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Clinical paper

Prevalence, characteristics, and outcomes of suicide-related out-of-hospital cardiac arrest among patients committing self-harm and suicide-attempts in Japan: A nationwide registry study

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Abstract

Background: Suicide-related out-of-hospital cardiac arrest (OHCA) is characterized by extremely low survival rates and represents a considerable global public health concern. This study aimed to investigate the prevalence, characteristics, and outcomes of suicide-related OHCA.

Methods: This multicenter, retrospective cohort study is an analysis of data collected from the JAPAN Registry of Self-harm and Suicide Attempts. Patients were divided into two groups, the OHCA group and the non-OHCA group. The primary outcome was death at 30 days.

Results: Among 1,960 self-harm and suicide attempts patients, 213 patients (10.9 %) were assigned to the OHCA group and 1,747 (89.1%) were in the non-OHCA group.

Patients in the OHCA group were older (44 vs. 33 years old, $p < 0.001$), and the OHCA group had a higher proportion of males compared to the non-OHCA group (122 [57.3%] vs. 604 [34.6%], $p < 0.001$). Despite missing and unknown data, lower proportions of psychiatric consultation history (54 [30.8%] vs. 1177 [70.5%], $p < 0.001$), psychiatric hospitalization history (9 [5.1%] vs. 386 [23.1%], $p < 0.001$), and previous suicide attempts (16 [9.2%] vs. 807 [48.4%], $p < 0.001$) were observed in the OHCA group. Risk of death at 30 days was significantly higher in the OHCA group (200 [93.9%] vs. 31 [1.8%], $p < 0.001$).

Conclusion: Suicide-related OHCA was rare and associated with poorer prognosis compared to patients without OHCA. It was more common in middle-aged men without a history of psychiatric care or prior suicide attempts, although the study was limited by missing data.

Keywords: Suicide, Cardiac arrest, Self-harm, Out-of-hospital cardiac arrest

Background

Suicide encompasses a spectrum of severity, ranging from vague thoughts about the lack of meaning in life to active ideation, detailed planning, attempts, and, ultimately, completion resulting in cardiac arrest.[1] Suicide is a major worldwide public health issue. Globally, nearly one million people die by suicide every year.[2] In Japan, approximately 20,000 people take their own lives annually.[3] Japan has one of the highest suicide rates among Organization for Economic Co-operation and Development countries in 2020, ranking third (16.1 per 100,000 people), with Korea having the highest rate (24.1 per 100,000), and a higher rate than the US (14.1 per 100,000)[4]. Although most self-harm and suicide attempts are

Abbreviations: CI, confidence interval, IQR, interquartile range, JA-RSA, JAPAN Registry of Self-harm and Suicide Attempts, OHCA, out-of-hospital cardiac arrest, RR, risk ratio

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nonfatal, suicide-related out-of-hospital cardiac arrest (OHCA) represents a terminal phase of a self-harm or suicide attempt. In general, patients admitted to the intensive care unit following hanging have favorable survival rates and neurological outcomes if asphyxia does not progress to cardiac arrest, whereas those who experience cardiac arrest typically have poor neurological outcomes.[5]

Considering the extremely high mortality risk associated with suicide-related OHCA, further research in this area is urgently needed. However, most studies in Japan have focused on nonfatal suicide attempts.[6–7] Among the limited studies investigating suicide-related OHCA, many have centered on specific methods[8] or particular populations.[9] Moreover, research in this field frequently exhibits notable regional biases, with a disproportionate concentration of studies originating from a limited number of specific countries,[10–11] thereby restricting the applicability of these findings to Japan.

The identification of individuals with characteristics of suicide-related OHCA is needed, although research in this area remains limited and require further investigation. Since 2022, the JAPAN Registry of Self-harm and Suicide Attempts (JA-RSA), the first and large-scale self-harm and suicide attempt registry system in Japan, has systematically collected data on self-harm and suicide attempts, including suicide-related OHCA. This unique registry provides a valuable opportunity to comprehensively investigate the risk factors and prognosis associated with suicide-related OHCA in Japan.

Therefore, this study aimed to investigate the prevalence, characteristics, and outcomes of suicide-related OHCA using data from the JA-RSA.

