Original Article

Relationship between the depressive state of emergency life-saving technicians and near-misses

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Aim: A depressive state is a key risk factor for medical errors made by emergency life-saving technicians (ELSTs). However, no study has examined the occurrence of near-misses in ELSTs. We investigated the association between a depressive state and near-misses among ELSTs.

Methods: A cross-sectional study was undertaken in 345 ELSTs using an anonymous self-administered questionnaire. The main exposure was a depressive state that was measured using the Quick Inventory of Depressive Symptomatology. For the main outcome, near-miss events, we calculated odds ratios (OR) of depressive states, adjusted for age and work-related factors by multivariable logistic regression. For exploratory purposes, we also undertook secondary analyses to determine whether work-related factors were associated with a depressive state.

Results: We obtained 254 responses. Compared to ELSTs without a depressive state, the adjusted OR for near-misses among ELSTs with a mild depressive state was 3.14 (95% confidence interval [CI], 1.37–7.16; $P = 0.007$), and that among ELSTs with a moderate or greater depressive state was 5.29 (95% CI, 1.46–19.09; $P = 0.011$). For a depressive state, in the exploratory analyses, the OR of nap duration while on duty for less than 2 h was 3.34 (95% CI, 1.15–9.67; $P = 0.027$), that for irregular mealtime while on duty was 3.71 (95% CI, 2.00–6.86; $P < 0.001$), and that for a duration of desk work of 4 h or longer was 2.21 (95% CI, 1.15–4.25; $P = 0.017$).

Conclusion: A depressive state was significantly associated with the occurrence of near-misses among ELSTs. That a depressive state among ELSTs was related to nap duration and excessive office work indicates that improved management of the work environment and operations of ELSTs is necessary for the provision of safe emergency medical services.

Key words: Emergency life-saving technician, medical error, near-miss, paramedic, quick inventory of depressive symptomatology

INTRODUCTION

THE EMERGENCE OF super-aged societies is being accompanied by an increase in the number of emergency responses. In Japan, the number of emergency response teams dispatched increases every year. Compared to the 5,290,236 responses in 2007, there were 6,210,082 responses in 2016, an increase of approximately 1 million responses in 10 years. Moreover, the duration of individual responses is also increasing.[1]

In recent years, there have been reports of the occurrence of medical errors by emergency life-saving technicians (ELSTs) during emergency activities carried out without a physician's order, such as the incorrect insertion of a tracheal tube and administration of adrenaline, which can only be given under a physician's direction.[2–4] Although ELSTs often carry out these advanced life-support activities on site and in ambulances, these techniques are very risky for patients. Moreover, errors in emergency medical care, where

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medical practice is performed on patients in very unstable conditions, threaten patient safety.

Most studies on the prevention of medical errors or risk factors for medical errors have adopted approaches to examine the occurrence of near-miss events. According to the Occupational Safety and Health Act (United States), a near-miss refers to "an incident in which no property was damaged and no personal injury was sustained, but where, given a slight shift in time or position, damage or injury easily could have occurred."

Previous reports that examined near-misses in health-care professionals investigated associations between stress in nurses and the occurrence of medical errors,[5] poorer general health condition and the frequency of medical errors,[6] depressive symptoms of first-year medical residents and an increase in needle stick injuries,[7] and experiencing fatigue, sleepiness, and a depressive state by residents and medical errors.[8] However, no study has examined near-misses in ELSTs.

Therefore, the current study aimed to verify the association between a depressive state in ELSTs and the occurrence of near-miss events. Once verified, the association with work-related factors that potentially affect the depressive state of ELSTs was analyzed.

METHODS

Subjects and methods

THE STUDY SETTING was the Sapporo Fire Bureau, which is responsible for the approximately 2 million people in the entire 1,121 km^2 area of the city of Sapporo, Japan. The survey was undertaken in all 345 ELSTs in the Sapporo Fire Bureau.

