 (51.8)		
	Sex [†]	Male	763 (62.9)	23.44±9.68	0~56
		Female	451 (37.2)		
	Main diagnosis (ICD-10)	C	464 (38.2)		
		I	154 (12.7)		
		J	131 (10.8)		
		K	118 (9.7)		
		D	49 (4.0)		
		Z	49 (4.0)		
		N	44 (3.7)		
		R	39 (3.2)		
		Ect	166 (13.7)		
	APACHE II score	≤ 22	615 (50.7)		
		≥ 23	599 (49.3)		
	Total GCS score	≤ 12	66 (5.4)	13.94±1.35	3~15
		≥ 13	680 (56.0)		
		Verbal E	393 (32.4)		
		Verbal T	75 (6.2)		
	Simplified GCS motor score	≤ 3	241 (19.85)	4.83±1.97	1~6
		4	86 (7.1)		
		5	50 (4.1)		
		6	837 (69.0)		
Situational factors	Route of ICU admission	Postoperative transfer	595 (49.0)	5.45±7.21	
		Postoperative admission	49 (4.0)		
		Transfer without surgery	443 (36.5)		
		Admission without surgery	127 (10.5)		
	ICU readmission	Yes	327 (26.9)		
		No	887 (73.1)		
	Number of days in the ICU	1 day	49 (4.0)		
		2 days	538 (44.3)		
		3 days	115 (9.5)		
		4~7 days	255 (21.0)		
		Over 7 days	257 (21.2)		
	CRRT	Yes	171 (14.1)		
		No	1,043 (85.9)		
	Ventilator use	Yes	762 (62.8)		
		No	452 (37.2)		
	Medication	General anesthetics [‡]	491 (40.5)		
		Sedative [§]	905 (74.6)		
		Narcotic analgesics	1,198 (98.7)		
		Non-narcotic analgesics [¶]	946 (77.9)		

APACHE=acute physiology and chronic health evaluation; C=malignant neoplasms; CRRT=continuous renal replacement therapy; D=in situ neoplasm, benign neoplasm, and neoplasm of uncertain or unknown behavior; GCS=glasgow coma scale; I=diseases of the circulatory system; ICD-10=international statistical classification of diseases and related health problems, 10th revision; ICU=intensive care unit; J=diseases of the respiratory system; K=diseases of the digestive system; N=diseases of the genitourinary system; R=symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified; SD=standard deviation; Z=diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism; [†] In this research, we defined the term "sex" as a set of biological attributes that are assigned at birth;

[‡] Propofol; [§] Midazolam, dexmedetomidine; ^{||} Fentanyl, remifentanyl, pethidine, morphine; [¶] Acetaminophen, tramadol hydrochloride, ketorolac, ibuprofen.

Table 4. Association between Symptoms and Related Factors

(N=1,214)

