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Impact of neurointensivist-managed intensive care unit implementation on patient outcomes after aneurysmal subarachnoid hemorrhage

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ABSTRACT

Purpose: The purpose of the study is to evaluate the impact of neurointensivist-managed intensive care unit (NIM-ICU) implementation for patients admitted with aneurysmal subarachnoid hemorrhage (SAH).
Methods: This study retrospectively evaluated 234 patients (mean age, 61.7 years; male, 67) admitted with SAH between January 1, 2001, and March 31, 2014. Neurologic outcomes between patients admitted from January 2001 to December 2006 (intensivist-managed intensive care unit group) and January 2007 to March 2014 (NIM-ICU group) were compared. The primary outcome was the incidence of a good neurologic outcome at discharge (GO; the modified Ranking Scale score: GO, 0-2; poor neurological outcome, 3-6) at discharge.
Results: Neurointensivist-managed intensive care unit was initiated for 151 (64.5%) of 234 patients. Univariate analysis demonstrated significantly better outcomes for NIM-ICU group vs intensivist-managed intensive care unit group (GOs, 58.3% vs 41.0%, respectively, $P = .01$). Multivariate logistic regression was used to evaluate NIM-ICU efficacy for SAH patients, but NIM-ICU was not significantly associated with GOs ($P = .054$). Subgroup analysis of patient grading by Hunt and Kosnik grades I to II showed that NIM-ICU implementation was an independent predictor of GOs (odds ratio, 4.54; 95% confidence interval, 1.08-22.17; $P = .04$).
Conclusion: Neurointensivist-managed intensive care unit may improve neurologic outcomes in SAH patients with Hunt and Kosnik grades I to II.

1. Introduction

The impact of neurocritical care/neurointensivist-managed care on the outcome in patients with life-threatening neurologic and neurosurgical illnesses has been reported [1-6]. In particular, the efficacy of a neurointensivist-managed neurocritical/intensive care unit (ICU) implementation for patients with aneurysmal subarachnoid hemorrhage (SAH) has been reported; however, there are no reported studies demonstrating this efficacy in terms of the direct outcomes (ie, good neurologic outcomes [GOs] at hospital discharge) [7-9]. Moreover, because those key studies have been conducted only in the United States [1-9], its efficacy outside the United States remains unknown.

This study aimed to evaluate the impact of neurointensivist-managed ICU (NIM-ICU) implementation for patients admitted with SAH using the direct outcome of the modified Ranking Scale (mRS) at discharge from our hospital and also to demonstrate its efficacy outside the United States.

2. Materials and methods

2.1. Study design and setting

This single-center study consisted of adult patients who were hospitalized with a confirmed diagnosis of SAH between January 1, 2001, and March 31, 2014, at the Kagawa University Hospital (ICU training facility for board-certified intensivists approved by the Japanese Society of Intensive Care Medicine). All data were collected retrospectively by reviewing medical records. This study was approved by the institutional review board of the Kagawa University Hospital and conducted in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. The institutional review board waived the requirement for patient consent due to the retrospective nature of the study.

2.2. Study participants and inclusion criteria

We included all patients of age 18 years or older who were diagnosed with SAH. Patients were excluded if they were given only comfort

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Table 1
Key differences in neurocritical care at Kagawa University Hospital between the 2 study groups

	IM-ICU group	NIM-ICU group
Period	From January 1, 2001, to December 31, 2006	From January 1, 2007, to March 31, 2014
ICU bed	Up to 6	Up to 20
Patient population	Surgical ICU	General ICU
Primary discipline of intensivists	Anesthesia	Neurosurgery, anesthesia, emergency medicine, internal medicine
Responsibility	Primary neurointensive care by the neurosurgery physician staff Routine medical and critical care services provided by the intensivists	Creation of neurointensivist-led critical care Multidisciplinary team Critical care nurses Nutrition support Respiratory support

care within 24 hours of admission. Patients were classified into 1 of 2 study periods depending on their admission date as follows: intensivist-managed ICU (IM-ICU) group (83 patients admitted between January 1, 2001, and December 31, 2006) and NIM-ICU group (151 patients admitted between January 1, 2007, and March 31, 2014). Table 1 describes key differences in the staffing and treatment of patients admitted to the ICU at Kagawa University Hospital over the study period that, for the purpose of this study, was the neurointensivist-led critical care with a multidisciplinary team that started treating patients on January 1, 2007. Neurointensivists contributed to nurse education, introduced close neurological monitoring for vasospasms, and organized the multidisciplinary conferences twice a day.

2.3. Data sampling

The following data were collected: age, sex, Hunt and Kosnik (H&K) grade, treatment modality (coil or clip), rate of delayed cerebral ischemia (DCI), the mRS at discharge from the hospital, length of ICU stay, length of hospital stay, and inhospital mortality.