In most cases, an ambulance contains a crew of three emergency providers, including at least one ELST, a person who has undergone extensive training, for provision of emergency care before a patient arrives at the hospital. The ELSTs are allowed to insert an i.v. line and an adjunct airway and to use semiautomated external defibrillators to treat patients experiencing an out-of-hospital cardiac arrest. Specially trained ELSTs have been permitted to insert tracheal tubes since July 2004, and to administer i.v. epinephrine since April 2006.[9]

The survey was carried out in November 2017 using an anonymous self-administered questionnaire by a Web-based system. This survey was undertaken as a part of the occupational health and safety activities at the Sapporo Fire Bureau, which might explain the high response rate. Among the 345 subjects, we received 260 (74.4%) valid responses without missing values. Because there were only six women among the respondents, their data were excluded and responses from the remaining 254 male ELSTs were analyzed (Fig. 1).

Measurements

The questionnaire asked questions about items related to depression, experiencing near-misses, and the subjects' working conditions. To determine the number of near-miss events at work, participants were asked the question: "During emergency activities, have you almost caused an accident or have you been at risk of causing an accident (near-miss event) in the past?" and responded by choosing among responses of "none", "once", and "more than once".

We included items about work conditions that could be related to depressive status or near-miss events in the questionnaire following consultation with the staff of the Fire Bureau. Questions regarding working conditions inquired about work-related factors, including sleep duration at night on days off, nap duration on days off, nap duration while on duty, mealtime while on duty, duration of desk work such as preparing reports, whether the number of responses was 3,000 or more per year, the number of near-miss events at work, the team the respondent belonged to, and the age of the respondent in the previous month.

Depressive state was investigated using the Quick Inventory of Depressive Symptomatology (QIDS), which consists of 16 self-administered survey items to evaluate the severity of depression. The QIDS is compliant with the diagnostic criteria for major depressive disorders in the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV, diagnostic criteria published by the American Psychiatric Association.[10]

The current study was approved by the Ethics Review Board of the University of Occupational and Environmental Health, Japan. The need for informed consent was waived for this study because we used anonymized secondary data obtained by the Sapporo Fire Bureau as part of a work task.

Statistical analyses

For statistical analyses, QIDS scores were categorized into three groups (no depression, 0–5; mild depression, 6–10; and moderate or severe depression, 11–27) based on previous research.[11,12] Dependent variables of near-miss events were dichotomized into responses of none or once or more.

To investigate the association between QIDS score and near-miss events, odds ratios (ORs) and 95% confidence intervals (CI) were calculated using logistic regression analysis. The multivariable model adjusted for age and work-related factors such as age, the number of responses, sleep duration at night on days off, nap duration on days off, nap duration while on duty, mealtime while on duty, and duration of desk work, such as preparing reports, because we assumed that these factors were associated with the
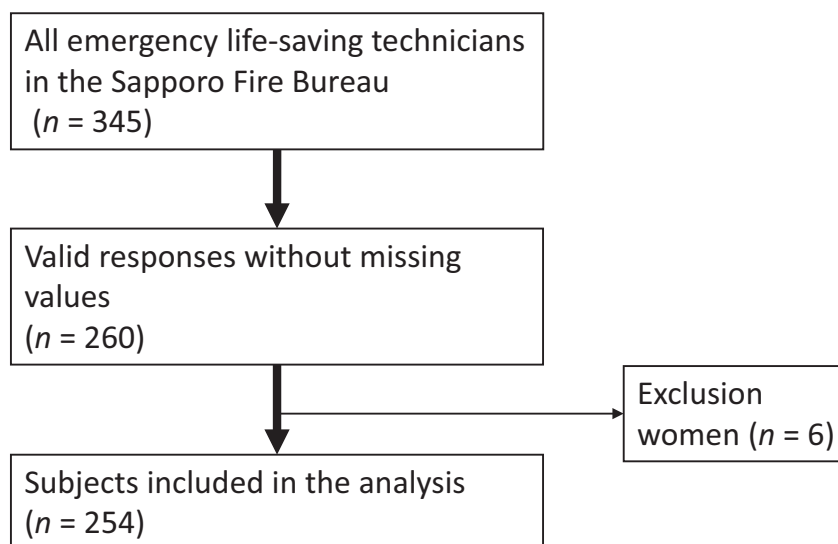
Fig. 1. Subject flowchart to determine the relationship between a depressive state among emergency life-saving technicians and medical near-misses.

depressive status of workers and could affect the occurrence of near-miss events. In addition, the ORs of survey items including work-related factors for a depressive state were estimated using multiple logistic regression analyses.