Variables	Categories	Pain			Delirium			Agitation			Dyspnea		
		Yes n (%)	No n (%)	χ^2 (p)	Yes n (%)	No n (%)	χ^2 (p)	Yes n (%)	No n (%)	χ^2 (p)	Yes n (%)	No n (%)	χ^2 (p)
Age (year)	≤ 64	426 (35.1)	159 (13.1)	5.50 (.019)	18 (1.48)	567 (46.7)	6.47 (.011)	144 (11.9)	441 (36.3)	13.28 ($< .001$)	156 (12.9)	429 (35.3)	0.88 (.348)
	≥ 65	418 (34.4)	211 (17.4)		40 (3.3)	589 (48.5)		216 (17.8)	413 (34)		184 (15.2)	445 (36.7)	
Sex	Male	518 (42.7)	245 (20.2)	2.38 (.123)	40 (3.3)	723 (59.6)	0.72 (.396)	237 (19.5)	526 (43.3)	1.77 (.183)	208 (17.1)	555 (45.7)	0.47 (.492)
	Female	326 (26.9)	125 (10.3)		18 (1.5)	423 (35.7)		123 (10.1)	328 (27)		132 (10.9)	319 (26.3)	
Main diagnosis	C	357 (29.4)	107 (8.8)	72.57 ($< .001$)	16 (1.3)	448 (36.9)	4.59 (.032)	126 (10.4)	338 (27.8)	16.41 (.003)	112 (9.2)	352 (29.0)	49.23 ($< .001$)
	I	95 (7.8)	59 (4.9)		6 (0.5)	148 (12.2)		49 (4.0)	105 (8.6)		34 (2.8)	120 (9.9)	
	J	53 (4.4)	78 (6.4)		9 (0.7)	122 (10.1)		58 (4.8)	73 (6.0)		70 (5.8)	61 (5.0)	
	K	91 (7.5)	27 (2.2)		6 (0.5)	112 (9.2)		33 (2.7)	85 (7.0)		28 (2.3)	90 (7.4)	
	Ect	248 (20.4)	99 (8.2)		21 (1.7)	326 (26.9)		94 (7.7)	253 (20.8)		96 (7.9)	251 (20.7)	
	≤ 22	489 (40.3)	126 (10.4)	57.76 ($< .001$)	21 (1.7)	594 (48.9)	4.50 (.034)	153 (12.6)	462 (38.1)	13.17 ($< .001$)	102 (8.4)	513 (42.3)	79.49 ($< .001$)
	≥ 23	355 (29.2)	244 (20.1)		37 (3.1)	562 (46.3)		207 (17.1)	392 (32.3)		238 (19.6)	361 (29.7)	
Total GCS score	≤ 12	48 (4.0)	18 (1.5)	0.00 (.921)	5 (0.4)	61 (5.0)		26 (2.1)	40 (3.3)	3.2 (.074)	28 (2.3)	38 (3.1)	7.97 (.047)
	≥ 13	504 (41.5)	176 (14.5)		25 (2.1)	655 (54)	(.175) [†]	191 (15.7)	489 (40.3)		173 (14.3)	507 (41.8)	
Simplified GCS motor score	≤ 3	149 (12.3)	92 (7.6)	30.65 ($< .001$)	16 (1.3)	225 (18.5)	(.055) [†]	72 (5.9)	169 (13.9)	2.32 (.121)	71 (5.9)	170 (14.0)	5.99 (.112)
	4	43 (3.5)	43 (3.5)		8 (0.7)	78 (6.4)		28 (2.3)	58 (4.8)		32 (2.6)	54 (4.4)	
	5	41 (3.4)	9 (0.7)		2 (0.2)	48 (4.0)		19 (1.6)	31 (2.6)		17 (1.4)	33 (2.7)	
	6	611 (50.3)	226 (18.6)		32 (2.6)	805 (66.3)		241 (19.9)	596 (49.1)		220 (18.1)	617 (50.8)	
Route of ICU admission	Postoperative transfer	538 (44.3)	57 (4.7)	276.77 ($< .001$)	17 (1.4)	578 (47.6)	(.013) [†]	149 (12.3)	446 (36.7)	11.96 (.008)	87 (7.2)	508 (41.8)	121.77 ($< .001$)
	Postoperative admission	42 (3.5)	7 (0.6)		3 (0.3)	46 (3.8)		16 (1.3)	33 (2.7)		8 (0.7)	41 (3.4)	
	Transfer without surgery	197 (16.2)	246 (20.3)		29 (2.4)	414 (34.1)		152 (12.5)	291 (24)		197 (16.2)	246 (20.3)	
