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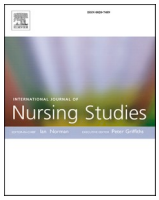

Patient outcomes after triage by emergency departments with or without advanced practice nurses in Japan: A retrospective cohort study using a nationwide inpatient database

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ABSTRACT

Background: Nurses play an important role in triage and delivering emergency care. According to previous studies, advanced practice nurses may be associated with better patient outcomes in emergency departments. However, existing evidence is limited, largely derived from high-income Western countries. Thus, the results may not be applicable to other regions. Broader and contextually diverse evidence is needed to inform international workforce planning and policy.
Objective: To determine whether the presence of advanced nursing roles (certified nurses and certified nurse specialists) in emergency departments is associated with patient outcomes among adults undergoing triage.
Design: Retrospective cohort study using a nationwide inpatient database.
Setting: Acute care hospitals across Japan.
Participants: A total of 440,420 patients admitted after emergency department triage at 1012 hospitals between 2013 and 2022.
Methods: In-hospital mortality and length of stay were evaluated using multivariable regression with generalized estimating equations, adjusting for detailed patient and hospital characteristics and accounting for within-hospital clustering. To address potential heterogeneity across clinical contexts, the analyses were stratified by the International Classification of Diseases, 10th Revision major diagnostic categories, and random effects meta-analysis was used to synthesize pooled estimates.
Results: In-hospital mortality was significantly lower in hospitals with certified nurses and/or certified nurse specialists in the emergency department for specific diagnostic categories, including certain infectious and parasitic diseases (adjusted odds ratio, 0.57; 95% confidence interval, 0.38–0.84) and endocrine, nutritional, and metabolic diseases (adjusted odds ratio, 0.65; 95% confidence interval, 0.45–0.94). By contrast, the overall pooled association between certified nurses/certified nurse specialists and in-hospital mortality was not statistically significant (adjusted odds ratio, 0.88; 95% confidence interval, 0.77–1.01). However, the pooled estimate suggested a potential protective effect. Regarding length of stay, no consistent association was observed.
Conclusions: Despite the absence of a significant pooled effect across all patients, the presence of certified nurses and/or certified nurse specialists in emergency departments was associated with lower in-hospital mortality in selected diagnostic groups. These findings suggest the potential value of advanced nursing roles, even in systems

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where prescriptive and diagnostic authority is limited, and may help to inform future discussion regarding workforce deployment and policy in Japan and other healthcare systems with similar structures.
Registration: Not registered.

What is already known

- Emergency department overcrowding is a global healthcare challenge, and nurses play an important role in triage and emergency care delivery.
- Most available evidence originates from a limited number of high-income countries and predominantly focuses on advanced practice nurses with diagnostic or prescriptive authority, including nurse practitioners, limiting applicability to other healthcare systems.
- In Japan, certified nurses and certified nurse specialists receive advanced training but do not have prescriptive and diagnostic authority, and their impact on patient outcomes in emergency departments has not been well studied.

What this paper adds

- Emergency departments with certified nurses and/or certified nurse specialists showed lower in-hospital mortality for infectious and endocrine/metabolic diseases.
- In the overall analysis, the presence of certified nurses and/or certified nurse specialists in emergency departments was not associated with reduced mortality or shorter hospital stay.

1. Introduction

Emergency department crowding is a pervasive global public health concern that compromises timely access to care and patient safety (Morley et al., 2018; Ouyang et al., 2022). In emergency departments, triage serves as an important mechanism for allocating limited resources and ensuring that patients with the most urgent needs receive timely and appropriate care (FitzGerald et al., 2010; Fekonja et al., 2024). Triage is primarily undertaken by registered nurses in many healthcare systems (FitzGerald et al., 2010; Fekonja et al., 2024; Shindul-Rothschild et al., 2017), highlighting their pivotal role in maintaining the quality and efficiency of emergency care delivery (Shindul-Rothschild et al., 2017).

According to evidence from previous studies, integrating advanced practice nurses into emergency department teams may be associated with greater patient satisfaction, shorter waiting times for consultation or treatment, reduced length of stay, lower mortality, and cost savings (Woo et al., 2017; Moxham and McMahon-Parkes, 2020; Horvath et al., 2023; Jiménez-García et al., 2025). However, owing to heterogeneity in study designs, interventions, and outcome measures, this evidence remains inconclusive. Furthermore, most previous studies were observational in nature, limited by small sample sizes, and predominantly conducted in high-income Western countries (e.g., the United States, Canada, and Australia) (Horvath et al., 2023). These constraints raise important concerns with regard to the findings' generalizability to other healthcare contexts where advanced nursing roles are structured differently.

In Japan, the Japanese Nursing Association introduced two advanced nursing qualifications in the 1990s: certified nurses and certified nurse specialists. Together, they represent advanced nursing roles emphasizing on specialized clinical expertise, modeled in part on clinical nurse specialists in the United States. In emergency departments, certified nurses and certified nurse specialists typically contribute to triage and early assessment by performing structured information gathering and systematic observation with timely reassessment, managing patient flow and infection-control processes, and providing reassurance and guidance to patients awaiting care (Ogura et al., 2024). However, despite these responsibilities, their impact on patient outcomes in Japanese emergency departments has not been well established. To address this gap, we performed a nationwide retrospective observational study using a large inpatient database to examine the association between the presence of certified nurses and/or certified nurse specialists in emergency departments and patient outcomes among adults who underwent triage.

