

# Association Between Symptoms of Patients With Heart Failure and Patient Outcomes Based on Electronic Nursing Records

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We examined the association between symptoms (ie, dyspnea and pain) and patient outcomes (ie, length of stay, 30-day readmission, and death in hospital) among patients with heart failure using EMRs. This was a descriptive study that was conducted from July 1, 2014, to November 30, 2017. Participants were 754 hospitalized patients with heart failure (mean age, 70.62 ± 14.78 years; male-to-female ratio, 1:1.1). Data were analyzed using descriptive statistics,  $\chi^2$  tests, and logistic regression analyses. Patients' average length of stay was 8.92 ± 13.12 days. Thirty-two patients (4.2%) were readmitted, and 100 patients (13.3%) died during hospitalization. Two-thirds (67.7%) experienced dyspnea, and 367 (48.7%) experienced pain. Symptoms and ICU admission were significantly related to patient outcomes. In the regression analyses, dyspnea, pain, and ICU admission were significantly related to higher-than-average lengths of stay. Dyspnea and ICU admission were related to death in hospital. Information regarding patients' symptoms, which was extracted from records, was a valuable resource in examining the relationship between symptoms and patient outcomes. The use of EMRs may be more advantageous than self-reported surveys when examining patients' symptom and utilizing big data.

**KEY WORDS:** Heart failure, Length of stay, Mortality, Patient readmission, Signs and symptoms

Heart failure (HF) is a clinical syndrome caused by structural and functional ventricular abnormality, and it is characterized by cycles of exacerbation and improvement.<sup>1</sup> Approximately 18.5% of patients with HF are readmitted within 30 days, 49.8% of whom are readmitted because of heart disease.<sup>2</sup> In South Korea, the HF patient population rose by approximately 24% from 123 000 in 2013 to 153 000 in 2018, and the allowance of medical care also increased by approximately 80% over 5 years from US \$8.4 trillion in 2013 to US \$15 trillion in 2018.<sup>3</sup> Interest in patients with HF is mounting. Because of the nature of HF, patients are required to be admitted for symptom control once their condition worsens. This increases the burden of not only the patients themselves but also their families and caregivers.<sup>4</sup>

Patients with HF experience a variety of symptoms including dyspnea, pain, depression, gastrointestinal disease, and fatigue.<sup>5</sup> Dyspnea is particularly a common symptom, and a higher symptom burden intensifies patients' challenges in their work life, social involvement, and activities of daily living. In addition, repeated symptom experience deteriorates patients' function.<sup>6</sup> Symptoms are important not only for patients and families but also for healthcare systems. They are dose-dependent and correlate with adverse clinical events, such as mortality, hospitalization, emergency room visits, and heart transplantation from all causes.<sup>5</sup> In response to the growing interest in the symptom burden among patients with HF, the US and European HF associations have shifted the focus for palliative care for patients with HF from prognosis to symptoms, thereby underlining the importance of symptom management in patients with HF. Past studies on the symptoms of patients with HF have particularly been focused on strategies to lower the number or severity of uncomfortable symptoms.<sup>7</sup> Many studies have utilized self-rated instruments in measuring the level of symptoms in patients with HF.

A thorough understanding and knowledge of symptoms are crucial for the effective care of patients with HF. In the inpatient setting, nursing intervention is critical for symptom management for patients with HF. In a study of NANDA nursing diagnosis in inpatients with HF in a tertiary hospital, the most frequent diagnoses were “ineffective breathing pattern” and “acute pain.”<sup>8</sup> This can be understood based on the fact that “ineffective breathing pattern” is related to the

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signs and symptoms of dyspnea, the most common symptom among patients with HF. “Acute pain” is related to pain, which is experienced by more than 50% of inpatients. The pain prevalence among inpatients has been reported as 64.4%.<sup>9</sup> Multiple healthcare facilities have designated pain as the fifth vital sign with blood pressure, pulse rate, respiration rate, and body temperature and recommend the daily assessment of pain.<sup>10</sup> Thus, it would be worth investigating the symptoms of patients with HF during hospitalization focusing on dyspnea and pain.

Patients' symptoms during hospitalization and relevant nursing interventions can be found in nursing records. Electronic nursing records (ENRs) are an important part of electronic medical records (EMRs). Electronic nursing records contain information in a structured format to efficiently access and obtain patient information.<sup>11</sup> As nursing records are based on continuous monitoring of the patient's condition, ENR reflects the health problems and subsequently the interventions for each patient.<sup>12</sup> Information about patient conditions recorded in ENR is obtained through the nursing processes. Therefore, HF inpatient symptoms and their relationships to patient outcomes from documented nursing records can be examined using EMR data.