	Admission without surgery	67 (5.5)	60 (4.9)		9 (0.7)	118 (9.1)		43 (3.5)	84 (6.92)		48 (4.0)	79 (6.5)	
ICU readmission	Yes	224 (18.5)	152 (12.5)	24.76 ($< .001$)	26 (2.1)	350 (28.8)	4.81 (.028)	122 (10.1)	254 (20.9)	1.85 (.174)	131 (10.8)	245 (20.2)	12.13 ($< .001$)
	No	620 (51.1)	218 (18)		32 (2.6)	806 (66.4)		238 (19.6)	600 (49.4)		209 (17.2)	629 (51.8)	
Number of days in the ICU	1 day	23 (1.9)	26 (2.1)	60.05 ($< .001$)	2 (0.2)	47 (3.9)	($< .001$) [†]	5 (0.4)	44 (3.6)	65.99 ($< .001$)	8 (0.7)	41 (3.4)	267.18 ($< .001$)
	2 days	423 (34.8)	115 (9.5)		10 (0.8)	528 (43.5)		124 (10.2)	414 (34.1)		62 (5.1)	476 (39.2)	
	3 days	69 (5.7)	46 (3.8)		3 (0.3)	112 (9.2)		32 (2.6)	83 (6.8)		26 (2.1)	89 (7.3)	
	4-7 days	208 (17.1)	84 (6.9)		9 (0.7)	283 (23.3)		88 (7.3)	204 (16.8)		91 (7.5)	201 (16.6)	
	Over 7 days	121 (10)	99 (8.2)		34 (2.8)	186 (15.3)		111 (9.1)	109 (9.0)		153 (12.6)	67 (5.5)	
CRRT	Yes	80 (6.6)	91 (7.5)	47.32 ($< .001$)	13 (1.1)	158 (13.0)	2.81 (.094)	66 (5.4)	105 (8.7)	7.14 (.008)	85 (7.0)	86 (7.1)	45.24 ($< .001$)
	No	764 (62.9)	279 (23)		45 (3.7)	998 (82.2)		294 (24.2)	749 (61.7)		255 (21.0)	788 (64.9)	
Ventilator	Yes	460 (37.9)	302 (24.9)	79.53 ($< .001$)	41 (3.4)	721 (59.4)	1.21 (.272)	246 (20.7)	516 (42.5)	6.29 (.012)	278 (22.9)	484 (39.9)	71.69 ($< .001$)
	No	380 (31.3)	67 (5.5)		17 (1.4)	430 (35.4)		113 (9.3)	334 (27.5)		61 (5.0)	386 (31.8)	
General anesthetic	Yes	236 (19.4)	255 (21)	177.45 ($< .001$)	27 (2.2)	464 (38.2)	0.70 (.404)	161 (13.3)	330 (27.2)	3.64 (.056)	183 (15.1)	308 (25.4)	34.33 ($< .001$)
	No	608 (50.1)	115 (9.5)		31 (2.6)	692 (57)		199 (16.4)	524 (43.2)		157 (12.9)	566 (46.6)	
Sedative	Yes	592 (48.8)	313 (25.8)	5.71 (.017)	50 (4.1)	855 (70.4)	3.74 (.053)	302 (24.9)	603 (49.7)	22.84 ($< .001$)	291 (24.0)	614 (50.6)	29.54 ($< .001$)
	No	252 (20.8)	57 (4.7)		8 (0.7)	301 (24.8)		58 (4.8)	251 (20.7)		49 (4.0)	260 (21.4)	
Narcotic analgesics	Yes	840 (69.2)	358 (29.5)	($< .001$) [†]	57 (4.7)	1,141 (94.0)	(.545) [†]	354 (29.2)	844 (69.5)	(.582) [†]	333 (27.4)	865 (71.3)	(.167) [†]
	No	4 (0.0)	12 (1.0)		1 (0.1)	15 (1.2)		6 (0.5)	7 (0.6)		7 (0.6)	9 (0.7)	
Non-narcotic analgesics	Yes	663 (54.6)	283 (23.3)	0.52 (.469)	47 (3.9)	899 (74.1)	0.18 (.672)	297 (24.5)	649 (53.5)	5.86 (.016)	277 (22.8)	669 (55.1)	3.17 (.075)
	No	181 (14.9)	87 (7.2)		11 (0.9)	257 (21.2)		63 (5.2)	205 (17.0)		63 (5.2)	205 (16.9)	