All statistical analyses were carried out using STATA statistical software (Stata/IC 12.1; Stata, College Station, TX, USA).

RESULTS

TABLE 1 shows the relationship between the surveyed items and depression among the 254 ELSTs. More than 70% of ELSTs in all age groups had no depression. Similarly, when analyzed for survey items other than age, in general, more than 70% of respondents had no depression. Among subjects who never experienced a near-miss event, 80% had no depression and 20% had mild or greater depression. Among those who had experienced one or more near-miss events, 55% had no depression, and 45% had mild or greater depression.

Table 2 shows the results of univariable and multivariable analyses of the association between a depressive state and the occurrence of near-miss events adjusted for work-related factors. The OR for mild depression and moderate or severe depression was 3.14 (95% CI, 1.37–7.16; $P = 0.007$) and 5.29 (95% CI, 1.46–19.09; $P = 0.011$), respectively. There were no associations between other work-related factors and the occurrence of near-miss events. The results of the multivariate model presented in Table 2 provides an area under the receiver operating characteristic curve of 0.69. The Hosmer–

Lemeshow test produces a P-value of 0.93. These results suggest that the model fitness is sufficient.

Table 3 shows the results of logistic regression analysis of the association between a depressive state and items related to working conditions adjusted for age. The OR for a nap duration while on duty of less than 2 h was 3.34 (95% CI, 1.15–9.67; $P = 0.027$), that for irregular mealtime while on duty was 3.71 (95% CI, 2.00–6.86; $P < 0.001$), and that for a duration of desk work of 4 h or longer was 2.21 (95% CI, 1.15–4.25; $P = 0.017$).

DISCUSSION

THE CURRENT STUDY showed that ELSTs who were more depressed experienced significantly more near-miss events. Moreover, the surveyed work-related factors nap duration while on duty, irregular mealtime while on duty, and duration of desk work, such as preparing reports, were significantly associated with experiencing a depressive state.

Stress and being in a depressive state are the main risk factors for medical errors made by ELSTs. Several published works have reported that stress and a depressive state in health-care professionals can cause medical errors.[8,13–16] Emergency life-saving technicians work in an environment in which they are on standby 24 h a day, 365 days a year. Moreover, once they are dispatched to the necessary sites, they often face life-or-death situations. Therefore, ELSTs work under highly stressful working conditions, even compared to other health-care professionals. Due to these conditions, ELSTs frequently experience a depressive state due to

Table 1. Relationship between a depressive state among emergency life-saving technicians according to Quick Inventory of Depressive Symptomatology (QIDS) and general characteristics

	n (%)	QIDS		
		Good (%)	Mild (%)	Moderate or severe (%)
Number (%)	254 (100)	192 (76)	49 (19)	13 (5)
Age, years				
18–29	78 (31)	57 (30)	15 (31)	6 (46)
30–49	140 (55)	108 (56)	26 (53)	6 (46)
≥50	36 (14)	27 (14)	8 (16)	1 (8)
Responses, /year				
<3,000	134 (53)	53 (101)	27 (55)	6 (46)
≥3,000	120 (47)	91 (47)	22 (45)	7 (54)
Sleep duration (day off), h				
<5	43 (17)	32 (17)	10 (20)	1 (8)
5–7	131 (52)	103 (53)	23 (47)	5 (38)
>7	80 (31)	57 (30)	16 (33)	7 (54)
Nap duration (day off), h				
<2	137 (54)	105 (55)	26 (53)	6 (46)
2–4	90 (35)	70 (36)	15 (31)	5 (38)
>4	27 (11)	17 (9)	8 (16)	2 (15)
Nap duration (on duty), h				
<2	46 (18)	30 (16)	9 (18)	7 (54)
2–5	165 (65)	125 (65)	36 (73)	4 (31)
>5	43 (17)	37 (19)	4 (8)	2 (15)
Mealtime				
Regular	138 (54)	119 (62)	15 (31)	4 (31)
Irregular	116 (46)	73 (38)	34 (69)	9 (69)
Desk work, h				
<4	195 (77)	154 (80)	31 (63)	10 (77)
>4	59 (23)	38 (20)	18 (37)	3 (23)