Previous studies utilizing EMR include research showing the impact of the introduction of the EMR system<sup>13,14</sup> and a cohort study of HF with preserved ejection fraction and a screening system for a rapid response.<sup>15,16</sup> Patient safety incidents associated with EMRs also have been analyzed.<sup>17</sup> A recent study was conducted to apply text mining methods to improve the quality of ENR.<sup>18</sup> Studies attempted to obtain baseline data for developing pain management guidelines by analyzing ENR<sup>19</sup> and to support clinical decision-making by developing a patient outcomes prediction model using initial nursing assessment records.<sup>20</sup> However, it is difficult to find studies to examine the relationship between patients' symptoms and outcomes using EMR, in particular extracting symptoms from the nursing process. Providing timely treatment by understanding and predicting patients' signs and symptoms would contribute to attaining good patient outcomes. Identifying the chief complaints and symptoms of patients hospitalized with HF in nursing records is important for examining their relationship with patient outcomes such as length of stay (LOS), 30-day readmission, and death in hospital. Thus, this study aims to identify patients' symptoms, namely, dyspnea and pain, using ENR for patients with HF during their hospital stay, to examine the predictors, including these symptoms, of such patient outcomes.

## METHODS

This is a descriptive retrospective study using EMR of inpatients with HF in one tertiary hospital located in Seoul, Korea, between July 1, 2014, and November 30, 2017.

## Participants

Among adult patients 19 years or older who had inpatient treatment in a tertiary hospital, the EMR of patients admitted to the cardiac general ward with an *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* code including I50 as the main diagnosis was used for this study. The exclusion criteria were patients who have major psychiatric disorders, those with malignant tumors receiving chemotherapy or radiotherapy, and those who underwent an operation irrelevant to cardiovascular problems during the hospital stay. The medical records department of the study hospital provided the researchers with the list of patients who met the inclusion criteria as well as their medical records.

## Variables

The data included subjects' general characteristics, medical diagnosis, procedures performed during the hospital stay, and nursing records. General and clinical characteristics were sex, age, medical diagnosis, date of admission, date of discharge, intensive care unit (ICU) admission, and operations. Outcome variables were LOS, 30-day readmission, and death in hospital. Length of stay was computed by subtracting the date of admission from the date of discharge in the EMR.

Description of the presence and severity of symptoms of dyspnea and pain was extracted from ENR. In the study hospital, an ENR system was established based on the nursing process into which nurses input nursing diagnosis, nursing intervention, nursing activity, and nursing attributes. A patient's nursing problem was identified based on the “nursing diagnosis” section. The nursing intervention was identified from the “nursing intervention” section. Specific nursing activities delivered to the patient were identified in the “nursing activity” section. Finally, the details of nursing activities were identified based on the “nursing attributes” section. The nursing activity category provides specific activity information of nursing interventions. For example, nursing activities falling under “surveillance” of Nursing Intervention Classification include “checking of...,” “monitoring of...,” and “measuring of...,” which shows the specific nursing activities delivered to patients.<sup>21</sup> Nursing attributes refer to specific properties such as the nursing activity of “assessing pain” and include attributes such as characteristics, severity, aggravating factor, relieving factor, pain-related symptoms, and pain scale.

Nursing intervention, activity, and attributes may overlap, depending on the nursing diagnosis. The same nursing intervention can be provided for different nursing diagnoses, and the same nursing activity can be provided for different nursing diagnoses and interventions. For example, Figure 1 shows that the same nursing activity and nursing attributes were recorded for different nursing diagnoses and nursing interventions. In the example in Figure 1, the nursing activity of “observe breathing patterns” can be linked to the nursing

