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Original Article

Characteristics and Risk Factors for Delirium in The Surgical Step-Down Unit

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ABSTRACT

Purpose: This study aimed to investigate the incidence rate, types and risk factors for delirium in patients admitted to the surgical Step-Down Unit (SDU).

Methods: This study was a retrospective study of the electronic medical records of patients admitted to a surgical SDU from February 2020 to July 2020. The delirium assessment was conducted using the short Confusion Assessment Method (a tool that allows quick and easy screening of delirium) and the incidence and risk factors for delirium were determined.

Results: Among a total of 227 patients in the study, the incidence rate of delirium was 35 cases (16.7%). It predominantly occurred on the first day (n = 16, 45.7%) and the second day of admission (n = 15, 42.8%). The peak occurrence of delirium was between 14:00 and 22:00 (n = 30, 85.7%). The most common type of delirium was hypoactive (n = 19, 54.3%). The results of multiple logistic regression analysis indicated that the factors influencing the occurrence of delirium in the surgical step down unit (SDU) were age, hypertension, stroke, white blood cell count, and the use of restraints.

Conclusion: Considering the characteristics of high-risk groups for delirium in the surgical SDU, it is necessary to establish nursing practice guidelines to minimize delirium.

Keywords: aging, delirium, risk factor

Introduction

Due to aging societies and advances in medical technology, the demand for long-term care is increasing [1]. As a result, the need for intensive care unit (ICU) bed capacity has increased [2]. Moreover, the premature transfer of patients to general wards increases the ICU readmission rate and mortality [3].

Efforts have been made to ensure patient recovery and intensive care of ICU patients to prevent unnecessary prolonged stays in the ICU [4-6]. This effort led to the formation and establishment of the Step-down unit (SDU) in the US which provides recovery and intensive care [7].

The use of SDU beds has been reported in the US and Europe to significantly reduce the rates of rehospitalization and ICU readmission for intensive care patients, and also increases the utilization rate of ICU beds [4,8]. In Korea, SDUs were first set up in 2017 in university hospitals [9]. They offer recovery care for long-term ICU patients and provide postoperative monitoring for high-risk patients with underlying diseases.

While delirium occurred in 7.6% of the patients in an Italian study who were transferred from the ICU to an SDU after acute-phase treatment [10], another study in the US reported that it persisted in the post-ICU period in 47% of the ICU delirium cases [11]. Management of delirium is important because untreated delirium is associated with long-term cognitive impairment, falls, and prolonged hospital stays [12-14].

Nurses play an important role in detecting the presence of delirium because they spend more time than doctors with patients at their bedside and can observe changes in the patients' conditions [15]. Currently, the Confusion Assessment Method (CAM) is the most widely used screening tool for delirium [16]. However, since the CAM is a 10-item behavioral observation

scale, which takes more than 10 minutes to complete, there is a need for a delirium assessment tool that can be used in hospital wards for a rapid delirium check [17].

The short CAM was developed in 2014 based on the CAM algorithm for quickly assessing delirium [18]. This 4-item scale can be completed within 5 minutes, greatly simplifying the delirium assessment [19]. It has been reported that the short CAM is useful in emergency rooms and hospital wards, particularly for elderly patients aged 70 years and older [18].

This study was conducted using the short CAM to identify risk factors for delirium and to provide foundational data for the development of delirium prevention guidelines for patients in the SDU.

Materials and Methods

1. Study design

This study was a retrospective investigation to determine the occurrence of delirium and its associated risk factors in patients admitted to a surgical SDU, based on their Electronic Medical Records (EMR).

The SDU model [7] used in this study involves a separate unit adjacent to the General Ward, incorporated into the medical center as a stand-alone unit. As a 4-bed separate room in the General Ward, it provides a quiet environment for the patient, and space for one co-residing caregiver per patient.

2. Patients

Patients admitted to the surgical SDU of Asan Medical Center during February 1 to July 31, 2020 were recruited for this study. Delirium was assessed using the short CAM at each change of shift. The selection criteria were adult patients (> 18 years) admitted to the surgical SDU, who stayed for at least 24 hours, and were capable of the communication necessary for daily delirium assessments. Those with dementia prior to hospitalization and those with a tracheostomy tube (incapable of verbal communication), were excluded from the analysis.

The sample size required for an independent t test was determined using the G*Power program Version 3.1.9.2 for Windows. As a result, the minimum necessary sample size was calculated to be 210 with the significance level (α) set at 0.05; medium effect size, at 0.5; and power (1-β), at 0.95. Thus, the number of patients analyzed in this retrospective study was 227 which satisfied the sample size requirement.