Methods

Study design

This study used data from the JA-RSA, which was registered in the Japan Registry of Clinical Trials as jRCT1030220570 and managed by the Japan Suicide Countermeasures Promotion Center and the Japanese Society for Emergency Medicine. This registry is the first and large-scale self-harm and suicide attempt registry system in Japan, aimed at establishing a system to register and collect information on self-harm and suicide attempt patients in Japan. This retrospective multicenter cohort study was conducted using JA-RSA database. As of December 31, 2023, 57 emergency and critical care centers in Japan participated in this registry, providing comprehensive nationwide coverage, with institutions from half of the country's prefectures included (Supplement 1). All self-harm and suicide attempt patients were registered in the JA-RSA at each participating hospital, regardless of their method of arrival, such as walk-in visit, ambulance transport, or physician-staffed ground emergency medical service. The registry systematically documented the methods of self-harm or suicide attempts, including hanging, overdose, charcoal burning, jumping, and sharp instruments, as well as other methods such as poison gas inhalation, self-immolation, gunshot, and drowning. Self-harm or suicide attempts involving multiple methods were documented with multiple responses. In all participating institutions, the requirement for patient consent was waived due to the retrospective nature of the study. Our study was approved by the Okayama University Hospital Ethics Committee (K2405-045).

Study population and endpoint

The inclusion criteria encompassed all self-harm and suicide attempt patients who visited any of the 57 participating hospitals between December 2022 and December 2023 and were registered in the JA-RSA. Patients for whom OHCA could not be confirmed, resulting in missing OHCA data, were excluded from the analysis. The primary outcome of the study was death at 30 days. We categorized patients into two groups based on the presence or absence of OHCA. The OHCA group included patients who experienced suicide-related OHCA at the scene or during ambulance transport and received cardiopulmonary resuscitation, without obvious signs of death at the scene, such as decomposition, incineration, or rigor mortis. The non-OHCA group comprised patients with self-harm and suicide attempts who did not experience OHCA. Secondary outcomes included death on arrival.

Data collection

The following patient data were collected from the JA-RSA: patient characteristics (age, sex, nationality, work, presence of psychiatric consultation history prior to suicide, presence of psychiatric hospitalization prior to suicide, and presence of history of previous suicide attempts), time course (day of suicide attempt (weekday or weekend), timing of suicide attempt (daytime [AM6:00 to PM6:00] or night-time [PM6:00-AM6:00]), suicide location, suicide method, and patient outcome (death on arrival and death at 30 days). All information, including 30-day mortality was determined by investigators at each institution using hospital medical records or telephone interviews with the patient, a surrogate, or the physician in charge at the receiving hospital.

Statistical analysis

Continuous variables were described using medians with interquartile ranges (IQR). Categorical variables were described using numbers and percentages. Comparisons between two groups were made using the Mann-Whitney U Test for continuous variables and the chi-square test for categorical variables. Missing data were calculated as a proportion of the total cohort. For variables with available responses, analyses were conducted using complete-case analysis, excluding cases with missing data. Multivariable analysis was conducted using Poisson regression with robust error variance to examine the association between suicide-related OHCA and outcomes, estimating risk ratios (RRs) with 95% confidence intervals (CIs). We first estimated crude RRs and then adjusted RRs, controlling for age (0–17, 18–59, or $\geq$60 years), sex, date of suicide attempt (weekday or weekend), timing of suicide attempt (daytime or nighttime), suicide method (hanging, overdose, charcoal burning, jumping, sharp instruments, other, unknown), location (home, skyscraper, healthcare facility, workplace, other), employment status (employed, unemployed, student, unknown), prior psychiatric consultation, and history of previous suicide attempts. These clinical confounders were selected based on previous literature and our clinical interests.[10–14]

All tests were two-tailed with $p < 0.05$ considered statistically significant. The analyses were performed using Stata SE version 18 statistical software (Stata-Corp LP, College Station, TX, USA).

Results

Patient population

The JA-RSA registry enrolled 1,987 self-harm and suicide attempt patients over a one-year period. After excluding patients with missing OHCA data ($n = 27$) (Supplement 2), 1,960 patients were included in the study analysis. Ultimately, 213 patients (10.9%) had an OHCA (OHCA group) and 1,747 (89.1%) did not have an OHCA (non-OHCA group).