2. Methods

2.1. Data sources

The Japanese Diagnosis Procedure Combination database (a nationwide acute care inpatient database integrated with the country's lump-sum payment system) was used in this study. The structure and characteristics of this database have been described in detail in a previous study (Yasunaga, 2024). The database compiles administrative claims and discharge abstracts from approximately 1200 acute care hospitals across Japan. It contains patient demographics; diagnoses coded according to the International Classification of Diseases, 10th Revision; clinical information; and administrative claims, including daily drug prescriptions and medical procedures. These data are derived from hospital billing records submitted for reimbursement during hospitalization. The database encompasses approximately 7 million inpatient cases annually, accounting for >50% of all acute care hospitalizations in Japan and covering nearly 90% of all tertiary emergency care hospitals. Hospitals that are not participating in the Diagnosis Procedure Combination database are mainly long-term care, rehabilitation, or psychiatric institutions that do not provide acute inpatient care. Although the database was originally developed for reimbursement purposes, it has been extensively applied in clinical and health services research because of its breadth and reliability (Fujinaga and Fukuoka, 2022). Numerous validation studies have verified high positive predictive values for several diagnosis codes and strong validity for daily records of drug utilization and medical procedures (Yamana et al., 2023, 2017), with reported sensitivity of diagnosis codes ranging from approximately 50–78%, high specificity around 96%, and positive predictive values varying widely across conditions (approximately 10% to 100%).

To complement these patient-level data, hospital-level information from the Annual Report for Functions of Medical Institutions, which provides comprehensive statistics on healthcare facility characteristics, was incorporated (Morita et al., 2023). Under the Medical Care Act, all acute care hospitals in Japan must submit this report. The dataset, which is publicly available, contains structural indicators, including type of hospital, bed capacity, availability of intensive care units, and staffing configurations. Using unique hospital identifiers, these hospital-level data were linked to the Diagnosis Procedure Combination database, thereby enabling the integration of patient- and facility-level information for analysis.

2.2. Study participants

Patients were included if they met all of the following criteria: (i) patients aged 18 years or older, (ii) those who were admitted to the hospital following triage in emergency departments, and (iii) those who were admitted between April 1, 2013 and March 31, 2023 (Japanese fiscal years 2013–2022; fiscal years in Japan run from April 1, to March 31 and are denoted by the starting year). To maintain a clinically homogeneous cohort, the analysis was restricted to adults, and the study period was limited to 2013–2023 because information regarding

certified nurses/certified nurse specialists has been available since 2013. Furthermore, only the first admission episode for each patient during the study period was retained to prevent duplication. Triage encounters were identified through billing records for the designated emergency department triage fee, which exclusively applies to walk-in patients (i.e., those who were not transported by ambulance) who visit during nights or holidays and are promptly triaged by either a physician or a nurse with at least three years of emergency care experience. Therefore, in this study, "patients who underwent triage" refer to those who met these billing conditions.

The exclusion criteria were as follows: (i) patients who died within 24 h of admission (as their outcomes were unlikely to be influenced by triage decisions or initial emergency department care) and (ii) those whose admission-precipitating diagnosis belonged to the International Classification of Diseases, 10th Revision major categories representing $<2\%$ of all admissions. Moreover, we excluded hospitals that could not be successfully linked to facility-level data from the Annual Report for Functions of Medical Institutions.

2.3. Certified nurses and certified nurse specialists in Japan

In the 1990s, the Japanese Nursing Association introduced two nationally recognized specialist nursing qualifications in Japan: certified nurse and certified nurse specialist (Morita et al., 2017). To qualify as a certified nurse, candidates must (i) hold a registered nurse license for at least five years, including three years of clinical experience in the relevant specialty; (ii) complete a Japanese Nursing Association-accredited course of at least 615 contact hours; and (iii) pass a credentialing examination administered by the Japanese Nursing Association. Meanwhile, to qualify as a certified nurse specialist, candidates must fulfill the same clinical experience requirements but additionally obtain a master's degree and complete certified nurse-specialist-specific specialty training before passing the Japanese Nursing Association's examination. The credentials of certified nurses and certified nurse specialists must be renewed every five years.

The roles and core competencies of certified nurses and certified nurse specialists differ in scope. Certified nurses are expected to provide advanced nursing practice, teach and advise staff nurses, and support interprofessional care. However, certified nurse specialists assume broader responsibilities, including team coordination, ethical advocacy, and clinical research involvement. In the context of the emergency department, certified nurses and certified nurse specialists contribute to triage-related activities, including early assessment, protocol implementation, supervision of triage nurses, and coordination with physicians. However, neither roles have prescriptive or diagnostic authority in Japan. Although certified nurses are not formally categorized as advanced practice nurses under Japanese regulations, their scope of practice aligns with the contextual definition of advanced practice nursing of the International Council of Nurses (Ordóñez-Piedra et al., 2021).

For this study, exposure was defined as the presence of certified nurses and/or certified nurse specialists assigned to emergency departments. Certified nurses and certified nurse specialists were analyzed together because they serve as advanced nursing roles within Japanese emergency departments and share overlapping responsibilities in triage supervision, early assessment, protocol adherence, and collaboration with physicians, despite having differences in formal training.

Information regarding the annual presence of certified nurses and/or certified nurse specialists specializing in critical care or emergency nursing was obtained from the Japanese Nursing Association, which has provided these data since 2013 following approval by the association's ethics review process. Subsequently, hospitals were linked to the Diagnosis Procedure Combination database by fiscal year using unique facility identifiers.

2.4. Study outcomes

The primary outcome of interest was in-hospital mortality occurring after the first 24 h of admission as it represents a clinically important and objective endpoint and has been examined in previous studies evaluating advanced practice nursing in emergency and acute care settings (Woo et al., 2017; Halm, 2021; Kilpatrick et al., 2024). Meanwhile, the secondary outcome was the length of hospital stay, measured in days, which reflects the recovery process and has also been examined in prior studies (Moxham and McMahon-Parkes, 2020; Hardway et al., 2023; Forte et al., 2025).