3. Measurement instruments

The CAM-ICU, primarily used for ICU patients, is administered to those receiving mechanical ventilation and who may have difficulty with verbal communication [17]. In contrast, the short CAM is designed for patients capable of verbal communication in a busy clinical setting and can be easily used in the General Ward [19]. It has a high sensitivity (98%) and specificity (99%) [20]. In this study, the short CAM was used because SDU patients are less dependent on invasive medical equipment compared with those SDU patients in the ICU, and are capable of verbal communication.

The short CAM consists of 4 features: (1) Acute onset and fluctuating symptoms; (2) Inattention; (3) Disorganized thinking; and (4) Altered level of consciousness using which the presence of delirium is assessed. At each shift change, the nurse on duty recorded the results of delirium assessment and assigned the code “delirium (+)” in the event of a short CAM score of 2 or higher.

For delirium subtype classification, we used the Delirium Symptom Interview (DSI) scale developed by Albert et al [21]. DSI classifies delirium into 3 subtypes according to psychomotor activity: (1) hyperactive delirium (at least 3 out of 16 hyperactive features); (2) hypoactive delirium (at least 4 out of 7 hypoactive symptoms); and (3) mixed delirium (both feature groups [21]).

During their shift, the attending nurse also evaluated the type of delirium during the delirium assessment and it was documented in the EMR.

4. Data collection

Based on a systematic review of previous studies, participants were categorized according to the following characteristics: patient, disease, treatment, and environment. For disease-related characteristics, the Charlson Comorbidity Index (CCI) was used to measure comorbidities. CCI scores were adjusted by assigning weights between 1 and 6 based on the severity of 17 disease categories. After this adjustment, the CCI scores were divided into 2 groups using 3 as the reference score. The severity of the patients' status upon admission was assessed using the Acute Physiology and Chronic Health Evaluation (APACHE) II score, which was measured within the first 24 hours of SDU admission. Treatment-related characteristics included hemodialysis (HD), type of surgery, occurrences of systolic hypotension (< 90 mmHg) within 24 hours of SDU admission, use of high-flow nasal cannula, use of arterial line and blood tests. Blood tests taken within the first 24 hours of SDU admission included white blood cell count (WBC), hemoglobin, blood urea nitrogen, plasma creatinine, aspartate transaminase, alanine transaminase, plasma albumin, sodium, and potassium levels. Environmental characteristics were examined prior to ICU stays and the use of restraints was recorded. However, only the use of restraints prior to the onset of delirium was considered in order to establish the sequential relationship between restraint use and delirium.

5. Statistical analyses

The data analysis was conducted using the SPSS WIN Version

23.0 program, and the significance level for all statistical tests was set at $p < 0.05$. Descriptive statistics, such as frequencies, percentages, means, and standard deviations were employed to analyze the patients' general characteristics, and the incidence of delirium. Participant characteristics (delirium and non-delirium groups) were compared using chi-square test, t test, and Fisher's exact test. The risk factors for delirium were analyzed using multiple logistic regression.

6. Ethical considerations

This study was conducted after obtaining approval from the nursing division and the Institutional Review Board of Asan Medical Center and before conducting the study (IRB No.: 2020-1830). Data was collected and analyzed retrospectively. Informed consent was waived.

Results

1. Incidence rate and patterns of delirium

The incidence rate of delirium in the surgical SDU was 15.4% (Figure 1). Delirium occurred most frequently on the day of admission to the surgical SDU, (n = 16, 45.7%), followed by (n = 15, 42.8%) on the 2nd day of admission. The main occurrence of delirium was between 14:30 and 22:30 accounting for 30 cases (85.7%). Regarding the types of delirium, hypoactive delirium was the most common (n = 19, 54.3%), followed by hyperactive delirium (n = 10, 28.6%; Table 1).

Table 1. Characteristics and patterns in patients with delirium (N = 35)

Characteristics	Category	N (%)
Time of short CAM positive (d)	0	16 (45.7)
	1	15 (42.8)
	2	3 (8.6)
	3	1 (2.8)
Time of occurrence	06:30-14:30	5 (14.3)
	14:30-22:30	30 (85.7)
Type of delirium	Hypoactive	19 (54.3)
	Hyperactive	10 (28.6)
	Mixed	6 (17.1)

CAM = confusion assessment method.