Patient characteristics

The clinical and demographic characteristics of the study cohort are listed in Table 1. The OHCA group was older (44 vs. 33 years old) and had a higher percentage of male patients than the non-OHCA group (122 [57.3%] vs. 604 [34.6%]). Among the OHCA group, although more than half of the individuals had unknown employment status, the most common employment statuses were unemployed, followed by employed, and then student. The presence of psychiatric consultation history prior to suicide (54 [30.8%] vs. 1,177 [70.5%]), presence of psychiatric hospitalization prior to suicide (9 [5.1%] vs. 386 [23.1%]), and presence of history of previous suicide attempts (16 [9.2%] vs. 807 [48.4%]) were lower in the OHCA group compared to the non-OHCA group. Missing data were more prevalent in OHCA group compared to the non-OHCA group. Specifically, the presence of psychiatric consultation history prior to suicide and the timing of suicide attempts were missing in over 20% of the overall cohort.

Table 2 shows baseline characteristics of suicide methods. Overdose was the most common method in the total cohort, but it was less frequent in the OHCA group compared to the non-OHCA group. Hanging was significantly more prevalent in the OHCA group compared to the non-OHCA group.

Overall, death at 30 days was confirmed in 231 patients (11.8%) and death on arrival was observed in 164 patients (8.5%). The risk of deaths at 30 days (200 [93.9%] vs. 31 [1.8%]) and death on arrival (153 [71.8%] vs. 11 [0.6%]) were higher in the OHCA group. In the non-OHCA group, 11 patients—8 from hanging, 2 from jumping, and 1 from sharp instruments—died after hospital arrival. However, the detailed cause of death was unknown. When adjusted for confounders, suicide-related OHCA had a significant impact on death at 30 days (adjusted RRs 30.0, 95% CIs 7.46 to 120.7) and death on arrival (adjusted RRs 65.3, 95% CIs 5.4 to 783.6) (Table 3).

Discussion

In this multicenter, retrospective cohort study of patients presenting with self-harm and suicide attempts, data were derived from a Japanese nationwide registry of patients transported to emergency critical care centers. Suicide-related OHCA accounted for a low proportion of all suicide attempts and self-harm cases. Hanging was more commonly chosen as a method in suicide-related OHCA. Suicide-related OHCA was more common among males, middle-aged individuals, those without prior psychiatric consultation, and those with no history of psychiatric hospitalization before the suicide attempt or previous suicide attempts. However, mental health-related variables exhibited a high rate of missing or unknown data, limiting their applicability across all cases. The outcomes for suicide-related OHCA were universally poor, highlighting the urgent need to identify risk factors that increase the likelihood of a suicide attempt resulting in OHCA.

Most self-harm and suicide attempts are not fatal, and the majority of patients who attempt suicide do not eventually die by suicide.[15] The prevalence of suicide-related OHCA was approximately 10% among self-harm and suicide attempt patients in our study. Although studies on the prevalence of suicide-related OHCA have been limited, prior similar studies in the US and Taiwan have described overall case fatality proportions ranging from 8.8% to 22%, results similar to those from our study.[16–18] Suicide cases where death is evident at the scene (e.g., decomposition, incineration, or rigor mortis) are not subject to resuscitation and are not transported in Japan. Therefore, we may have underestimated the true rate of suicide-related OHCA, as detailed information on these cases could not be obtained. Due to the lack of data on suicide-related OHCA patients who were not transported, further investigation is needed to identify their characteristics and provide appropriate support for this urgent issue.

The higher proportion of males in suicide-related OHCA observed in this study is consistent with other studies, while self-harm and suicide attempts were more common among females.[19,10–11] This notable gender disparity in suicidal behavior, characterized by a higher prevalence of nonfatal suicidal actions among females and a greater incidence of completed suicides among males, is often referred to as the “gender paradox” in suicidal behavior..[20] While the mechanisms underlying the gender paradox in suicide are not yet fully understood, suicide risk is thought to emerge from intricate interactions between neurobiological factors—such as neuroendocrine, neurochemical, and inflammatory processes—and life events, including stressful experiences like divorce, the loss of a loved one, or sudden unemployment..[21]

In this study, although various methods of self-harm and suicide attempts were analyzed, our findings demonstrated that hanging was the most prevalent method for suicide-related OHCA, consistent with studies from European countries.[22] A prior study in Japan focusing exclusively on hanging-induced OHCA and utilizing data from a nationwide population-based registry reported approximately 4,000 annual cases of hanging-induced OHCA, with significantly poor prognoses.[8] Furthermore, the incidence of hanging-induced OHCA among suicide-related OHCA has been reported to be increasing.[8,10] Similarly, hanging-induced OHCA was more common in males than females in the middle-aged populations.[23] Hanging may be a predominant method of suicide-related OHCA due to the widespread availability of ligatures and ligation points, which pose a significant challenge to means-restriction strategies, such as limited access to drugs for overdose. These findings highlight the need for suicide prevention strategies that extend beyond means restriction.