2.5. Covariates

Covariates were selected on the basis of their potential to confound the association between nurse staffing and patient outcomes (e.g., patient-level prognostic factors reflecting severity or frailty) and hospital characteristics related to quality of care. Patient- and hospital-level characteristics were included as covariates in risk adjustment models to minimize confounding. At the patient level, variables included age; sex; smoking status (nonsmoker or current/past smoker); level of consciousness on admission (assessed using the Japan Coma Scale (Nakajima et al., 2023)); body mass index; activities of daily living at admission (measured using the Barthel Index (Mahoney and Barthel, 1965)); Charlson comorbidity index (Quan et al., 2005); and International Classification of Diseases, 10th Revision major category of the admission-precipitating diagnosis. We also included the season and fiscal year of admission to account for potential seasonal variations in disease incidence and secular improvements in healthcare quality and the increase in number of certified nurses and/or certified nurse specialists over time.

Meanwhile, at the hospital level, covariates included designation as an academic hospital, classification as a tertiary or secondary care facility, availability of intensive care units, and presence of a discharge planning department. Structural indicators, including the hospital bed capacity ($\leq$250, 251–500, or $\geq$ 501 beds), physician supply (number of physicians per 100 hospital beds), percentage of registered nurses among inpatient staff, patient-to-nurse ratio per shift in inpatient general wards, and annual ambulance acceptance volume ($\leq$1000, 1001–2999, 3000–4999, or $\geq$ 5000 cases), were also included. The geographic location was categorized by rurality (e.g., urban, intermediate, or rural).

Some continuous variables were categorized into clinically meaningful groups on the basis of established thresholds commonly used in previous clinical studies. The detailed definitions of each covariate are shown in Supplementary material Tables S1 and S2. Meanwhile, a directed acyclic graph illustrating the assumed causal structure and rationale for covariate selection is presented in Supplementary Fig. S1.

2.6. Statistical analysis

The baseline characteristics of patients and hospitals with and without certified nurses and/or certified nurse specialists assigned to emergency departments were compared. Continuous variables were summarized as means with standard deviations, whereas categorical variables were presented as proportions.

We performed multivariable logistic regression for in-hospital mortality and multivariable linear regression for length of hospital stay to evaluate associations between the presence of certified nurses and/or certified nurse specialists in emergency departments and study outcomes. Considering the heterogeneity of clinical contexts, the analyses were stratified by International Classification of Diseases, 10th Revision major diagnostic categories of the admission-precipitating diagnosis. Within each diagnostic stratum, the models were adjusted for all patient- and hospital-level covariates and International Classification of Diseases, 10th Revision subcategories (e.g., J00–J06, J09–J18, J20–J39,

J40–J47, J60–J70, and J80–J99 for respiratory diseases and U for coronavirus disease 2019; the full lists are provided in Supplementary material Table S3). Generalized estimating equations with an exchangeable working correlation structure and robust standard errors were applied to account for clustering within hospitals (Hanley et al., 2003). Multiple imputation with chained equations was used to address missing data for smoking status (12.5%), body mass index (10.6%), and activities of daily living on admission (10.5%) (Rubin, 1996; Morita, 2021).

Finally, because heterogeneity was expected to exist across diagnostic categories, random effects meta-analysis was used to synthesize results across International Classification of Diseases, 10th Revision major diagnostic categories in order to derive an overall pooled estimate.

2.7. Sensitivity analysis

Three sensitivity analyses were performed to assess the primary findings' robustness. First, multivariable regression analyses including patients who died within 24 h of admission were repeated. Second, multivariable regression models including diagnostic categories that were excluded in the main analysis (e.g., diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism [D50–D89]; diseases of the musculoskeletal system and connective tissue [M00–M99]; and symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified [R00–R99]) were reestimated. For the latter, diagnostic categories with extremely low death events were not analyzed because such strata would yield unstable and uninterpretable estimates. These categories included mental and behavioral disorders (<20 death cases [1%]); diseases of the nervous system (<90 death cases [0.9%]); diseases of the eye and adnexa (<10 death cases [0.06%]); diseases of the ear and mastoid process (<10 death cases [0.06%]); diseases of the skin and subcutaneous tissue (<80 death cases [0.9%]); pregnancy, childbirth, and puerperium (0 death cases [0%]); certain conditions originating in the perinatal period (0 death cases [0%]); congenital malformations, deformations, and chromosomal abnormalities (<10 death cases [0.83%]); external causes of morbidity and mortality (0 death cases [0%]); and factors influencing health status and contact with health services (0 death cases [0%]). Third, the association between the presence of certified nurses and/or certified nurse specialists in emergency departments and 30-day readmission was also examined as an exploratory sensitivity outcome. This analysis was restricted to patients who were discharged alive.

2.8. Ethical approval

The study protocol was approved by the Research Ethics Committee of the University of Tokyo (approval number: 3501-5) and performed in accordance with the principles of the Declaration of Helsinki. The requirement for patient informed consent was waived because of the use of anonymized administrative data. Approval for use of hospital-level data on certified nurse/certified nurse specialist staffing was separately obtained from the Research Ethics Committee of the Japanese Nursing Association.

All data were deidentified before analysis, and no individual patient could be identified. Access, storage, and analysis of data were performed under secure environments to ensure confidentiality and integrity of data.

3. Results

The final analysis included 440,420 patients from 1012 hospitals (Fig. 1). Among hospitals, 251 (24.8%) reported the presence of certified nurses and/or certified nurse specialists in their emergency departments. Overall, 177,596 patients (40.3%) were admitted to hospitals with certified nurses and/or certified nurse specialists assigned to emergency departments.

3.1. Characteristics of patients

The patient-level characteristics are presented in Table 1. Patients who were admitted to hospitals with certified nurses and/or certified nurse specialists were, on average, younger, more likely to be smokers, and more frequently admitted for circulatory system diseases (International Classification of Diseases, 10th Revision codes I00–I99) than those who were admitted to hospitals without certified nurses and/or certified nurse specialists. Conversely, they had a lower prevalence of respiratory diseases, including coronavirus disease 2019 (International Classification of Diseases, 10th Revision codes J00–J99 and U codes). No clinically meaningful differences were observed in other baseline characteristics. The International Classification of Diseases, 10th Revision subcategories used within each major diagnostic category for stratified analyses are provided in Supplementary material Table S3.