2. Comparison of general characteristics between the delirium and non-delirium groups of surgical SDU patients

When comparing the groups (without delirium and delirium) differences in various aspects were observed (Table 2). In terms of general characteristics, there were distinctions in age (p < 0.001). Regarding disease-specific characteristics, differences were observed in CCI (p = 0.016), hypertension (p = 0.021), stroke (p = 0.001), and APACHE II scores (p = 0.002). In terms of treatment characteristics, disparities were noted for HD (p = 0.006), WBC (p = 0.043), and albumin (p = 0.050). In terms of environmental characteristics, there was a difference in the use of restraints (p < 0.001).

3. Risk factors for delirium in patients admitted to a surgical SDU

Based on multivariate logistic regression analysis significant variables including age, CCI, HTN, stroke, APACHE II score, HD, WBC, albumin level, and use of restraint were included. Logistic regression analysis determined that the regression model was valid statistically significant (p < 0.001), with an explanatory power of 41.9% (using Nagelkerke's coefficient of determination). The classification accuracy was 87.2%. The model's goodness of fit was assessed using the Hosmer and Lemeshow's method and indicated that data fitted the model well (p = 0.562). The analysis results indicated that age, HTN, stroke, WBC, and the use of restraint was the most significant factors influencing the occurrence of delirium (Table 3). As age increases, there is a higher association with delirium (95% CI:

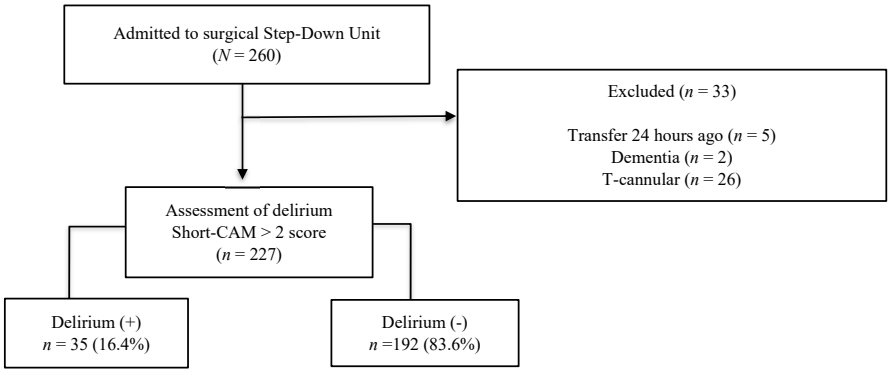

Figure 1. Flow diagram of the subject selection.
CAM = confusion assessment method.

Table 2. Comparison of patient characteristics between delirium and non-delirium groups (n = 227)

Characteristics	Category	Delirium (n = 35)	Non-delirium (n = 192)	p
Patient characteristic				
Sex (n, %)	Male	26 (74.3)	146 (76.0)	0.824
	Female	9 (25.7)	46 (24.0)	
Age (mean ± SD)		75.2 ± 7.7	65.2 ± 13.7	< 0.001
Sleep disorders (n, %)		12 (34.3)	46 (24.0)	0.198
Smoking (n, %)		13 (37.1)	87 (45.3)	0.371
Vision impairment (n, %)		12 (34.3)	59 (30.7)	0.676
Hearing impairment (n, %)		8 (22.9)	23 (12.0)	0.085
Marital status	Married	35 (100.0)	178 (92.7)	0.099
Disease characteristics				
Charlson Comorbidity Iindex (n, %)	< 3	0	28 (23.7)	0.016
	> 3	35 (100.0)	164 (82.4)	
Past medical history (n, %)	HTN1	24 (68.6)	91 (47.4)	0.021
	Stroke	11 (34.1)	19 (9.9)	0.001
	Alcohol use	11 (31.4)	88 (45.8)	0.114
Diagnosis (n, %)	Hepatobiliary and pancreatic disease	9 (25.7)	47 (24.5)	0.228
	Gastrointestinal disease	14 (40.0)	53 (27.6)	
	Vascular disease	11 (31.4)	67 (34.9)	
	Others	1 (2.8)	25 (13.0)	
Reason of ICU admission (n, %)	Postoperative monitoring	23 (65.7)	141 (73.4)	0.483
	Respiratory failure	6 (17.1)	14 (7.3)	
	Bleeding	1 (2.8)	2 (1.0)	
	Fever	1 (2.8)	8 (4.2)	
	Others	5 (14.3)	27 (14.1)	
APACHE II (mean±SD)		11.6 ± 4.1	9.6 ± 3.7	0.002
Treatment characteristics				
Hemodialysis (n, %)		4 (11.8)	9 (4.3)	0.006
Surgery (n, %)		29 (82.9)	168 (87.5)	0.456
< SBP 90 mmHg (n, %)		4 (11.4)	13 (6.8)	0.336
High flow nasal cannula (n, %)		3 (9.6)	13 (6.8)	0.702
Applied to arterial line (n, %)		26 (74.3)	154 (80.2)	0.426
Laboratory test (n, %)	WBC	13.1 ± 5.9	11.2 ± 4.7	0.043
	Hb	9.5 ± 1.6	10.5 ± 5.9	0.323
	BUN	20.0 ± 11.0	17.4 ± 13.3	0.288
	Creatine	1.17 ± 0.92	1.29 ± 1.64	0.681
	AST	50.6 ± 109.8	46.3 ± 79.2	0.781
	ALT	40.0 ± 113.9	35.5 ± 60.5	0.732
	Albumin	2.9 ± 1.7	3.9 ± 6.5	0.050
	Sodium	139.5 ± 4.5	139.3 ± 3.0	0.762
	Potassium	3.81 ± 0.4	3.98 ± 0.4	0.053
Environmental characteristics				
Admitted via SICU (n, %)		12 (34.3)	54 (28.1)	0.460
Applied restraint (n, %)		9 (25.7)	6 (3.1)	< 0.001