Date	Nursing diagnosis	Nursing intervention	Nursing activity	Nursing attribute	Attribute	
2016-12-25 10:08	Impaired Gas Exchange	Respiratory monitoring	Observe breathing patterns	Respiratory Rhythm	Regular	
		Respiratory monitoring	Observe breathing patterns	Respiration rate	breaths per minute	20
		Respiratory monitoring	Monitor oxygenation status	Blood gas test	PaO2	78
		Respiratory monitoring	Monitor oxygenation status	Oxygenation state	SpO2	92
		Oxygen therapy	Administer oxygen	Oxygen concentration	L/min	4
2016-12-24 10:13	Hyperthermia	Vital sign monitoring	Monitor the effect of the oxygen therapy	Oxygenation state	SpO2	97
		Vital sign monitoring	Observe breathing patterns	Respiration rate	breaths per minute	18
2016-12-24 12:24	Chronic pain	Pain management	Assess the pain	Location (Anatomical)	Shoulder	
		Pain management	Assess the pain	Pain intensity	5	
		Pain management	Assess the pain	Pain assessment tool	NPIS(Numerical Pain Intensity Scale)	
		Pain management	Assess the pain	Pain aggravating factors	Moving	
		Pain management	Assess the pain	Pain relieving factors	Lying	
2016-12-24 17:01	Acute pain	Pain management	Assess the pain	Pain pattern	Dull	
		Pain management	Assess the pain	Location (Anatomical)	Abdomen	
		Pain management	Assess the pain	Pain intensity	6	
		Pain management	Assess the pain	Pain assessment tool	NPIS(Numerical Pain Intensity Scale)	
2016-12-24 17:20	Activity intolerance	Physical energy management	Monitor reaction to the activity	Pain pattern	Sharp	
		Physical energy management	Monitor reaction to the activity	Pain intensity	5	
				Pain assessment tool	NPIS(Numerical Pain Intensity Scale)	

FIGURE 1. Electronic nursing record example.

diagnosis of “impaired gas exchange” or “hyperthermia” and also be applied to the nursing interventions of “respiratory monitoring” or “vital sign monitoring.”

### Data Preprocessing

The data were extracted from nursing records routinely recorded in the cardiac general ward only; thus, the research team removed the nursing records from outside the ward, such as during diagnostic testing or procedures and in an emergency situation (ie, cardiopulmonary resuscitation). For dyspnea symptoms, a total of 26 273 cases with respiratory-related nursing records were extracted. From there, nursing records pertinent to patients' dyspnea symptoms were extracted. As nursing records presenting dyspnea were determined by a combination of various factors, the nursing diagnosis was checked to classify dyspnea symptoms among the respiratory-related nursing records first. Altogether, 17 840 nursing records with oxygen concentration, PaO<sub>2</sub>, and arterial blood gas analysis were included in the nursing attribute code. After excluding the duplicate records, a total of 10 273 dyspnea symptoms were finally extracted.

Nursing records of pain were simpler than dyspnea nursing records. In the “nursing attributes” section, all pain records were extracted, including characteristics, severity, aggravating factor, relieving factor, pain-related symptoms, and pain scale. Recorded numeric scales were extracted from nursing records indicating pain severity. This recorded number is the figure the patient represented as a number from 0 to 10, with “no pain” as 0 and “extreme pain” as 10. A pain score of 1 or higher in the nursing records was considered as a complaint of pain symptoms, and the presence and frequency of pain complaints during hospital stay were determined. Similar to the dyspnea-related records, records outside the ward, for example, during the procedure, were removed, resulting in a

total of 25 946 cases of pain records, 2908 of which were considered pain complaints with a pain score of 1 or higher. After excluding duplicate admission numbers and date of record, a total of 2886 pain-related nursing records were finally extracted.

### Ethical Considerations

This study was approved by the institutional review board (no. Y-2018-0050) of the study hospital. To ensure confidentiality, researchers did not state any personal data to prevent the disclosure of such data, and all data were accessible only by the research team.

### Data Analysis

The research team performed data cleaning, using Python 3.6 (Python Software Foundation, Wilmington, DE), and the data were analyzed using the IBM SPSS Statistics version 25 (IBM, Armonk, NY). The demographic and clinical characteristics of patients with HF were analyzed using descriptive statistics, including frequency, percentage, mean, and SD. The frequency of symptom complaints was computed based on the number of times dyspnea was detected and the number of times the pain score was 1 or higher during the hospital stay. The presence of symptoms was determined by allotting “1” for participants who complained about the corresponding symptom at least once and “0” for participants who never complained of the corresponding symptom, and frequency analysis was performed for each symptom. Patients' LOS, 30-day readmission, and death in hospital according to their characteristics and symptoms were analyzed with  $\chi^2$  tests. The predictors of LOS, 30-day readmission, and death in hospital were identified using logistic regression.