To prevent suicide among individuals at risk, it is essential to consider various risk factors and provide tailored support to individuals such as appropriate welfare and medical interventions. The 30-day mortality rate for suicide-related OHCA in our study is 93%, which is similar to that from other studies, including a mortality rate of 92% in Australia[11] and 95% in South Korea.[10] In particular, OHCA caused by hanging had a mortality rate of 97%.[24] Based on our study, the suicide-related OHCA is significantly associated with a worse prognosis compared to cases without OHCA. Therefore, it is crucial to implement comprehensive interventions and multidisciplinary collaboration before a suicide attempt occurs, particularly to prevent those that could lead to OHCA. However, little is known regarding those who die by suicide without ever receiving help. Our study revealed that among individuals attempting suicide or engaging in self-harm, those who lacked psychiatric consultation and had no prior history of suicide attempts or psychiatric hospitalization were more prevalent in the suicide-related OHCA group. How-

Table 1 – Characteristics of the study population.

	All (n = 1,960)	OHCA* (n = 213)	non-OHCA** (n = 1,747)	P value
Baseline Characteristics				
Age, median (IQR), y	34 (23–52)	44 (29–59)	33 (23–51)	<0.001
Age category, n (%)				<0.001
0–17	155 (7.9)	13 (6.1)	142 (8.1)	
18–59	1494 (76.2)	146 (68.9)	1348 (77.2)	
60-	310 (15.8)	53 (25.0)	257 (14.7)	
Missing data	1 (0.05)	1 (0.4)	0 (0)	
Sex, n (%)				<0.001
Male	726 (37.0)	122 (57.3)	604 (34.6)	
Female	1234 (63.0)	91 (42.7)	1143 (63.4)	
Nationality, n (%)				0.013
Japanese	1926 (98.4)	210 (98.6)	1716 (98.3)	
Non-Japanese	23 (1.2)	0 (0)	23 (1.3)	
Unknown	8 (0.4)	3 (1.4)	5 (0.3)	
Missing data	3 (0.1)	0 (0)	3 (0.2)	
Work, n (%)				<0.001
Employed	560 (28.6)	35 (16.4)	525 (30.2)	
Unemployed	737 (37.7)	40 (18.8)	697 (40.1)	
Student	236 (12.1)	20 (9.4)	216 (12.4)	
Unknown	419 (21.5)	118 (55.4)	301 (17.3)	
Missing data	8 (0.4)	0 (0)	8 (0.5)	
Presence of psychiatric consultation history prior to suicide, n (%)				<0.001
Yes	1231 (66.7)	54 (30.8)	1177 (70.5)	
No	449 (24.3)	45 (25.7)	404 (24.2)	
Unknown	164 (8.9)	76 (43.4)	88 (5.2)	
Missing data	116 (5.9)	38 (17.8)	78 (4.4)	
Presence of psychiatric hospitalization prior to suicide, n (%)				<0.001
Yes	395 (21.4)	9 (5.1)	386 (23.1)	
No	905 (49.2)	58 (33.1)	847 (50.9)	
Unknown	539 (29.3)	108 (61.7)	431 (25.9)	
Missing data	121 (6.1)	38 (17.8)	83 (4.7)	
Presence of history of previous suicide attempts, n (%)				<0.001
Yes	823 (44.7)	16 (9.2)	807 (48.4)	
No	604 (32.8)	48 (27.6)	556 (33.3)	
Unknown	412 (22.4)	110 (63.2)	302 (18.1)	
Missing data	121 (6.1)	39 (17.8)	82 (4.7)	
Day of suicide attempts, n (%)				0.670
Weekday	1391 (73.7)	144 (75.0)	1247 (73.6)	
Weekend	496 (26.3)	48 (25.0)	448 (26.4)	
Missing data	73 (3.7)	21 (9.8)	52 (2.9)	
Timing of suicide attempts, n (%)				0.002
Daytime	817 (53.8)	51 (40.8)	766 (54.9)	
Nighttime	702 (46.2)	74 (59.2)	628 (45.1)	
Missing data	8 (0.4%)	0 (0%)	8 (0.5%)	
	441 (22.5)	88 (41.3)	353 (20.2)	
Location, n (%)				<0.001
Home	1490 (77.7)	132 (63.7)	1358 (79.4)	
Skyscraper	22 (11.4)	13 (6.3)	9 (0.5)	
Healthcare facility	48 (2.5)	7 (3.4)	41 (2.4)	
Workplace	23 (1.2)	7 (3.4)	16 (0.9)	
Other	333 (17.4)	48 (23.2)	285 (16.7)	
Missing data	44 (2.2)	6 (2.8)	38 (2.1)	