$p < 0.05$.
ALT = alanine transaminase; APACHE II = acute physiology and chronic health evaluation; BUN = blood urea nitrogen; Hb = hemoglobin; HTN = hypertension; IIAST = blood levels of aspartate transaminase; SBP = systolic blood pressure; SICU = surgical intensive care unit ; WBC = white blood cell.

Table 3. Multiple logistic regression analysis of risk factors associated with delirium

Characteristics	B	SE	*p*	OR	95% confidence interval	
					Lower	Upper
Age	0.084	0.030	0.005	1.088	1.025	1.155
CCI	0.031	0.135	0.819	1.032	0.791	1.345
HTN	1.217	0.526	0.024	3.378	1.206	9.463
Stroke	1.487	0.524	0.005	4.424	1.583	12.362
APACHE II	0.121	0.063	0.053	1.129	0.998	1.277
Hemodialysis	0.398	1.010	0.694	1.488	0.206	10.372
WBC	0.131	0.045	0.004	1.140	1.044	1.246
Albumin	0.028	0.053	0.594	1.029	0.928	1.141
Use of restraint	3.099	0.787	< 0.001	22.184	4.748	103.644

$p < 0.05$
APACHE II = acute physiology and chronic health evaluation; CCI = Charlson comorbidity index; HTN = hypertension ; OR = odds ratio; WBC= white blood cell.

1.025-1.15, $p = 0.005$). Having hypertension increases the odds 3.3 times (95% CI: 1.206-9.463, $p = 0.024$), and having a history of stroke increases the odds 4.4 times (95% CI: 1.583-12.362). The higher the WBC count, the higher the odds of delirium (95% CI: 1.044-1.246, $p = 0.004$). The use of restraint increases the odds 22.2 times (95% CI: 4.748-103.644, $p < 0.001$).

Discussion

This retrospective study was conducted with patients admitted to the Surgical SDU using the short CAM as an assessment tool for delirium in order to identify risk factors for delirium. This analysis, spanning a period of 6 months, revealed a delirium incidence rate of 15.4%. In the 2014 Sullivan study [18], the delirium incidence rate in older adults (≥ 70 years) using the abbreviated CAM ranged from 36% to 68%, which was lower than the mean rate calculated in this study. Direct comparison between the 2 studies is not possible due to contextual differences, including the fact that this study was conducted in a single surgical ward in Korea. In this current study, delirium occurred in the majority of cases on the first and second days following admission to the SDU, which is consistent with the results of similar studies [22,23]. In terms of the time of day, 85.7% of delirium cases occurred between 14:30 and 22:30, which may be attributed to the "sundown syndrome" characterized by a sudden surge of neurotic symptoms such as agitation, confusion, and anxiety late in the afternoon and into the evening [24].

Among the different types of delirium, hypoactive delirium was observed in 54.3% of the patients. Previous studies have reported that hypoactive patients are less likely to be identified as delirious, as they tend to comply with treatment [25] and thus escape the attention of the medical staff [26]. This study showed that a high proportion of hypoactive delirium, was detected suggesting that rapid identification through assessments was beneficial. Delayed delirium diagnosis, negatively impacts mortality and prognosis. Therefore, early detection of delirium through delirium assessment proves to be a crucial factor in delirium management.