stress.[17,18] In fact, a survey on stress in ELSTs undertaken by the Tokyo Fire Department showed that 50% of ELSTs had experienced stress and that the source of their greatest stress was time-urgency due to continuous responses.[19]

The present study is the first to determine that there is also a relationship between a depressive state in ELSTs and the occurrence of near-miss events. Although depressed ELSTs tended to experience some near-miss events, severely depressed members tended to experience three to four times more near-miss events. Kaneko *et al.*[20] reported that depressed nurses working in acute care wards are approximately twice as likely to experience near-miss events. In the same report, depressed nurses were also found to have two to four times higher probability of experiencing medical errors.[20]

There are several possible reasons for this. First, ELSTs in Japan are government employees; therefore, their working hours and breaks are properly managed compared to other health professionals such as physicians and nurses. Second, ELSTs undergo routine physical training and have a good physique and physical strength. Third, because the subjects were working as ELSTs at the time of the study, the healthy worker effect, a phenomenon where workers are generally healthier than the general population because those who are ill are typically excluded from employment, might have been a factor in these results. The present findings suggest that, in addition to the number of responses and physical fatigue, the development of depressive tendencies is important for near-misses among ELSTs.

The association between depressive symptoms and increased risk of near-miss events could be explained by several mechanisms. Depression causes sluggish movements due to psychomotor retardation, and decreases attention and concentration, leading to conceivable increases in the risk of near-miss events. Inversely, experiencing medical errors or near-miss events could lead to a loss of confidence or depression. Studies have reported that the occurrence of medical errors not only harms the patient but also psychologically prevents the person who committed the error from smoothly returning to work due to fear of accidents.[21,22]

Previous studies have reported that sleep deprivation and stress from overwork among health-care professionals are significantly associated with a depressive state.[23–25] Among the surveyed work-related factors in the present study, nap duration while on duty and irregular mealtime while on duty were significantly associated with a depressive state. These findings are consistent with those of previous reports. Masuda *et al.*[26] showed that lack of a nap time was a factor for occupational stress among ELSTs. Motohashi *et al.*[27] reported that an increase in the number of emergency responses by ELSTs is correlated with an increase in the total amount of time spent in emergency responses, and a proportional decrease in the amount of time spent for meals, rest, and naps. The present study found that there was also a significant association between the duration of desk work, such as preparing reports, and a depressive state. Tasks other than emergency responses are estimated to account for approximately 25% of the working hours of ELSTs in Japan.[28] Given that good use of ELSTs' skills has been reported to reduce their stress,[28] desk work, such as preparing reports, in which ELSTs cannot make good use of their primary abilities, such as life-saving skills, is a factor for stress. Therefore, desk work, such as preparing reports, could be a major factor for the significant association between work-related factors and depressive state observed in the present study.

Table 2. Odds ratios of a depressive state according to Quick Inventory of Depressive Symptomatology (QIDS) for near-misses by emergency life-saving technicians

	No. of subjects	% of subjects who reported near-miss events	Univariable			Multivariable[†]		
			OR	95% CI	P-value	OR	95% CI	P-value
QIDS								
Good	192	13	Reference			Reference		
Mild	49	29	2.8	1.31–5.94	0.007	3.14	1.37–7.16	0.007
Moderate or severe	13	46	6.0	1.85–19.35	0.003	5.29	1.46–19.0	0.011

[†]Model adjusted for age, the number of responses, sleep duration at night on days off, nap duration on days off, nap duration while on duty, mealtime while on duty, and duration of desk work such as preparing reports.
CI, confidence interval; OR, odds ratio.