3.2. Characteristics of hospitals

The hospital-level characteristics are summarized in Table 2. Hospitals with certified nurses and/or certified nurse specialists in the emergency departments were more frequently academic institutions, provided tertiary emergency care, had intensive care unit capabilities,

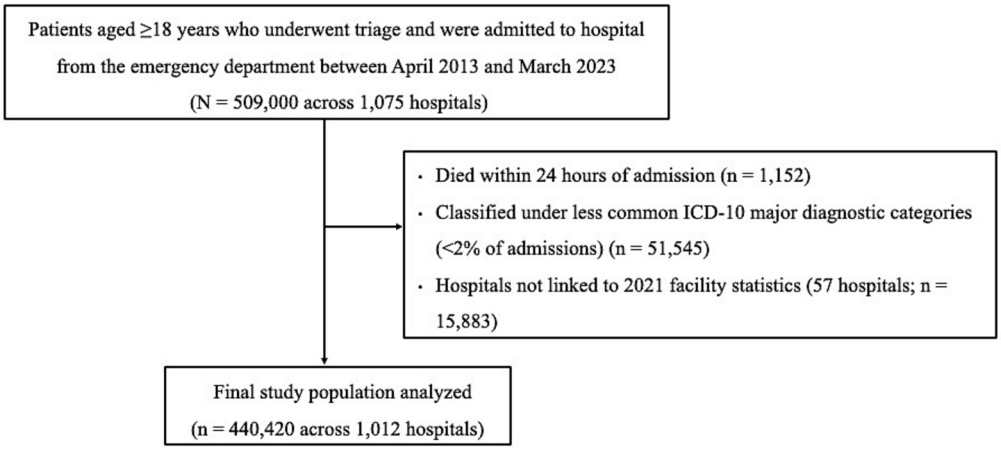

Fig. 1. Flowchart showing the patient inclusion and exclusion criteria.

Table 1
Characteristics of patients in hospitals with or without CNs and/or CNSs in the ED.

		All patients (n = 440,420)		Patients in hospitals without CNs/CNSs (n = 262,824)		Patients in hospitals with CNs/CNSs (n = 177,596)	
Age, mean (SD)		64.6	(21.2)	65.5	(21.3)	63.4	(21.1)
Male sex, n (%)		229,279	(52.1)	134,831	(51.3)	94,448	(53.2)
Smoking status, n (%)	Nonsmoker	259,961	(59.0)	161,434	(61.4)	98,527	(55.5)
	Current/past smoker	125,430	(28.5)	71,132	(27.1)	54,298	(30.6)
	Missing	55,029	(12.5)	30,258	(11.5)	24,771	(13.9)
Consciousness level, n (%)†	Alert	380,068	(86.3)	227,777	(86.7)	152,291	(85.8)
	Dizziness	51,786	(11.8)	29,839	(11.4)	21,947	(12.4)
	Somnolence/coma	8566	(1.9)	5208	(2.0)	3358	(1.9)
Body mass index, n (%)†	<18.5	59,437	(13.5)	38,045	(14.5)	21,392	(12.0)
	18.5–24.9	238,128	(54.1)	143,272	(54.5)	94,856	(53.4)
	25.0–29.9	75,925	(17.2)	44,596	(17.0)	31,329	(17.6)
	≥30.0	20,225	(4.6)	11,748	(4.5)	8477	(4.8)
	Missing	46,705	(10.6)	25,163	(9.6)	21,542	(12.1)
Activities of daily living, n (%)†	Independent	207,902	(47.2)	127,673	(48.6)	80,229	(45.2)
	Partial assistance	110,613	(25.1)	63,544	(24.2)	47,069	(26.5)
	Total assistance	75,738	(17.2)	46,320	(17.6)	29,418	(16.6)
	Missing	46,167	(10.5)	25,287	(9.6)	20,880	(11.8)
Charlson comorbidity index, n (%)	0	307,714	(69.9)	180,062	(68.5)	127,652	(71.9)
	1–2	102,650	(23.3)	63,151	(24.0)	39,499	(22.2)
	≥3	30,056	(6.8)	19,611	(7.5)	10,445	(5.9)
Admission-precipitating diagnosis, n (%)	Certain infectious and parasitic diseases	22,633	(5.1)	14,505	(5.5)	8128	(4.6)
	Neoplasms	18,397	(4.2)	10,957	(4.2)	7440	(4.2)
	Endocrine, nutritional, and metabolic diseases	11,783	(2.7)	7583	(2.9)	4200	(2.4)
	Diseases of the circulatory system	76,176	(17.3)	40,910	(15.6)	35,266	(19.9)
	Diseases of the respiratory system (including COVID-19)	92,008	(20.9)	60,375	(23.0)	31,633	(17.8)
	Diseases of the digestive system	137,828	(31.3)	80,044	(30.5)	57,784	(32.5)
	Diseases of the genitourinary system	31,880	(7.2)	19,800	(7.5)	12,080	(6.8)
	Injury, poisoning, and certain other consequences of external causes	49,715	(11.3)	28,650	(10.9)	21,065	(11.9)
Season	Spring (Mar–May)	108,472	(24.6)	64,117	(24.4)	44,355	(25.0)
	Summer (Jun–Aug)	119,761	(27.2)	71,709	(27.3)	48,052	(27.1)
	Autumn (Sep–Nov)	109,364	(24.8)	65,119	(24.8)	44,245	(24.9)
	Winter (Dec–Feb)	102,823	(23.3)	61,879	(23.5)	40,944	(23.1)
Fiscal year	2013	29,452	(6.7)	18,770	(7.1)	10,682	(6.0)
	2014	35,208	(8.0)	22,870	(8.7)	12,338	(6.9)
	2015	33,884	(7.7)	21,998	(8.4)	11,886	(6.7)
	2016	39,953	(9.1)	23,211	(8.8)	16,742	(9.4)
	2017	40,487	(9.2)	22,814	(8.7)	17,673	(10.0)
	2018	44,919	(10.2)	24,109	(9.2)	20,810	(11.7)
	2019	44,299	(10.1)	21,803	(8.3)	22,496	(12.7)
	2020	85,112	(19.3)	54,068	(20.6)	31,044	(17.5)
	2021	55,140	(12.5)	32,379	(12.3)	22,761	(12.8)
	2022	31,966	(7.3)	20,802	(7.9)	11,164	(6.3)