APACHE=acute physiology and chronic health evaluation; C=malignant neoplasms; CRRT=continuous renal replacement therapy; GCS=glasgow coma scale; I=diseases of the circulatory system; ICU=intensive care unit; J=diseases of the respiratory system; K=diseases of the digestive system; [†] p-values based on the Fisher exact test. p-values without a superscript are based on the χ^2 test.

variables that significantly explain the variance in the occurrence of each symptom, after accounting for all other related factors. Table 5 presents the factors influencing each symptom based on the logistic regression analysis. It shows both the crude odds ratio (OR) and the adjusted OR concurrently to clarify the relationship between symptom-related factors. Additionally, Table 5 summarizes the logistic regression models for each symptom and confirms

that all models for the four symptoms passed the Hosmer-Lemeshow goodness-of-fit test ($p > .05$), indicating that the models were well-fitted (Table 5).

For the pain model, the APACHE II score, simplified GCS motor score, route of ICU admission, number of days in the ICU, and the use of a ventilator, general anesthetics, and narcotic analgesics were relevant factors. Specifically, with a high APACHE II score, the likelihood of experienc-

Table 5. Risk Factors Associated with Symptoms

Variables	Categories	Crude odds ratio		Adjusted odds ratio		
		Odds ratio	95% CI	Odds ratio	95% CI	<i>p</i>
Pain	Intercept	2.28	2.02~2.58	2.67	0.58~10.49	.177
	APACHE II score	0.93	0.92~0.94	0.98	0.96~1.00	.015
	Simplified GCS motor score	1.12	1.06~1.19	1.07	0.98~1.16	.118
	Route of ICU admission (postoperative transfer)			Reference		
	Route of ICU admission (postoperative admission)	0.64	0.29~1.61	0.57	0.25~1.48	.209
	Route of ICU admission (transfer without surgery)	0.08	0.06~0.12	0.12	0.08~0.17	< .001
	Route of ICU admission (admission without surgery)	0.12	0.08~0.18	0.13	0.08~0.22	< .001
	Number of days in the ICU	0.96	0.94~0.98	1.04	1.02~1.06	< .001
	Ventilator (Yes)	0.27	0.2~0.36	0.65	0.44~0.98	.039
	General anesthetic (Yes)	0.18	0.13~0.23	0.29	0.21~0.41	< .001
	Narcotic analgesics (Yes)	7.04	2.43~25.31	7.54	2.33~29.78	.002
Nagelkerke=.41, Hosmer and Lemeshow goodness-of-fit ($p=.099$)						
Delirium	Intercept	0.05	0.04~0.06	0.00	0.00~0.00	< .001
	Age	1.05	1.02~1.07	1.05	1.03~1.08	< .001
	APACHE II score	1.04	1.02~1.07	1.01	0.98~1.04	.579
	ICU readmission	1.87	1.09~3.18	1.75	0.98~3.09	.054
	Number of days in the ICU	1.09	1.06~1.12	1.08	1.06~1.11	< .001
Nagelkerke=.17, Hosmer and Lemeshow goodness-of-fit ($p=.227$)						
Agitation	Intercept	0.42	0.37~0.48	0.06	0.03~0.13	< .001
	Age	1.01	1.00~1.02	1.01	1.00~1.02	.008
	Number of days in the ICU	1.08	1.06~1.10	1.07	1.05~1.10	< .001
	Sedative (Yes)	2.17	1.59~3.00	1.65	1.19~2.31	.003
	Use of non-narcotic analgesics (Yes)	1.49	1.09~2.05	1.47	1.07~2.06	.021
Nagelkerke=.10, Hosmer and Lemeshow goodness-of-fit ($p=.132$)						
Dyspnea	Intercept	0.39	0.34~0.44	0.19	0.04~0.91	.038
	APACHE II score	1.07	1.06~1.09	1.04	1.02~1.06	< .001
	Total GCS score	0.87	0.79~0.95	0.89	0.80~0.99	.027
	Route of ICU admission (postoperative transfer)			Reference		
	Route of ICU admission (postoperative admission)	1.14	0.48~2.39	0.69	0.15~2.27	.59 ⁰
	Route of ICU admission (transfer without surgery)	4.68	3.49~6.30	2.52	1.57~4.06	< .001
	Route of ICU admission (admission without surgery)	3.55	2.31~5.42	2.92	1.63~5.21	< .001
	Number of days in the ICU	1.20	1.16~1.23	1.19	1.13~1.26	< .001
	Ventilator (Yes)	3.63	2.69~4.98	1.58	0.97~2.56	.065
	General anesthetic (Yes)	2.14	1.66~2.76	0.63	0.40~1.01	.055
Nagelkerke=.36, Hosmer and Lemeshow goodness-of-fit ($p=.627$)						

APACHE=acute physiology and chronic health evaluation; GCS=glasgow coma scale; ICU=intensive care unit.

ing pain decreased (OR=0.98; 95% CI, 0.96~1.00; $p=.015$). Compared to postoperative transfer, transfer without surgery (OR=0.12; 95% CI, 0.08~0.17; $p<.001$) and admission without surgery (OR=0.13; 95% CI, 0.08~0.22; $p<.001$) were associated with a lower probability of experiencing pain. With each additional day spent in the ICU, the likelihood of pain increased by 1.04 (OR=1.04; 95% CI, 1.02~1.06; $p<.001$). Ventilator use (OR=0.65; 95% CI, 0.44~0.98; $p=.039$) and general anesthetic use (OR=0.29; 95% CI, 0.21~0.41; $p<.001$) were associated with a lower risk of pain occurrence, but the use of narcotic analgesics was associated with a substantially higher risk of pain 7 (OR=7.54; 95% CI, 2.33~29.78; $p=.002$).