RESULTS

Participants' General and Clinical Characteristics

The EMR of 754 patients diagnosed as having HF was used in this study. Three hundred ninety-six (52.5%) were women, and the mean age was 70.62 (SD, 14.78) years. Most participants belonged to the age group of 75 to 84 years (n = 248, 32.9%), followed by 65 to 74 years (n = 220, 29.2%). The mean LOS was 8.92 (SD, 13.12) days, with a range of 0.14 to 140.02 days. Length of stay below average was shown in 573 patients (76%). Thirty-two patients (4.2%) were readmitted within 30 days of discharge, and 100 (13.3%) died during their hospital stay. Eighty-six patients (11.4%) were admitted to the ICU, and 24 patients (3.2%) underwent surgery during their hospital stay (Table 1).

Patient Symptoms Based on Nursing Records

A total of 511 patients (67.8%) complained of dyspnea during their hospital stay. Among these patients, the mean number of dyspnea episodes was 20.03 (SD, 32.01) during the hospital stay per patient. The average daily frequency of dyspnea was 1.49 (SD, 1.04). A total of 367 patients (48.7%) complained of pain during their hospital stay. The mean number of pain episodes was 7.81 (SD, 12.20) during the hospital stay per patient. The average daily frequency of pain was 0.65 (SD, 0.60) (Table 2).

Length of Stay, 30-Day Readmission, and Death in Hospital According to Participants' Characteristics and Symptoms

Length of stay, 30-day readmission, and death in hospital according to participants' characteristics and symptoms were

analyzed with univariate analysis (Table 3). Patients were divided into long LOS and short LOS groups using a cutoff of the average LOS of patients with HF (8.92 days). The results showed there were significant differences in the presence of dyspnea ( $\chi^2 = 46.39, P < .001$ ), presence of pain ( $\chi^2 = 61.31, P < .001$ ), and ICU admission ( $\chi^2 = 129.07, P < .001$ ) between the two LOS groups. That is, patients who complained of dyspnea or pain and patients who were admitted to the ICU were more likely to have a longer LOS. In addition, among patients who underwent an operation, the percentage of patients with higher-than-average LOS (average, 8.92 days) was 100% compared with that of the nonoperation group (21.5%) ( $\chi^2 = 78.48, P < .001$ ).

The 30-day readmission rate was associated with age ( $\chi^2 = 9.55, P = .049$ ), presence of pain symptom ( $\chi^2 = 3.84, P = .050$ ), and operation ( $\chi^2 = 4.16, P = .041$ ). In other words, some age groups, patients with pain, and patients who underwent an operation had higher 30-day readmission rates.

Death in hospital was associated with age ( $\chi^2 = 18.93, P = .001$ ), presence of dyspnea symptom ( $\chi^2 = 12.24, P < .001$ ), and ICU admission ( $\chi^2 = 18.10, P < .001$ ). That is, older patients, patients with dyspnea, and patients who had been admitted to the ICU showed a higher rate of death in hospital (Table 3).

Predictors of Length of Stay, 30-Day Readmission, and Death in Hospital

Multivariate logistic regression was performed to identify the predictors of LOS, 30-day readmission, and death in hospital. After adjusting for age and sex, the factors found to be statistically significant in the univariate analysis—dyspnea

Table 1. General and Clinical Characteristics (n = 754)

Characteristics	Categories	n (%)	Mean (SD)
Sex	Male	358 (47.5)	70.62 (14.78)
	Female	396 (52.5)	
Age, y	20–50	79 (10.5)	8.92 (13.12)
	51–64	103 (13.6)	
	65–74	220 (29.2)	
	75–84	248 (32.9)	
	≥85	104 (13.8)	
LOS, d	Lower than average	573 (76.0)	8.92 (13.12)
	Higher than average	181 (24.0)	
30-d Readmission	Yes	32 (4.2)	
	No	722 (95.8)	
Death in hospital	Yes	100 (13.3)	
	No	654 (86.7)	
ICU admission	Yes	86 (11.4)	
	No	668 (88.6)	
Operation	Yes	24 (3.2)	
	No	730 (96.8)	

**Table 2. Descriptive Statistics of Patients' Symptoms of Dyspnea and Pain (n = 754)**

Variable	Categories	n (%)	Mean (SD)	Median (Range)
Dyspnea	No	243 (32.2)		
	Yes	511 (67.8)		
	Total no. of dyspnea records		20.03 (32.01)	10 (1–276)
	No. of dyspnea complaints per day		1.49 (1.04)	1.33 (0–9.50)
Pain	No	387 (51.3)		
	Yes	367 (48.7)		
	Total no. of pain records		7.81 (12.20)	4 (0–134)
	No. of pain complaints per day		0.65 (0.60)	0.5 (0–4.29)

complaint, pain complaint, ICU admission, and surgery—were entered in the logistic regression.