Abbreviations: CN, certified nurse; CNS, certified nurse specialist; ED, emergency department; SD, standard deviation; COVID-19, coronavirus disease 2019. †Measured on admission. Detailed definitions of each covariate are provided in Supplementary material Table S1.

and maintained larger bed capacities than those without certified nurses and/or certified nurse specialists. In addition, these hospitals reported higher annual ambulance acceptance volumes and were more commonly located in urban settings. With respect to staffing, hospitals with certified nurses and/or certified nurse specialists had higher physician-to-bed ratios, a greater proportion of registered nurses among inpatient staff, and lower patient-to-nurse ratios in general wards than those without.

3.3. Primary analyses

The unadjusted proportion of in-hospital mortality was 2.2% among patients admitted to hospitals with certified nurses and/or certified nurse specialists and 3.1% among those admitted to hospitals without certified nurses and/or certified nurse specialists. Similarly, hospitals with certified nurses and/or certified nurse specialists had a shorter mean length of hospital stay (13.4 days) than those without (15.5 days).

After adjusting for patient- and hospital-level covariates, analyses stratified by International Classification of Diseases, 10th Revision major diagnostic categories demonstrated significantly lower in-hospital mortality in hospitals with certified nurses and/or certified nurse specialists for two diagnostic categories: certain infectious and parasitic diseases (adjusted odds ratio, 0.57; 95% confidence interval, 0.38–0.84) and endocrine, nutritional, and metabolic diseases (adjusted odds ratio, 0.65; 95% confidence interval, 0.45–0.94) (Fig. 2A). In the pooled meta-analysis across all International Classification of Diseases, 10th Revision categories, patients admitted to hospitals with certified nurses and/or certified nurse specialists tended to have lower in-hospital mortality than those admitted to hospitals without certified nurses and/or certified nurse specialists. However, this did not reach statistical significance (pooled adjusted odds ratio, 0.88; 95% confidence interval, 0.77–1.01; $I^2 = 54.5\%$) (Fig. 2A).

With respect to length of stay, stratified analyses showed that patients admitted for endocrine, nutritional, and metabolic diseases had significantly shorter length of stay in hospitals with certified nurses and/or certified nurse specialists (mean difference, −1.64 days; 95% confidence interval, −3.12 to −0.15). However, no significant association was observed between the presence of certified nurses and/or certified nurse specialists and length of stay in the pooled analysis across all diagnostic categories (overall mean difference, −0.05 days; 95% confidence interval, −0.17 to 0.08; $I^2 = 12.3\%$) (Fig. 2B).

The full results from the multivariable regression models for each International Classification of Diseases, 10th Revision major diagnostic category are summarized in Supplementary material Table S4.

Table 2
Characteristics of hospitals with or without CNs and/or CNSs in the ED.

	All hospitals (n = 1012)		Hospitals without CNs/CNSs (n = 761)		Hospitals with CNs/CNSs (n = 251)		*p*
Academic hospitals, n (%)	56	(5.5)	17	(2.2)	39	(15.5)	<0.001
Tertiary care centers, n (%)	237	(23.4)	23	(3.0)	214	(85.3)	<0.001
Secondary care centers, n (%)	722	(71.3)	687	(90.3)	35	(13.9)	<0.001
Intensive care unit availability, n (%)	419	(41.4)	204	(26.8)	215	(85.7)	<0.001
Discharge planning department capabilities, n (%)	1005	(99.3)	756	(99.3)	249	(99.2)	0.82
Number of physicians per 100 beds, mean (SD)	25.7	(15.7)	21.4	(12.1)	38.7	(18.0)	<0.001
Percentage of registered nurses in inpatient settings, mean (SD)	97.5	(4.7)	96.8	(5.1)	99.5	(1.3)	<0.001
Patient-to-nurse ratio per shift, mean (SD)	5.6	(2.0)	6.0	(2.0)	4.5	(1.0)	<0.001
Number of beds, n (%)							<0.001
≤250	312	(30.8)	309	(40.6)	3	(1.2)	
251–500	469	(46.3)	381	(50.1)	88	(35.1)	
≥501	231	(22.8)	71	(9.3)	160	(63.7)	
Annual ambulance acceptances, n (%)							<0.001
≤1000	249	(24.6)	242	(31.8)	7	(2.8)	
1001–1999	192	(19.0)	177	(23.3)	15	(6.0)	
2000–2999	189	(18.7)	155	(20.4)	34	(13.5)	
≥3000	382	(37.7)	187	(24.6)	195	(77.7)	
Rurality							0.026
Urban	403	(39.8)	298	(39.2)	105	(41.8)	
Intermediate	483	(47.7)	356	(46.8)	127	(50.6)	
Rural	126	(12.5)	107	(14.1)	19	(7.6)	

Abbreviations: CN, certified nurse; CNS, certified nurse specialist; ED, emergency department; SD, standard deviation. Detailed definitions of covariates are provided in Supplementary material Table S2.

3.4. Sensitivity analyses

The results of sensitivity analyses were consistent with the main findings. The forest plots of subgroup-specific and pooled estimates are provided in Supplementary Figs. S2 (sensitivity analysis 1) and S3 (sensitivity analysis 2). Moreover, 30-day readmission was examined in an exploratory sensitivity analysis, and no clear association was observed (Supplementary Fig. S4).