The relevant factors for the delirium model included age, APACHE II score, ICU readmission, and number of days in the ICU. With each additional year of age, the likelihood of delirium group increased by 1.05 times (OR=1.05; 95% CI, 1.03~1.08; $p<.001$). Each additional day spent in the ICU also increased the risk of experiencing delirium (OR=1.08; 95% CI, 1.06~1.11; $p<.001$).

The agitation model identified several relevant factors, including age, number of days in the ICU, and the use of sedative and non-narcotic analgesics. Each additional year of age (OR=1.01; 95% CI, 1.00~1.02; $p=.008$) and each additional day spent in the ICU (OR=1.07; 95% CI, 1.05~1.10; $p<.001$) increased the likelihood of experiencing agitation. There was a higher risk of agitation when sedatives (OR=1.65; 95% CI, 1.19~2.31; $p=.003$) and non-narcotic analgesics (OR=1.47; 95% CI, 1.07~2.06; $p=.021$) were administered.

In the dyspnea model, the APACHE II score, total GCS score, route of ICU admission, number of days in the ICU, and the use of a ventilator and general anesthetics were risk factors. Specifically, a higher APACHE II score was associated with an increased likelihood of experiencing dyspnea (OR=1.04; 95% CI, 1.02~1.06; $p<.001$). Transfer without surgery (OR=2.52; 95% CI, 1.57~4.06; $p<.001$) and admission without surgery (OR=2.92; 95% CI, 1.63~5.21; $p<.001$) were associated with higher probabilities of dyspnea compared to postoperative transfer. Each additional day spent in the ICU was associated with an elevated risk of dyspnea (OR=1.19; 95% CI, 1.13~1.26; $p<.001$). Although the specific factors and their influences on each symptom differed, a longer stay in the ICU was consistently linked to an increased risk of all four symptoms.

DISCUSSION

Through a retrospective analysis of EMRs, this study provided meaningful insights into the patterns and factors associated with various symptoms experienced by pa-

tients in the ICU. The results showed that most ICU patients experienced at least one symptom, with many reporting two or more. All symptoms, except for delirium, typically appeared early in the ICU stay. Since symptomatic cases were not excluded from the initial assessment after ICU admission, it was challenging to distinguish between symptoms that were present before admission and those that developed afterward. Nevertheless, the data confirmed that the majority of ICU patients experienced significant symptoms from the early stages of their stay. The fact that symptoms generally first appeared at the start of the ICU stay does not imply a reduction or disappearance of symptoms thereafter. While the factors associated with each symptom varied, the length of ICU stay was a common factor influencing all symptoms. This suggests that although symptoms often emerge early during the ICU stay, the likelihood of developing symptoms increases with the duration of the stay.

Pain was reported in 69.5% of cases and was present for 33% of the total days of ICU stay. Previous studies have shown varying incidence rates, with higher rates observed within the first 24 hours of ICU admission (75.4%) [12], and lower rates reported in cross-sectional studies (33.2%) [11]. These findings align with those of the current study, indicating an early onset of pain following ICU admission. In this study, the incidence rate of pain assessed using the CNPS tool was lower (46%) than that observed in all cases. A direct comparison of communication abilities between cases evaluated with CNPS and those assessed using NRS was not conducted in this study, making it challenging to definitively conclude that the communication ability of patients evaluated with CNPS was below average. However, given that CNPS is specifically designed for non-verbal patients, it can be inferred that patients assessed with CNPS likely had limited verbal expression abilities. This is consistent with the findings of a previous study that focused on patients unable to express pain verbally, which reported a relatively low incidence rate of pain [11]. The observed differences in pain occurrence based on the assessment tools could be due to distinct assessment methods or a reduction in communication ability resulting from the effects of sedation therapy [29]. Therefore, it is crucial to avoid underestimating symptoms in patients with limited communication abilities.