The predictors of LOS were the presence of symptoms of dyspnea and pain and ICU admission, and the model was significant (Nagelkerke  $R^2 = .338$ ,  $P < .001$ ). That is, patients who had dyspnea symptoms had 3.63 times (95% confidence interval [CI], 2.16–6.12) higher chance of staying in the hospital longer than the average LOS compared with patients who did not have dyspnea. Patients who complained of pain had 3.29 times (95% CI, 2.18–4.95) higher chance of staying in the hospital longer than the average LOS compared with their counterparts. Patients who were admitted to the ICU had 6.13 times (95% CI, 3.38–11.1) higher chance of longer-than-average LOS (8.29 days) compared with patients who were not admitted to the ICU. Because there was no below-average LOS among patients who underwent an operation, an operation was excluded from the analysis of predictors of LOS.

The predictors of death in hospital were dyspnea and ICU admission, and the model was significant (Nagelkerke  $R^2 = .094$ ,  $P < .001$ ). That is, patients with dyspnea had 1.92 times (95% CI, 1.09–3.39) higher chance of dying during their hospital stay compared with those who did not complain of dyspnea, and patients who were admitted to the ICU during their hospital stay had 3.27 times (95% CI, 1.76–6.09) higher chance of dying during their hospital stay compared with their counterparts (Table 4).

## DISCUSSION

This study attempted to identify the symptoms among inpatients with HF using nursing records and to examine the relationship between symptoms and patient outcomes. Because the ENR provides the patient's condition, treatment results, and nursing process, it is possible to obtain practical and quantitative information about nursing care and patient outcomes from it.<sup>11</sup> Whereas most studies that have examined patients' symptoms have generally relied on a self-reported survey, this study examined the relationship between patients' symptoms and outcomes utilizing ENR.

Among 754 adult patients with HF, the male-to-female ratio of this sample was 1:1.11. The male-to-female ratio among inpatients with HF in a Korean study analyzing data from 2013 to 2016 was 1:1.34,<sup>22</sup> but 40% of patients with HF were women in an Italian epidemiological study.<sup>23</sup> These results show that the sex ratio among patients with HF varies across countries. Further, the mean age of the sample in the present study was 70.62 (SD 14.78) years, which was similar to that (72 years) found in studies of this population in both Korea and other countries.<sup>22,23</sup> The mean LOS in the present study (8.92 [SD, 13.12] days) was similar to the mean LOS found among Korean patients with HF (9 days),<sup>24</sup> but the mean LOS among patients with HF differed in studies in other countries, at 5.6 or 10 days.<sup>23,25</sup> In a recent study, the 30-day readmission rate was 27.56%, which differed from 4.2% of this study.<sup>25</sup>

A total of 67.8% of the patients complained of dyspnea during their hospital stay, indicating that two-thirds of the patients had dyspnea symptoms. These patients had an average of 1.49 dyspnea symptoms a day. Nearly half of the patients (48.7%) complained of pain during their hospital stay, and they had an average of 0.65 pain complaints a day. This suggests that although pain is a common symptom among the HF population in an inpatient setting, dyspnea caused by the illness more frequently occurs than does pain among inpatients with HF. In fact, a study examining a 15-year trend among patients hospitalized for HF found that worsening dyspnea is the most common symptom among these patients, affecting 93% of them.<sup>26</sup> In contrast, a study on outpatients with HF in a cardiology clinic and palliative care center reported a pain rate of 84.4%,<sup>27</sup> which differed from the present results on inpatients with HF. This is because dyspnea is a major health problem affecting patients hospitalized for HF. In contrast, outpatients with HF do not need inpatient care for HF and thus are more affected by pain in their daily lives than by dyspnea. Musculoskeletal pain is a common type of pain among many patients diagnosed as having HF, and it tends to be exacerbated as patients engage in less physical activities with the progression of HF.<sup>5</sup> Thus, these results shed light on the need to study pain as well as dyspnea among inpatients with HF in more depth.