4. Discussion

4.1. Interpretation of results

This nationwide cohort study examined the association between the presence of certified nurses and/or certified nurse specialists (advanced nursing roles in Japan) in emergency departments and outcomes of patients admitted to hospitals following triage. Overall, the presence of certified nurses and/or certified nurse specialists was not significantly associated with reductions in in-hospital mortality and length of stay across the entire study population. Similarly, 30-day readmission as an exploratory outcome showed no clear association. However, stratified analyses revealed significant benefits in selected diagnostic groups. Specifically, hospitals with certified nurses and/or certified nurse specialists demonstrated lower in-hospital mortality among patients with infectious and parasitic diseases and endocrine, nutritional, and metabolic disorders. In addition, the length of stay was reduced among patients with endocrine, nutritional, and metabolic disorders. Furthermore, although the pooled estimate of mortality across all diagnostic categories did not reach statistical significance, the confidence interval was narrowly above the null value. This finding suggests a potential clinical relevance that warrants further investigation although it should be interpreted as exploratory rather than confirmatory.

4.2. Comparison with previous studies

The findings of the present study align with those of previous research suggesting that the presence of advanced practice nurses in emergency departments may be associated with better patient outcomes. Nevertheless, much of the existing evidence has been synthesized from studies involving diverse advanced practice nursing roles (e.g., nurse practitioners, clinical nurse specialists in the United States, and other advanced practice models) despite considerable variation in definitions and scope of practice across settings (Woo et al., 2017; Horvath et al., 2023; Denke et al., 2024). Notably, nurse practitioners typically hold prescriptive authority and directly participate in diagnostic and treatment decisions, which substantially distinguishes their role from that of certified nurses and certified nurse specialists in Japan.

Importantly, the present study represents one of the first large-scale investigations to specifically assess the impact of certified nurses and certified nurse specialists on patient outcomes in Japanese emergency departments, where advanced practice nurses have no prescriptive and diagnostic authority. Considering the increasing global interest in integrating advanced nursing roles into emergency care (Nashwan et al., 2024), our findings provide timely and relevant evidence regarding the potential value of nonprescriptive and nondiagnostic advanced practice nurse models for healthcare systems with comparable nursing frameworks.

4.3. Possible explanation and implications

Several factors may account for the observed findings. In the present study, the presence of certified nurses and/or certified nurse specialists in emergency departments was associated with reduced in-hospital mortality only for patients with infectious and parasitic diseases and those with endocrine, nutritional, and metabolic diseases. One explanation for this finding may be the widespread use of standardized emergency care protocols. For example, emergency physicians typically direct trauma management following the principles of Advanced Trauma Life Support, which may minimize the influence of nurse staffing on outcomes. Similarly, the contribution of certified nurses and/or certified nurse specialists may be comparatively limited for conditions characterized by well-defined clinical presentations and established treatment pathways, including fractures, acute myocardial infarction, stroke, respiratory diseases, and gastrointestinal disorders. By contrast, the involvement of certified nurses and/or certified nurse specialists may be particularly consequential for conditions that require more nuanced clinical judgment, including sepsis, diabetic ketoacidosis, or adrenal crisis. These conditions often present with nonspecific or atypical symptoms, making early recognition difficult. In such cases, the