Table 3. Odds ratios (OR) of a depressive state among emergency life-saving technicians according to Quick Inventory of Depressive Symptomatology (QIDS) for work-related factors

	n (%)	OR	95% CI	P-value
Age, years				
18–29	78 (31)	Reference		
30–49	140 (55)	0.80	0.42–1.52	0.503
≥50	36 (14)	0.90	0.36–2.23	0.828
Responses, /year				
<3,000	134 (53)	Reference		
≥3,000	120 (47)	0.98	0.54–1.73	0.935
Sleep duration (day off), h				
<5	43 (17)	0.86	0.37–2.00	0.734
5–7	131 (52)	0.67	0.35–1.29	0.235
>7	80 (31)	Reference		
Nap duration (day off), h				
<2	137 (54)	0.53	0.20–1.32	0.173
2–4	90 (35)	0.49	0.19–1.23	0.130
>4	27 (11)	Reference		
Nap duration (on duty), h				
<2	46 (18)	3.34	1.15–9.67	0.027
2–5	165 (65)	1.99	0.77–5.09	0.151
>5	43 (17)	Reference		
Mealtime				
Regular	138 (54)	Reference		
Irregular	116 (46)	3.71	2.00–6.85	0.000
Desk work, h				
<4	195 (77)	Reference		
>4	59 (23)	2.21	1.15–4.25	0.017

CI, confidence interval.

The present study has some limitations. First, this was a cross-sectional study. Therefore, causation for the association between a depressive state and the occurrence of near-miss events and between a depressive state and the surveyed work-related factors could not be determined. For example, a worker who recently experienced a near-miss event might have a higher QIDS score. Second, the present study used a simple self-administered test, the QIDS, to diagnose depressive symptoms; therefore, the validity of the diagnosis is unknown. However, QIDS is compliant with the diagnostic criteria for major depressive disorders of the DSM-IV, diagnostic criteria published by the American Psychiatric Association, and its use has been validated. Third, possible administration bias or social desirability bias cannot be excluded because the Sapporo Fire Bureau directors were involved in the survey collection process. However, anonymized processes are thought to be effective for reducing the possibility of such biases. In addition, underreporting of depression or near-miss events by participants can lead to underestimation of the association. That we observed a significant association despite potential underreporting suggests a strong association between near-miss events and a depressive state. Fourth, we did not consider years of experience in this survey; however, we speculate that age is strongly correlated with years of experience. Fifth, the results of this study are limited to male ELSTs because there were too few female cases for analysis. The number of female ELSTs has increased in recent years,[29] making it is necessary to investigate female members in the future. Sixth, the generalizability of the study results is uncertain because we only surveyed subjects from the Sapporo Fire Bureau, which is located in the northern part of Japan. However, the work content is likely highly homogeneous because the operations of ELSTs are based on a strict command and control system implemented throughout Japan, and Sapporo is a government-designated city. Finally, near-miss events were reported based on self-assessment by ELSTs; therefore, the validity of their criteria for near-misses is unknown. However, spontaneous reporting of on-site near-miss events by

workers is currently the only method for reporting near-miss events. Future studies should verify the association with the occurrence of actual accidents.

CONCLUSION

THE PRESENT STUDY found a significant association between the depressive state of ELSTs and the occurrence of near-miss events. Interventions for improving the depressive status of ELSTs aimed at reducing near-miss events in high-pressure emergency care settings could be important for the medical safety of patients. Moreover, the depressive state of ELSTs was associated with the duration of nap time while on duty and excessive desk work, indicating the importance of their working environment and managing their operations on their ability to provide safe emergency medical services.

DISCLOSURE

Approval of the research protocol: This study was approved by the Ethics Committee of the University of Occupational and Environmental Health, Kitakyushu, Japan (H30-054).
Informed consent: N/A
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A
Conflict of interest: None.

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