Continuous variables are given as median (interquartile range, from 25th to 75th Percentiles). Categorical variables are given as count (percent). Comparisons between two groups were made using the Mann-Whitney U for continuous variables and chi-square test for categorical variables.

IQR, interquartile range; OHCA, out-of-hospital cardiac arrest.

Missing data were calculated as a proportion of the total cohort. For variables with available responses, analyses were conducted using complete-case analysis, excluding cases with missing data.

* OHCA is defined as patients experiencing suicide-related out-of-hospital cardiac arrest at the scene or during ambulance transport.

** non-OHCA is defined as patients with suicide attempts and self-harm who did not experience OHCA.

Table 2 – Suicide methods.

	All (n = 1960)	OHCA* (n = 213)	non-OHCA** (n = 1747)	P value
Suicide methods, n (%)[a]				
Hanging	212 (10.8)	118 (55.3)	94 (5.3)	<0.001
Overdose	1142 (58.3)	5 (2.3)	1137 (65.1)	<0.001
Charcoal burning	53 (2.7)	6 (2.8)	47 (2.6)	0.918
Jumping	237 (12.1)	65 (30.5)	172 (9.8)	<0.001
Sharp instruments	221 (11.2)	6 (2.8)	215 (12.3)	<0.001
Other [b]	164 (8.3)	14 (6.5)	150 (8.6)	0.313
Unknown	4 (0.2)	1 (0.4)	3 (0.1)	0.364

Categorical variables are given as count (percent). Comparisons between two groups were made using chi-square test for categorical variables.

OHCA, out-of-hospital cardiac arrest.

Missing data were calculated as a proportion of the total cohort. For variables with available responses, analyses were conducted using complete-case analysis, excluding cases with missing data.

* OHCA is defined as patients experiencing suicide-related out-of-hospital cardiac arrest at the scene or during ambulance transport.

** non-OHCA is defined as patients with suicide attempts and self-harm who did not experience OHCA.

[a] Of 1,960 participants, three (1.7%) were missing from the non-OHCA group.

[b] Suicide methods including poison gas inhalation, self-immolation, gunshot, or drowning.

Table 3 – Outcomes of study population.

	All (n = 1960)	OHCA* (n = 213)	non-OHCA** (n = 1747)	Risk Ratio (95% CI) Crude	P value	Risk Ratio (95% CI) Adjusted	P value
Outcome							
Death at 30 days, n (%)[a]	231 (11.8)	200 (93.9)	31 (1.8)	52.7 (37.1–74.8)	<0.001	30.0 (7.46–120.7)	<0.001
Death on arrival, n (%)[b]	164 (8.4)	153 (71.8)	11 (0.6)	113.6 (62.6–206.1)	<0.001	65.3 (5.4–783.6)	<0.001

Adjusted for age (age category: 0–17, 18–59, or 60-), sex, date of suicide attempt (weekday or weekend), timing of suicide attempt (daytime or nighttime), suicide method (hanging, overdose, charcoal burning, jumping, sharp instruments, other, unknown), location (home, skyscraper, healthcare facility, workplace, other), work (employed, unemployed, student, unknown), presence of psychiatric consultation prior to suicide, and presence of history of previous suicide attempts. CI: confidence interval, OHCA: out-of-hospital cardiac arrest.

Missing data were calculated as a proportion of the total cohort. For variables with available responses, analyses were conducted using complete-case analysis, excluding cases with missing data.

* OHCA is defined as patients experiencing suicide-related out-of-hospital cardiac arrest at the scene or during ambulance transport.

** non-OHCA is defined as patients with suicide attempts and self-harm who did not experience OHCA.

[a] Of 1,960 participants, six (0.3%) were missing from the non-OHCA group.