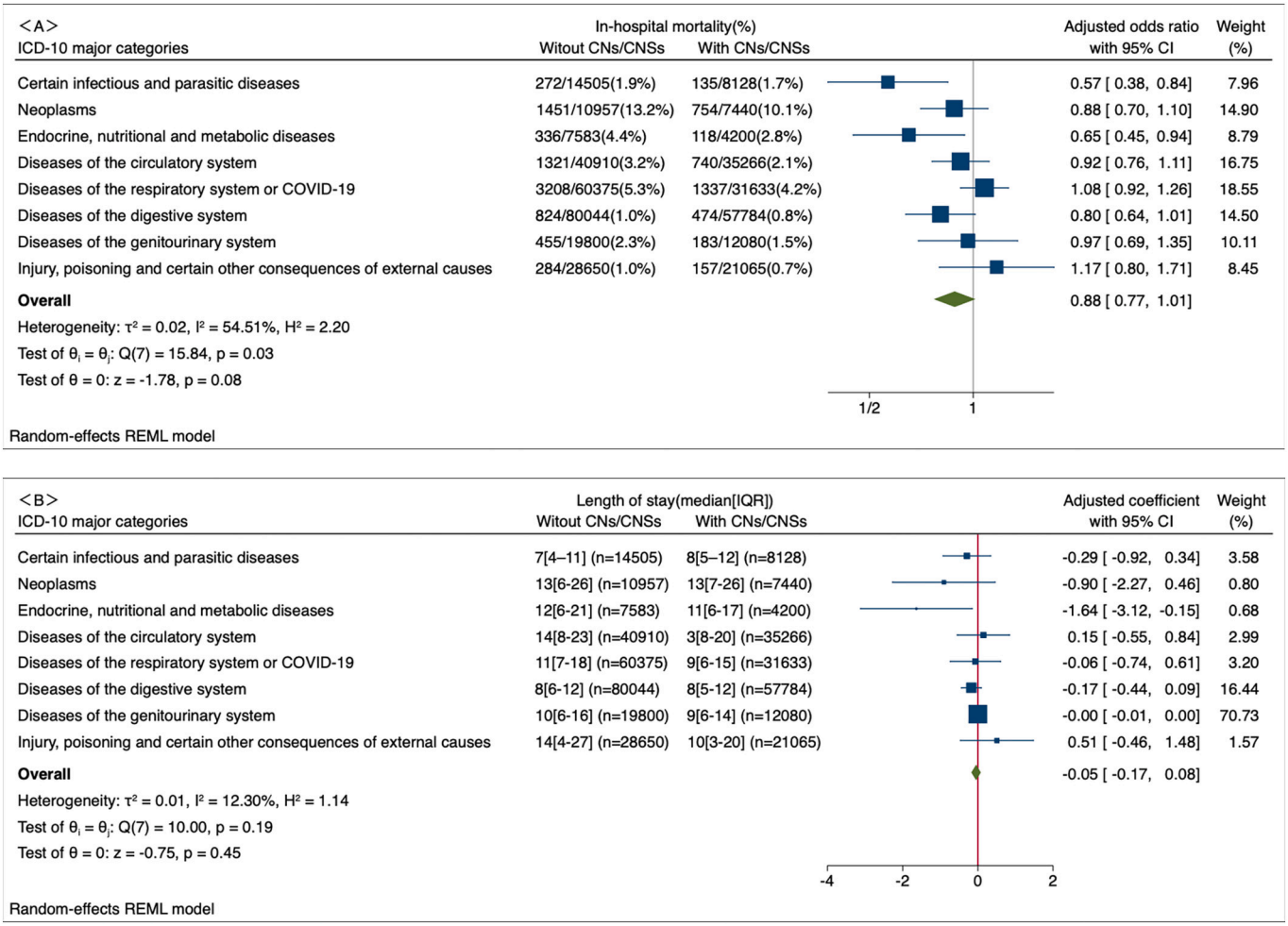

Fig. 2. Pooled adjusted odds ratios for in-hospital mortality (A) and pooled effect sizes for length of hospital stay (B) associated with the presence of certified nurses and/or certified nurse specialists in emergency departments.
Multivariable regression analyses were conducted for each ICD-10 major diagnostic category with adjustment for patient- and hospital-level characteristics. The adjusted estimates from each category were synthesized using a random effects meta-analysis with the REML method.
Abbreviations: CI, confidence interval; CNs, certified nurses; CNSs, certified nurse specialists; ICD-10, International Classification of Diseases, 10th Revision; IQR, Interquartile range; REML, restricted maximum likelihood.

observational skills, systematic triage practices, and reassessment competencies of certified nurses and certified nurse specialists may facilitate the detection of early signs of deterioration and enable timely escalation of care, thereby improving patient outcomes.

Of note, hospitals with certified nurses and/or certified nurse specialists substantially differed from those without in terms of structural characteristics. Nevertheless, significant associations were observed even after adjusting for these institutional differences, supporting a potential independent contribution of certified nurses and certified nurse specialists within specific diagnostic categories. Meanwhile, the pooled estimates for overall in-hospital mortality and length of stay did not achieve statistical significance. However, the upper bound of the confidence interval for mortality was close to 1 (pooled adjusted odds ratio, 0.88; 95% confidence interval, 0.77–1.01), suggesting the possibility of a clinically relevant effect that could not be excluded. Heterogeneity in effect sizes across different diagnostic groups may have diluted the overall association and contributed to the lack of statistical significance in the pooled analysis. Consistent with this overall pattern, the exploratory analysis of 30-day readmission also showed no clear association. According to a previous study, hospital stays are substantially longer in Japan than in other high-income countries (Papanicolas et al., 2018), and patients are usually discharged after complete recovery. Therefore, early readmission opportunities are inherently limited.

Unlike previous studies that evaluated emergency department patients as a single cohort, we stratified patients according to International Classification of Diseases, 10th Revision major diagnostic categories and used a meta-analytic framework to synthesize the findings. This approach enabled us to account for clinical heterogeneity and determine whether the association between the presence of certified nurses and/or certified nurse specialists in emergency departments and patient outcomes varied across diagnostic groups. Such stratification provides more nuanced insights and enhances the findings' clinical applicability. The Japanese certified nurse and certified nurse specialist system was originally based on the clinical nurse specialist role in the United States, which has shown effectiveness in emergency care across multiple domains, including direct patient care, development of nursing practice, and system-level improvements (Wolf et al., 2023; Miller et al., 2024). Although Japanese certified nurses and certified nurse specialists do not hold prescriptive and diagnostic authority, their contributions may nonetheless be associated with improved patient outcomes through advanced observation, structured triage, staff supervision, and interprofessional care coordination. These responsibilities are closely aligned with the established core competencies of clinical nurse specialists working in emergency departments, suggesting that even non-prescriptive advanced practice nurse models may yield measurable benefits within emergency care systems. These findings can be used to

inform workforce planning, especially the deployment of certified nurses/certified nurse specialists to roles focusing on triage and early assessment of conditions requiring rapid recognition, and guide the integration of advanced practice nursing roles in emergency departments in Japan and in systems with similar nursing structures. Although the present findings reflect the Japanese context, they may also help to clarify, in a global context, which advanced practice components (e.g., expert assessment, coordination, and leadership) can be transferred across systems with different healthcare systems. Therefore, our results complement previous research findings from countries where advanced practice nurses hold prescriptive and diagnostic authority by highlighting the contribution of nonprescriptive and diagnostic models.

4.4. Limitations

This study has several limitations that should be acknowledged. First, as with any observational design, the possibility of residual confounding cannot be eliminated. To mitigate this issue, we adjusted for a comprehensive set of patient- and hospital-level characteristics in multivariable analyses and used generalized estimating equations to account for clustering within hospitals. In particular, these adjustments addressed the substantial differences between hospitals with certified nurses and/or certified nurse specialists and those without them, especially in structural characteristics and other nursing-related factors. Regarding patient-level factors, the likelihood of significant bias was reduced by focusing on walk-in patients (those not transported by ambulance) who were unlikely to select hospitals on the basis of clinical severity. Moreover, the baseline characteristics of patients differed only modestly between hospitals with and without certified nurses and/or certified nurse specialists (Table 1). This finding suggests that selection bias based on patient acuity was limited. At the facility level, confounding was minimized by adjusting for detailed hospital structure and staffing characteristics and accounting for within-hospital correlation using generalized estimating equations. Furthermore, the presence of certified nurses/certified nurse specialists was defined at the hospital–year level, allowing the same hospital to contribute patients to both groups in different fiscal years. This time-varying specification helped to control for time-invariant hospital attributes and likely attenuated differences toward the null. We calculated the E-values for statistically significant subgroup results to assess the robustness of the observed associations to potential unmeasured confounding (VanderWeele and Ding, 2017). For the group of certain infectious and parasitic diseases, the observed association could be explained by an unmeasured confounder associated with the presence of certified nurses and/or certified nurse specialists and mortality by a risk ratio of at least 2.9 each. For the groups of endocrine, nutritional, and metabolic diseases, the corresponding value was 2.45. These values suggest that relatively strong unmeasured confounding would be needed to fully account for the observed effects. In addition, the choice of covariates and the categorization of continuous variables may influence regression estimates.