The factors influencing the occurrence of delirium were determined to be age, hypertension, stroke, WBC count, and use of restraints. Age was a significant risk factor for the incidence of delirium, which is in line with previous studies that report a high incidence of delirium among elderly patients aged 65 years [27] or 75 years or older [28]. In this current study, the mean age of the delirium group was 10 years higher than that of the non-delirium group (75.2 vs. 65.2%), supporting the finding that age is a risk factor for delirium. This may be explained by the fact that as one gets older, one is more affected by and less able to adapt to changes in physical and mental functions, and is more prone to functional decline [29]. Previous studies have reported that the incidence of delirium is higher when the patient has hypertension as a comorbidity [30,31]. Hypertension was identified as a risk factor in this current study. In general, patients with hypertension as an underlying disease are subjected to sustained vascular damage, leading to cerebral perfusion hypoxia, which may trigger cognitive impairment and delirium [32]. Stroke was also identified as a risk factor in this current study, which is consistent with the findings of previous studies that reported reduced brain perfusion induced by stroke may cause spatial and emotional disturbances, thus increasing the risk of delirium [33,34]. An elevated neutrophil count [35] increases the incidence of infection, which sends signals that induce systemic fever and stress responses to the brain, adversely affecting behavior [36] and cognitive function, which is thought to be responsible for the increased risk for delirium [37]. The use of restraint increased the incidence rate of delirium 32 times in the ICU [38] and several studies have demonstrated that the use of restraint is a cause of delirium [39-41]. In this current study,

physically restrained patients showed a 22-fold higher incidence of delirium. The mechanism by which the use of restraint causes delirium is not yet clear, but one possible explanation is that its use can cause tracheal extubation, threaten the patient's dignity, and trigger negative emotions such as anxiety and anger which may lead to delirium [38,40]. On the other hand, the use of restraint is a measure necessary to keep delirium patients, who undergo sudden changes in their state of consciousness and behavior, from dangerous actions and accidents, such as unplanned extubation or falls [38]. Thus, it may be an important intervention for delirium prevention that surgical SDU nurses pay attention to the emotional changes in physically restrained patients, re-evaluate the necessity of using the restraint, and make efforts and formulate strategies to gradually reduce the time required to apply the restraint.

This study has several potential limitations. The most significant one is its retrospective nature, utilizing EMR, which may hinder the generalizability of the research results. Additionally, the relatively low incidence of delirium is noteworthy. Previous studies have shown a wide range of incidence of delirium in ICU populations, ranging from 30% to 80%, primarily in studies targeting mechanically ventilated patients using CAM-ICU [10-12]. This study is limited by the specific characteristics of one surgical ICU population, the use of the short CAM diagnostic tool limited to patients capable of communication, and potential variability in the handling of the short CAM assessment tool due to nursing staff shifts. Furthermore, the study does not include the relationship with the use of sedatives and antipsychotic drugs which are factors associated with the risk of delirium.

Conclusion

This study is significant as the first attempt to assess delirium using the short CAM tool in patients admitted to the surgical SDU of 3rd-tier hospital in South Korea and to investigate the relationship between the occurrence of delirium and various risk factors. Notable clinical features include the predominance of hypoactive delirium, higher occurrence in the afternoon and evening, and the majority of instances of delirium occurring within 1 or 2 days of admission to the surgical SDU. Consideration of patient-related risk factors such as age, hypertension, and stroke, a disease-related risk factor such as elevated WBC, and an environmental risk factor such as sedative use emphasizes the multifaceted nature of delirium. This underscores the importance of implementing standardized delirium screening protocols, fostering interprofessional collaboration, reducing the frequency of restraint application, and improving the ward environment. Additionally, interventions such as establishing a family support system and minimizing restraint application can be included to reduce the occurrence and impact of delirium. Proactive measures that address the multifaceted nature of delirium and improvements in the ward environment are crucial for optimizing the prevention and management of delirium.

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Author Contributions

Conceptualization, Methodology: All. Data curation and Writing-original draft: SY, JK, and YJA. Writing-original draft: SY, JK, and YJA. Project administration: JO and YJ. Formal analysis, Investigation and Supervision: YJ.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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Ethical Statement

Clinical Research Registration no.: S2020-2691-0002. This study was conducted after obtaining approval from the nursing division and the Institutional Review Board of Asan Medical Center and before conducting the study (IRB no.: 2020-1830). Data was collected and analyzed retrospectively. Informed consent was waived.

Data Availability

All relevant data are included in this manuscript.

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