**Table 3.** Association Among Patients' Characteristics and LOS, 30-Day Readmission, and Death in Hospital (n = 754)

Variable	LOS			30-d Readmission			Death in Hospital			
	Lower Than Average (n = 573) n (%)	Higher Than Average (n = 181) n (%)	$\chi^2$ (P)	No (n = 722) n (%)	Yes (n = 32) n (%)	$\chi^2$ (P)	No (n = 654) n (%)	Yes (n = 100) n (%)	$\chi^2$ (P)	
Sex	Male	269 (75.1)	89 (24.9)	0.27 (.601)	348 (97.2)	10 (2.8)	3.53 (.060)	305 (85.2)	53 (14.8)	1.41 (.235)
	Female	304 (76.8)	92 (23.2)	6.67 (.0154)	374 (94.4)	22 (5.6)	9.55 (.049)	349 (88.1)	47 (11.9)	18.93 (.001)
Age, y	20-50	59 (74.7)	20 (25.3)	46.39 (<.001)	75 (94.9)	4 (5.1)	2.779 (.095)	75 (94.9)	4 (5.1)	12.24 (<.001)
	51-64	78 (75.7)	25 (24.7)	61.31 (<.001)	101 (98.1)	2 (1.9)	3.84 (.050)	96 (93.2)	7 (6.8)	0.51 (.475)
	65-74	156 (70.9)	64 (29.1)	129.07 (<.001)	204 (92.7)	16 (7.3)	3.63 (.057)	190 (86.4)	30 (13.6)	18.10 (<.001)
	75-84	201 (81.0)	47 (19.0)	78.48 (<.001)	243 (98.0)	5 (2.0)	4.16 (.041)	214 (86.3)	34 (13.7)	1.23 (.266)
Dyspnea	Yes	79 (76.0)	25 (24.0)	46.39 (<.001)	99 (95.2)	5 (4.8)	2.779 (.095)	79 (76.0)	25 (24.0)	12.24 (<.001)
	No	351 (68.7)	160 (31.3)	21 (8.6)	485 (94.9)	26 (5.1)	3.84 (.050)	428 (83.8)	83 (16.2)	0.51 (.475)
Pain	Yes	222 (91.4)	21 (8.6)	61.31 (<.001)	237 (97.5)	6 (1.2)	3.63 (.057)	226 (93.0)	17 (7.0)	18.10 (<.001)
	No	233 (63.5)	134 (36.5)	129.07 (<.001)	346 (94.3)	21 (5.7)	4.16 (.041)	315 (85.8)	52 (14.2)	1.23 (.266)
ICU admission	Yes	340 (87.9)	47 (12.1)	129.07 (<.001)	376 (97.2)	11 (2.8)	3.63 (.057)	339 (87.6)	48 (12.4)	18.10 (<.001)
	No	23 (26.7)	63 (73.3)	78.48 (<.001)	79 (91.9)	7 (8.1)	4.16 (.041)	62 (72.1)	24 (27.9)	1.23 (.266)
Operation	Yes	550 (82.3)	118 (17.7)	78.48 (<.001)	634 (96.3)	25 (3.7)	4.16 (.041)	592 (88.6)	76 (11.4)	1.23 (.266)
	No	0 (0)	24 (100.0)	157 (21.5)	21 (87.5)	3 (12.5)	4.16 (.041)	635 (87.0)	95 (13.0)	1.23 (.266)
Operation	Yes	573 (78.5)	157 (21.5)	78.48 (<.001)	701 (96.0)	29 (4.0)	4.16 (.041)	19 (79.2)	5 (20.8)	1.23 (.266)
	No	0 (0)	24 (100.0)	157 (21.5)	21 (87.5)	3 (12.5)	4.16 (.041)	635 (87.0)	95 (13.0)	1.23 (.266)

The categories of LOS were divided into lower-than-average and higher-than-average groups based on the mean LOS (8.92 days) in this study.

**Table 4.** Predictors of LOS, 30-Day Readmission, and Death in Hospital (n = 754)

Variables	LOS			30-d Readmission			Death in Hospital			
	B	SE	OR (P)	B	SE	OR (P)	B	SE	OR (P)	95% CI
Constant	-2.88	0.37	0.06 (<.001)	-3.99	0.69	0.02 (<.001)	-4.73	0.76	0.01 (<.001)	
Dyspnea (ref: no)	1.32	0.27	3.63 (<.001)	0.64	0.48	1.89 (.183)	0.65	0.29	1.92 (.024)	1.09-3.39
Pain (ref: no)	1.26	0.21	3.29 (<.001)	0.51	0.39	1.67 (.195)	0.05	0.23	1.06 (.816)	0.67-1.66
ICU admission (ref: no)	2.17	0.29	6.13 (<.001)	0.54	0.47	1.71 (.256)	1.19	0.32	3.27 (<.001)	1.76-6.09
Operation (ref: no)				0.50	0.83	1.65 (.549)	-0.33	0.60	0.72 (.582)	0.22-2.32

Abbreviations: OR, odds ratio; ref, reference.

