Table 3. Psychiatric comorbidity at 4–6 wks after motor vehicle accident in injured patients at follow-up (n = 100)

		Comorbid Diagnosis					
Psychiatric Illness	n	Major Depression	Minor Depression	PTSD	Partial PTSD[a]	Alcohol Dependence	Anxiety Disorder[b]
Major depression	16	—	—	7	5	1	2
Minor depression	7	—	—	0	5	1	0
PTSD	8	7	0	—	—	1	1
Partial PTSD	16	5	5	—	—	1	1
Alcohol dependence	3	1	1	1	1	—	0
Any psychiatric illness	31						

PTSD, posttraumatic stress disorder.

[a]Fulfilled only two out of the three symptom criteria (B, re-experiencing; C, avoidance; D, hyperarousal) and criteria A-1 (stressor), E (duration), and F (impairment) according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision;* [b]obsessive-compulsive disorder, agoraphobia, or social phobia.

sive disorder (n = 2), agoraphobia (n = 2), and social phobia (n = 1). Table 3 shows the number of patients who met the diagnostic criteria for psychiatric illness after MVA and the comorbidity for each diagnosis. In examining comorbidity, obsessive–compulsive disorder, agoraphobia, and social phobia were grouped together under the heading of anxiety disorders. As in previous studies, depression and PTSD were the most common comorbid conditions.

In addition, at the follow-up assessment, 15 patients were identified retrospectively to have a history of one or two psychiatric illnesses before MVA: alcohol abuse or dependence (n = 11), general anxiety disorder (n = 1), agoraphobia (n = 1), panic disorder (n = 1), hypomanic episode (n = 1), and personality disorder (n = 1).

Predictors of Psychiatric Morbidity and PTSD. In terms of psychiatric morbidity, women, family history of psychopathology, a sense of life threat, nondriver's position, HR, ISS, and IES-R intrusion subscale showed the expected association at follow-up (Table 4). For PTSD syndrome, women, family history of psychopathology, a sense of life threat, nondriver's position, HR, ISS, and IES-R intrusion subscale showed the expected association at follow-up (Table 4).

Finally, three of the 11 predictor variables, namely, a sense of life threat (OR, 4.2; 95% CI, 1.2–14.1; $p = .02$), HR (OR, 1.6; 95% CI, 1.2–2.2; $p < .01$), and IES-R intrusion subscale (OR, 1.1; 95% CI, 1.0–1.2; $p = .08$), contributed to the predictive model for psychiatric morbidity (Table 5). Then, a sense of life threat (OR, 6.2; 95% CI, 1.5–26.3; $p = .01$), HR (OR, 1.7; 95% CI, 1.1–2.4; $p < .01$), and IES-R intrusion subscale (OR, 1.1; 95% CI, 1.0–1.3; $p = .04$) contributed to the predictive model for PTSD syndrome (Table 5).

DISCUSSION

The finding that one third of MVA-injured patients met the diagnostic criteria for at least one psychiatric diagnosis at 4–6 wks after injury is disturbing, given the frequency at which such injuries occur. This incidence of trauma-related psychiatric illness is consistent with previous reports. For instance, Schnyder et al. (7) found that 25.5% of more severely injured patients (mean ISS, 21.9) met the diagnostic criteria for PTSD or partial PTSD, with the exception of the time criterion of 2 wks after the accident. More recently, O'Donnell et al. (8) reported that 23.1% of physically injured patients in a similar sample suffered from at least one psychiatric illness at 3 months after injury, and Gil et al. (40) found that 24.2% of mildly injured patients (mean ISS, 5.8) with mild traumatic brain injury met the diagnostic criteria for psychiatric illness at 6 months after injury. Unlike other studies, our study included minor depression as a psychiatric illness. This difference might explain the relatively high incidence of psychiatric illness obtained. Our results revealed that injury severity was not associated with the development of later psychopathology, as has been reported by other studies (32, 41, 42). Taking into account our findings and those of previous studies, about 25–30% of MVA-injured patients seem to develop trauma-related psychiatric illness, regardless of injury severity and cultural background.