The incidence of delirium was 4.8%, significantly lower than the 31.8% reported in a systematic literature review of 42 prospective observational studies [13]. However, a previous retrospective study conducted in South Korea [14] found a similar incidence of delirium (6%), suggesting that the discrepancy may be due to differences in study

methodologies. The lack of specific guidelines for periodic assessments in the hospital where the study was conducted might have caused retrospective investigations to miss cases of short-term acute delirium. Therefore, future research should include periodic assessments to overcome this limitation. The incidence rate of delirium was notably higher in older patients who had prolonged stays in the ICU. This study not only reaffirmed well-established risk factors identified in previous research, but also investigated the pattern of delirium occurrence by examining the onset time. Although the rate of delirium occurring within the first 24 hours after ICU admission was relatively low compared to other symptoms, approximately half (48.3%) of all cases developed delirium within the first three days of ICU admission. An extended stay in the ICU was associated with an increased risk of delirium, highlighting that a significant number of delirium cases occur within the initial 3 days of admission. This underscores the importance of monitoring for signs of delirium not only in long-term ICU patients but also in those within the first 3 days of admission.

Agitation was observed in 29.7% of cases, which is similar to the findings of a previous study that reported a 31.8% incidence of anxiety [30]. The consistency in results may be attributed to the use of retrospective EMR data review methods and RASS as an assessment tool in both our study and the prior investigation. Based on findings from this study and previous research, it appears that approximately one-third of critically ill patients experience anxiety, which manifests as agitation.

In this study, dyspnea was reported in 28% of the cases, a figure that is comparable to or slightly lower than the incidence rates of 34% to 47% reported in previous studies [15,16,31]. This variation may stem from different assessment methods or variations in participant characteristics. Previous research typically involved regular self-reporting of dyspnea by patients using tools such as numeric rating scales or visual analog scales [15,16,31]. In contrast, our study did not employ standardized protocols for regular dyspnea assessments and relied on retrospective analysis of EMR data, likely leading to a number of undetected dyspnea cases. This underscores the importance of systematic and routine assessments to avoid underestimating the prevalence of dyspnea. Additionally, the study populations differed; earlier studies primarily included patients undergoing mechanical ventilation [15,31] or those with more severe illnesses [16], unlike the patients in our current study. In this study, patients who were receiving mechanical ventilation and had high severity levels exhibited higher incidence rates of dyspnea than other patients.

Although there were some variations in incidence rates due to the inclusion of a diverse patient population in the ICU, the subgroup analysis yielded results consistent with previous studies.

Although the magnitude of this trend varied, all symptoms other than delirium showed an initial concentration during the early stages of admission. Therefore, it is important to monitor these symptoms closely during the early stages of ICU admission. However, the apparent concentration of symptom onset in the early stages may have been influenced by the relatively short average length of stay in this study (5.45 ± 7.21 days).

Three related factors—namely, the APACHE II score, the route of admission to the ICU, and the length of stay in the ICU—showed significant differences between the groups with and without symptoms. The incidence rate of all four symptoms varied according to the source of ICU admission. Specifically, the risk of pain was 0.1 times lower in cases admitted without surgery compared to those admitted after surgery. This suggests that patients admitted to the ICU following surgery are likely to experience pain related to the surgical procedure, a finding that is consistent with previous research indicating a higher incidence of pain in surgical admissions than in non-surgical admissions [32]. Delirium and anxiety were least common in cases transferred from the general ward after surgery. This may be because transfers from the general ward following surgery are typically pre-planned for postoperative observation, whereas admissions from other routes tend to be unplanned and associated with a deterioration in the patient's condition. Although no previous studies have categorized sources of ICU admission into four distinct groups as in this study, the findings can be understood in a context similar to that of previous studies, which identified emergency surgery as a risk factor for delirium [33] and agitation [34]. Regarding respiratory symptoms, the risk of breathing difficulties was higher in cases admitted without undergoing surgery. Previous research has identified worsening dyspnea as a primary reason for ICU admission [35]. Therefore, it is important to monitor for post-surgery pain, dyspnea in patients admitted to the ICU without surgery, and symptoms of delirium and agitation in patients with unplanned ICU admissions. Since the route of admission to the ICU is a factor that ICU nurses can easily identify, understanding how symptom occurrence varies based on this factor can provide valuable insights for clinical practice.