Second, data regarding the specific triage systems implemented at each hospital or the presence of structured educational programs (e.g., training in the Japan Triage and Acuity Scale, which was adapted from the Canadian Triage and Acuity Scale for the Japanese setting) were not available. In addition, variability in diagnostic testing capabilities may have influenced outcomes. However, advanced diagnostic equipment, including computed tomography, is widely accessible in Japan regardless of the hospital type or location. Moreover, Japan has the highest per capita availability of computed tomography scanners among the Organization for Economic Cooperation and Development nations (Aoyama et al., 2025). Therefore, it is unlikely that variation in diagnostic capacity substantially biased our findings.

Third, whether certified nurses and/or certified nurse specialists personally performed triage in the emergency department, even when assigned to these units, could not be confirmed. Nonetheless, approximately 90% of triage in Japanese emergency departments is reportedly performed by nurses (Ministry of Health, Labour and Welfare of Japan, 2022). In hospitals with certified nurses and/or certified nurse specialists, these staff members likely contributed to triage quality indirectly through supervision, training, and protocol implementation, thereby enhancing the performance of other nurses. Conversely, triage may have been performed by physicians, who are highly trained in emergency medicine, in hospitals without certified nurses and/or certified nurse specialists. This could have improved outcomes in the comparison group, potentially attenuating the observed differences and rendering our estimates conservative.

Fourth, reliance on administrative claims data precluded the evaluation of important process-related and patient-centered outcomes, including waiting times, timeliness of interventions, or patient satisfaction. In addition, admission to the intensive care unit could not be assessed because not all hospitals in the database have intensive care units, making this indicator not uniformly applicable. Future studies incorporating real-world data and patient-reported measures are needed to obtain a more comprehensive understanding of the contribution of advanced practice nurses to emergency care.

Finally, the study period included the coronavirus disease 2019 pandemic years, during which emergency department operations and patient case mix were substantially affected. Although the analysis adjusted for the fiscal year and included coronavirus disease 2019 as a diagnostic category, pandemic-related changes may still affect the comparability of our estimates. Therefore, caution should be exercised when generalizing the results to nonpandemic settings.

5. Conclusion

The presence of certified nurses and/or certified nurse specialists in emergency departments was associated with reduced in-hospital mortality within specific diagnostic categories. Although the overall pooled analysis did not achieve statistical significance, the point estimate for mortality suggested a potential beneficial effect that warrants further investigation.

Considering the substantial variation in the roles and scope of practice of advanced practice nurses internationally, these findings may help to clarify the contribution of advanced nursing roles in emergency departments where prescriptive and diagnostic authority is absent. While the results should be interpreted with caution, they suggest that certified nurses and certified nurse specialists may contribute to emergency care delivery within certain clinical contexts and may serve as a basis for future studies and ongoing discussions regarding the optimal deployment and integration of advanced nursing roles in emergency departments, both in Japan and healthcare systems with comparable nursing structures.

CRediT authorship contribution statement

Kojiro Morita: Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization, Visualization. **Gojiro Nakagami:** Writing – review & editing, Project administration, Funding acquisition, Conceptualization, Supervision. **Mari Ikeda:** Writing – review & editing, Supervision, Project administration. **Kenshi Hayashida:** Writing – review & editing, Supervision. **Tamaki Isobe:** Writing – review & editing, Data curation, Conceptualization. **Yoshie Takahashi:** Writing – review & editing, Data curation, Conceptualization. **Maho Inoue:** Writing – review & editing, Data curation, Conceptualization. **Junhua Zhang:** Writing – review & editing, Data curation, Conceptualization. **Yuichiro Matsuo:** Writing – review & editing, Resources, Data curation. **Hiroki Matsui:** Writing – review & editing, Software, Resources, Data curation. **Kiyohide Fushimi:** Writing – review & editing, Resources, Funding acquisition, Data curation. **Hideo Yasunaga:** Writing – review & editing, Supervision, Resources, Methodology, Funding acquisition, Data curation, Conceptualization.

Consent for publication

Not applicable.

Ethics approval and consent to participate

The study protocol was approved by the research ethics committees of the University of Tokyo (approval number: 3501-5) and Japanese Nursing Association. The requirement for patient informed consent was waived because only anonymized administrative data were used.

Declaration of Generative AI and AI-assisted technologies in the writing process

The authors used ChatGPT-4o (OpenAI) to assist with English proofreading during the preparation of this work. The authors reviewed and edited the content as needed and take full responsibility for the final content of the published article.

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Declaration of competing interest

This study was supported by a collaborative research fund from the Japanese Nursing Association, received by Dr. Gojiro Nakagami as the project leader. Following the project, Drs. Kenshi Hayashida, and Junhua Zhang hold academic positions in the Department of Nursing Data Science, a cooperative program between the University of Tokyo and the Japanese Nursing Association. Other authors received no direct financial support. The Japanese Nursing Association had no role in the design, conduct, analysis, or reporting of this study.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnurstu.2026.105371.

Data availability

The datasets analyzed in this study are not publicly available because of contractual agreements with the participating hospitals.

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