The incidence of acute PTSD (8%) in the present study was lower than that (18–53%) reported in Israel, the United States, and France (4, 12–15). However, the present rate is comparable with those reported in Switzerland and Australia (7, 8), where the incidence of acute PTSD (excluding the duration criteria of 4 wks) was found to be 5–9%. Unlike previous studies in the United States (12–14), which were based on accident victims who had sought assessment or treatment for posttraumatic psychological problems, recent studies in Switzerland (7) and Australia (8), and in the present study, involved consecutive samples from trauma surgery intensive care units as a single source. Although an Israeli study that consecutively collected a sample from an emergency department found a high incidence of PTSD at 1 month after trauma (4), the response rate was substantially lower than in the other studies (7, 8) and the present study. These characteristics may explain the discrepancy. Another possible explanation for the higher rate in the Israeli study could be inclusion in the sample of survivors of intentional injury, such as terrorism and combat (43). The reason for the comparatively high rate in the recent French study, despite a similar method of recruitment and criteria, remains unclear (15), although the high proportion of the patients experiencing a sense of life threat (66%) may have partly contributed to the high incidence of PTSD. Such a difference might be attributable to a cultural-based reticence among Japanese that might have kept injured patients from freely admitting their symptoms. However, this first standardized study among a Japanese population has shown that the incidence of MVA-related PTSD in Japan is within the range of that in Western countries.

Depression (major depression and minor depression) and PTSD syndrome (full PTSD and partial PTSD) were the most frequent diagnoses. More than 70% of patients diagnosed with one psychiatric diagnosis also met the criteria for another diagnosis, with PTSD being most frequently comorbid with depression. These findings are consistent with those of the aforementioned Australian study (8) and an American epidemiologic study showing a close relationship between PTSD and depression (44, 45), and they highlight the importance of assessing comorbid psychiatric conditions in general

Table 4. Relationship between psychiatric morbidity or posttraumatic stress disorder (PTSD) syndrome (full and partial PTSD) at follow-up and predictor variables at initial assessment (n = 100 for psychiatric morbidity, n = 93 for PTSD syndrome)

	Psychiatric Morbidity			PTSD Syndrome		
	n (%)	OR (95% CI)	*p*	n (%)	OR (95% CI)	*p*
Categorical variable						
Sex						
Male	18/71 (25.3)	1		14/67 (20.9)	1	
Female	13/29 (44.8)	2.4 (0.9–5.9)	.06	10/26 (38.5)	2.4 (0.9–6.3)	.09
Previous trauma						
No	6/20 (30.0)	1		4/18 (22.2)	1	
Yes	25/80 (31.3)	1.1 (0.4–3.1)	.91	20/75 (26.7)	1.3 (0.4–4.3)	.70
Family history of psychopathology						
No	21/78 (26.9)	1		16/73 (21.9)	1	
Yes	10/22 (45.5)	2.3 (0.9–6.1)	.10	8/20 (40.0)	2.4 (0.8–6.8)	.11
History of psychiatric illness						
No	26/86 (30.2)	1		21/81 (25.9)	1	
Yes	5/14 (35.7)	1.3 (0.4–4.2)	.68	3/12 (25.0)	1.0 (0.2–3.9)	.95
Sense of life threat						
No	17/73 (23.3)	1		12/68 (17.6)	1	
Yes	14/27 (51.9)	3.6 (1.4–8.9)	<.01	12/25 (48.0)	4.3 (1.6–11.7)	<.01
Feeling of self-reproach						
No	13/49 (26.5)	1		10/46 (21.7)	1	
Yes	18/51 (35.3)	1.5 (0.6–3.6)	.35	14/47 (29.8)	1.5 (0.6–3.9)	.38
Driver (vehicle or motorcycle)	15/63 (23.8)	1		10/58 (17.2)	1	
Passenger, bicyclist, or pedestrian	16/37 (43.2)	2.4 (1.0–5.8)	.04	14/35 (40.0)	3.2 (1.2–8.4)	.02
Education						
0 (junior high school)	8/22 (36.4)	1		6/20 (30.0)	1	
1 (high school)	11/30 (36.7)	1.4 (0.6–3.6)	.42	9/28 (32.1)	1.6 (0.6–4.2)	.36
2 (junior or technical college)	7/26 (26.9)	0.8 (0.3–2.1)	.60	5/24 (20.8)	0.7 (0.2–2.1)	.52
3 (university or more)	5/22 (22.7)	0.6 (0.2–1.7)	.35	4/21 (19.0)	0.6 (0.2–2.0)	.42
Ordinal variable						
Heart rate[a] per 10 beats/min		1.4 (1.1–1.8)	<.01		1.4 (1.1–1.8)	.02
Injury Severity Score[b] per 10 points		1.4 (0.9–2.2)	.19		1.7 (1.0–2.8)	.04
IES-R intrusion subscale per 1 point		1.1 (1.0–1.2)	<.01		1.1 (1.0–1.2)	<.01

OR, odds ratio; CI, confidence interval; IES-R, Impact of Event Scale-Revised.