The length of stay in the ICU was identified as a common risk factor for all four symptoms, with a longer stay correlated with an increased risk of pain, delirium, agi-

tation, and dyspnea. Previous research has demonstrated that implementing pain management algorithms for patients in the ICU can effectively reduce the length of ICU stay [7]. By integrating the findings of this study with previous research, we emphasize the importance of a comprehensive approach that includes proper management of ICU stay duration to minimize unnecessary symptom occurrence. Additionally, appropriate symptom management can help reduce the length of ICU stay. This approach can contribute to the cost-effective utilization of medical resources and promote the prevention and effective management of symptoms in critically ill patients.

This study has several limitations. First, as a retrospective study, it was constrained in its ability to investigate symptoms or symptom-related factors not recorded in the EMRs, as well as in establishing causal relationships between events. For example, we did not explore sleep deprivation or thirst, which are common sources of discomfort in critically ill patients [16], due to the difficulty of identifying these conditions in the EMRs. Second, we were unable to differentiate between symptoms present at the time of ICU admission and those that developed subsequently, as comprehensive symptom assessments at the time of admission were lacking. This limitation made it challenging to determine whether symptoms preceded or followed ICU admission. Although our primary focus was on identifying the prevalence and related factors of symptoms in ICU patients, more detailed insights might have been gained by concentrating on the initial period following ICU admission. This is supported by our findings that over 50% of the three symptoms, excluding delirium, first appeared within 24 hours of admission. Third, the explanatory power of the regression models used to predict symptom occurrence was low. This may have resulted from the study's broad focus on general factors rather than specific factors unique to each symptom. Despite this, the study is noteworthy for its examination of the association between easily identifiable factors in EMRs and their impact on symptoms, suggesting that screening for and addressing these factors could be a cost-effective approach to symptom management. Fourth, since the study was conducted in the ICUs of a single university hospital, the generalizability of the findings is limited.

Despite these limitations, this study had several strengths. It comprehensively examined multiple symptoms experienced by patients in the ICU across various severity levels and communication abilities. Participants were not selected through convenience sampling; instead, all ICU admissions and discharges from the university hospital that met the study criteria were reviewed. The use of EMR data

in this study facilitated the inclusion of a diverse range of patients. The methodology of this study addressed the limitations of previous research, which primarily depended on patient self-reports. Considering the unique characteristics of ICU patients, including those with impaired communication skills, was crucial. Notably, 38.6% of the patients were unable to verbally express themselves. The inclusion of a wide range of patients in the ICU could enhance our understanding of the symptom experiences of general patients in ICUs. Furthermore, this study detailed the incidence of symptoms in small groups based on differences in related factors, allowing for a more nuanced understanding of symptom experiences. This study also explored various symptom assessment tools and proposed a method for analyzing natural language records, which could serve as a foundation for integrating various symptom assessment tools and analyzing natural language records in future research.

CONCLUSION

The results of this study indicate that the majority of patients in the ICU experienced at least one symptom during their stay, with a significant number experiencing two or more symptoms. Pain was the most common symptom, followed by agitation, dyspnea, and delirium. Given the relatively lower incidence of dyspnea and delirium, which currently lack specific guidelines for periodic assessments at the hospital where this study was conducted, regular assessments using validated tools are essential. Additionally, since symptoms frequently occur in the initial stages of ICU admission, it is crucial to focus on them during this early phase. Various factors influencing each symptom were identified, with the length of ICU stay emerging as a common risk factor for all four symptoms. The findings suggest the importance of managing the length of ICU stays to minimize unnecessary symptoms and addressing symptoms effectively to potentially shorten the duration of ICU stays. This study provides a framework for validating the symptomatic experiences of critically ill patients with limited communication abilities through the analysis of EMR data. EMR data facilitates the integration of patient-reported symptoms and nursing assessments. Given the characteristics of EMR data and the focus of this research, the study proposes an efficient and reasonable method for extracting and structuring essential information from extensive EMR datasets. The abundance of information in EMR data makes it valuable for a broad spectrum of future clinical research. The methodology outlined in our study establishes a foundation for future in-

vestigations driven by EMR data.

CONFLICTS OF INTEREST

The authors declared no conflict of interest.

AUTHORSHIP

Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing - original draft - KM; Conceptualization, Methodology, Supervision, Writing - review & editing- PYH.

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