Table 2
Comparison of covariates between IM-ICU and NIM-ICU groups

Variables	IM-ICU, n = 83	NIM-ICU, n = 151	*P*
Age (y)	63 (52-74)	62 (48-73)	.97
Sex (male)	32 (38.6)	35 (23.2)	.02
H&K grades			.03
I	4 (4.8)	13 (8.6)	
II	22 (26.5)	57 (37.8)	
III	20 (24.1)	41 (27.2)	
IV	29 (34.9)	25 (16.6)	
V	8 (9.6)	15 (9.9)	
Treatment modality			<.01
Clip	39 (47.0)	34 (22.5)	
Coil outcome	44 (53.0)	117 (77.5)	
mRS			<.01
0	4 (4.8)	40 (26.5)	
1	10 (12.1)	21 (13.9)	
2	20 (24.1)	27 (17.9)	
3	10 (12.1)	17 (11.3)	
4	12 (14.5)	19 (12.6)	
5	12 (14.5)	13 (8.6)	
6	15 (18.1)	14 (9.3)	
GOs	34 (41.0)	88 (58.3)	.01
DCI	14 (16.9)	12 (7.9)	.03
ICU stay	8 (3-16)	13 (9-16)	<.01
Hospital stay	38 (23-70)	26 (20-44)	<.01
Hospital mortality	15 (18.1)	14 (9.3)	.06

Data are presented as medians (interquartile range) for continuous variables and number (percentages) for categorical variables.

Table 3a
Multivariate logistic regression analysis of GOs

	Univariate analysis			Multivariate analysis		
	OR	95% CI	*P*	Adjusted OR	95% CI	*P*
NIM-ICU	2.01	1.17-3.49	.01	2.14	0.99-4.76	.054
Age	0.94	0.92-0.96	<.01	0.93	0.90-0.96	<.01
Sex (male)	1.29	0.73-2.30	.37	1.33	0.60-3.02	.48
H&K grades	0.27	0.19-0.38	<.01	0.25	0.00-0.02	<.01
Treatment (coil)	0.73	0.42-1.27	.27	0.89	0.41-1.95	.78

2.4. Outcome measures

The primary outcome was the incidence of a GO, as assessed using the mRS at discharge from our hospital, and defined as an mRS score of 0 to 2; poor neurologic outcome was defined as an mRS score of 3 to 6. The secondary outcome was the rate of DCI; furthermore, we aimed to identify the group for which NIM-ICU implementation was most effective, according to patient H&K grading.

2.5. Statistical analysis

Demographic factors and baseline characteristics were summarized for participants using descriptive statistics. The distribution of each variable was compared between the 2 groups (IM-ICU and NIM-ICU), using Mann-Whitney *U* tests or Fisher exact tests, depending on variables. Univariate and multivariate logistic regression analyses (with stepwise variable selection) were conducted to explore the prognostic factors for GO and DCI in SAH patients overall as well as in the subcategories of H&K grades (I-II and III-V).

All statistical analyses were conducted using IBM SPSS, version 20.0J (IBM Corp, Armonk, NY) and SAS version 9.3 (Cary, NC). A 2-sided *P* value less than .05 was considered statistically significant.

3. Results

3.1. Demographic factors and clinical characteristics of all study patients and univariate analysis of the association between IM-ICU and NIM-ICU

Of the 234 patients (mean age, 61.7 years; male, 67) included in this study, NIM-ICU was initiated for 151 patients.

In a univariate analysis, NIM-ICU group demonstrated significantly better outcomes than IM-ICU group (GOs, 58.3% vs 41.0%, respectively, $P = .01$; DCI, 7.9% vs 16.9%, respectively, $P = .03$; Table 2).

3.2. Multivariate analysis

Multiple logistic regression analyses showed that NIM-ICU for patients with SAH was not significantly associated with GOs (odds ratio [OR], 2.14; 95% confidence interval [CI], 0.99-4.76; $P = .054$; Table 3a) or DCI (OR, 0.41; 95% CI, 0.16-1.01; $P = .053$; Table 3b).

Table 3b
Multivariate logistic regression analysis of DCI

	Univariate analysis			Multivariate analysis		
	OR	95% CI	*P*	Adjusted OR	95% CI	*P*
NIM-ICU	0.39	0.17-0.89	.03	0.41	0.16-1.01	.053
Age	1.00	0.98-1.03	.67	1.00	0.97-1.03	.95
Sex (male)	1.06	0.41-2.52	.90	0.78	0.28-1.99	.61
H&K grades	1.63	1.11-2.42	.01	1.54	1.03-2.36	.04
Treatment (coil)	1.07	0.45-2.74	.89	1.23	0.47-3.44	.67