[b] Of 1,960 participants, six (0.3%) were missing from the non-OHCA group.

ever, a significant limitation of our study is the presence of more than 20% missing or unknown data regarding mental health variables, including prior psychiatric consultation and the timing of suicide attempts, in the total study population. These missing covariates can substantially impact the validity of analyses related to suicide-related OHCA. Bridging this data gap is essential to enhance the reliability of future research. It is generally recognized that a prior suicide attempt is one of the strongest predictors of suicide-related death; however, the opposite result observed in our study may be attributed to the large amount of missing data.[25] Nevertheless, our findings are consistent with certain aspects of previous research. For example, it has been reported that fewer than half of individuals who die by suicide had a previously identified mental health condition.[26] Furthermore, only one-third had seen a specialized mental health care provider in the year preceding their death.[27–28] Our findings underscore the need for further research to better understand the underlying mechanisms of suicide-related OHCA and to develop effective prevention strategies. Our findings indicate that future research should prioritize the enhancement of mental health data collection and the integration of comprehensive psychiatric assessments into emergency care settings to improve the identification of individuals at risk for suicide-related OHCA. Furthermore, additional studies are warranted to assess the efficacy of proactive screening programs and targeted mental health interventions in reducing the incidence of suicide-related OHCA and improving patient outcomes.

Limitations

The study had several limitations. First, this study was conducted as an analysis of data from a Japanese nationwide registry. Our findings may not be generalizable to other areas due to varying nationalities, patient characteristics, public health systems, and available mental health resources. However, a strength of this registry was that it had the largest sample size compared to those of previous suicide-related studies in Japan. Second, previous studies on OHCA utilize information based on Utstein elements,[29] such as circumstances, prehospital treatment, and outcomes. However, these elements could not be integrated due to the lack of a linkage between the JA-RSA registry and the Utstein registry. Third, in the OHCA group, a higher proportion of patients had unknown patient characteristics, primarily due to the high mortality rate among this group. Additionally, for individuals living alone or those who were single, obtaining relevant information was challenging. These factors may have contributed to an underestimation of the reported figures. Fourth, due to the retrospective design of the study, we must acknowledge that uncaptured clinical data, such as socioeconomic status, psychiatric disorders (e.g., schizophrenia, major depressive disorder, and bipo-

lar disorder), and educational background, may have influenced the factors contributing to suicide-related OHCA. Fifth, our registry does not distinguish between individuals who attempted suicide and those who engaged in self-harm, preventing a direct comparison of the mortality rate of suicide-related OHCA with that of suicide attempters. Furthermore, our registry does not include patients with self-harm and suicide attempts who do not seek medical treatment or consult other healthcare providers. Consequently, the rate of suicide-related OHCA in our study might be overestimated. Finally, neurological outcome factors, including Cerebral Performance Category score and long-term follow-up, were not investigated.

Conclusions

Among patients with self-harm and suicide attempts who presented to the hospital, this study found that the incidence of suicide-related OHCA in Japan was 10%. Suicide-related OHCA was more common among males, middle-aged individuals, those without prior psychiatric consultation, and those with no history of psychiatric hospitalization before the suicide attempt or previous suicide attempts. However, the substantial proportion of unknown data in our study may restrict its applicability to all cases.

Ethical approval and consent to participate

This study conforms to the principles outlined in the Declaration of Helsinki and was approved by the Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences and Okayama University Hospital Ethics Committee (ID: K2405-045). Patient consent was waived.

Consent for publication

Not applicable.

Authors' contributions

TH had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. TH wrote the first and subsequent drafts of the manuscript. TH, HN, MN, AI, TS, YK, and AN conceived and designed the study. TH, MN, HN, TY, YK, TY, TH, AI, TS, YK, and AN acquired and interpreted the data. TH, YY and TY analyzed the data. All authors reviewed and edited the manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the authors upon reasonable request.

CRediT authorship contribution statement

Takashi Hongo: Writing – review & editing, Supervision, Investigation, Formal analysis. **Tetsuya Yumoto:** Writing – review & editing, Investigation, Data curation. **Shunta Jinno:** Investigation, Data curation. **Yuka Yamamura:** Formal analysis. **Takafumi Obara:** Investigation. **Tsuyoshi Nojima:** Investigation. **Kohei Tsukahara:** Data curation. **Hiromichi Naito:** Writing – review & editing, Investigation, Data curation, Conceptualization. **Takashi Yorifuji:** Writing – review & editing, Supervision, Investigation, Formal analysis. **Atsunori Nakao:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2025.100923.

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