Adjusted by sex and age. The categories of LOS were divided into below and above mean LOS (8.92 days) in this study. The variable "Operation" was not included in the LOS analysis because none of the patients who underwent an operation had a lower-than-average LOS.

Logistic regression revealed that patients' symptoms, particularly dyspnea, significantly predicted LOS and death in hospital among inpatients with HF. "Worsening heart failure," including dyspnea and fatigue, is a symptom causing adverse outcomes and requiring interventions in inpatients, and it has been reported that patients who show such signs and symptoms in clinical practice had a high mortality rate and longer LOS.<sup>28</sup> This is similar to the results of the present study showing that patients with dyspnea symptoms are associated with such outcomes. On the other hand, a prior multicenter study analyzing nursing records of older adult inpatients diagnosed as having HF found "activity intolerance," "decreased cardiac output," "deficient knowledge," and "risk of falls" to be among the top 10 most common nursing diagnoses and that "pain management" and "skin surveillance" were common nursing interventions.<sup>29</sup> Although this study did not analyze the total nursing records of HF patients but instead selected and analyzed the major symptoms of HF patients based on the corresponding nursing records, the diagnoses of "activity intolerance" and "decreased cardiac output" and the nursing intervention of "pain management" reflecting dyspnea and pain in the previous study are in line with the findings of this study. This suggests that studies utilizing nursing records can take diverse approaches and that analyzing nursing records is crucial in identifying patient symptoms, administering interventions, and examining patient outcomes.

In this study, the nursing records showed that pain evaluation was performed even if the patient did not complain of pain. In the dyspnea-related records, all records indicated that the patient complained of dyspnea. In nursing practice, pain assessment has been recognized as important, and many healthcare institutions recommend periodic evaluation of pain.<sup>10</sup> The hospital of the present study also performs pain evaluations in both inpatient and outpatient settings. The development of patient-centered evidence-based practice and an increase in the level of nursing are also possible through ENR.<sup>11</sup> Thus, it is important to structure nursing records in EMR such that nurses can periodically assess and record pain, which is common among inpatients, as well as common symptoms of the illness involved, such as dyspnea among patients with HF, to enhance this type of practice and the quality of care. This process could systematize the nursing process from nursing assessment to nursing intervention and activities appropriate for the chief complaint and will have positive effects on patients' symptom management. As nursing records organized in standard terminology can be analyzed through various methods, which is expected to have a positive impact on the development of big data research using nursing records, the structured ENR is of great benefit for research.<sup>30</sup>

In this study, the EMRs of adult patients hospitalized with HF over a period of 3 years and 5 months were analyzed to

determine the relationship between their symptoms and outcomes. One limitation of this study is the inability to analyze diagnostic tests, such as echocardiography findings, laboratory results, and intake and output measurements, which may affect the patients' symptoms, in addition to subjective symptoms in patients with HF. Subsequent studies should include these types of data in their analysis. The significance of this study is that it illuminates the roles of nurses through their documentation, showing that patients' subjective symptoms directly related their outcomes.

## CONCLUSION

This study strongly supports the hypothesis that the subjective symptoms such as dyspnea and pain of patients with HF have significant associations with their outcomes. Developing and implementing interventions enabling more effective symptom monitoring and management for inpatients would also have positive effects on patients and hospitals in terms of cost. Instead of relying on self-reported questionnaires, which have previously been used in nursing studies to measure and understand patients' symptoms, this study extracted symptoms using ENR and analyzed the corresponding patient outcomes. Healthcare organizations should be well aware of the importance of documenting and reusing systematically structured records related to patient symptoms for further care plans and research. In particular, adding more detailed information about the symptoms common for a particular illness in the nursing assessment section would lay a foundation for providing customized nursing interventions for patients. Most importantly, more big data studies utilizing ENR should be conducted so this method can become one type of frequently used and high-quality approaches for investigating patient symptoms and outcomes.

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