[a]Entered as 50–59 beats/min = 0, 60–69 beats/min = 1, 70–79 beats/min = 2, 80–89 beats/min = 3, 90–99 beats/min = 4, 100–109 beats/min = 5, 110–119 beats/min = 6, 120–129 beats/min = 7, 130–139 beats/min = 8, 140–149 beats/min = 9; [b]entered as 1–9 points = 0, 10–19 points = 1, 20–29 points = 2, 30–39 points = 3, 40–49 points = 4.

Table 5. Multivariate logistic regression analysis: Prediction of psychiatric morbidity or posttraumatic stress disorder (PTSD) syndrome (full and partial PTSD) in motor vehicle accident—related injured patients (n = 100 for psychiatric morbidity, n = 93 for PTSD syndrome) at follow-up

	Psychiatric Morbidity		PTSD Syndrome	
Predictor Variable	OR (95% CI)	*p*	OR (95% CI)	*p*
Women	2.05 (0.48–8.85)	.33	2.14 (0.38–12.15)	.39
Previous trauma, yes	1.71 (0.39–7.55)	.48	2.51 (0.43–14.85)	.31
Family history of psychopathology, yes	2.56 (0.69–9.44)	.16	2.79 (0.61–12.73)	.18
History of psychiatric illness, yes	1.56 (0.36–6.87)	.55	1.31 (0.22–7.83)	.77
Sense of life threat, yes	4.17 (1.23–14.12)	.02	6.19 (1.46–26.29)	.01
Feeling of self-reproach, yes	0.98 (0.33–2.93)	.98	0.93 (0.26–3.31)	.91
Nondriver	1.98 (0.51–7.72)	.33	3.93 (0.71–21.80)	.12
Education				
1 (high school)	0.48 (0.11–2.08)	.33	0.57 (0.10–3.35)	.53
2 (junior or technical college)	0.37 (0.07–1.88)	.23	0.31 (0.05–2.18)	.24
3 (university or more)	0.71 (0.15–3.31)	.67	1.13 (0.19–6.85)	.89
Heart rate[a] per 10 beats/min	1.62 (1.17–2.23)	<.01	1.65 (1.14–2.39)	<.01
Injury Severity Score[b] per 10 points	1.31 (0.73–2.33)	.37	1.61 (0.84–3.07)	.15
IES-R intrusion subscale per 1 point	1.09 (0.99–1.19)	.08	1.12 (1.00–1.26)	.04

OR, odds ratio; CI, confidence interval; IES-R, Impact of Event Scale-Revised.

[a]Entered as 50–59 beats/min = 0, 60–69 beats/min = 1, 70–79 beats/min = 2, 80–89 beats/min = 3, 90–99 beats/min = 4, 100–109 beats/min = 5, 110–119 beats/min = 6, 120–129 beats/min = 7, 130–139 beats/min = 8, 140–149 beats/min = 9; [b]entered as 1–9 points = 0, 10–19 points = 1, 20–29 points = 2, 30–39 points = 3, 40–49 points = 4.

medical practice among patients with physical injuries or illness.

We found that in MVA-injured patients, an elevated HR at admission was an independent predictor for the development of psychiatric morbidity and PTSD syndrome at 4–6 wks after the injury. This result is comparable with that of previous studies investigating the association between elevated HR and subsequent (4–6 months postinjury) development of PTSD (34–36, 46). Other research groups, however, did not report any significant positive correlation between initial HR and subsequent development of PTSD (37, 38). A recent review indicated that HR in the acute phase cannot be used to accurately identify people who are at risk for PTSD (39). The available evidence points to much variability in HR levels, heterogeneity in HR response within samples, and variability across trauma types (39) and to the influence of loss of consciousness as defined by the Glasgow Coma Scale on the

relationship between HR and PTSD (47). Such evidence underscores the problem of implementing HR as a screening measure. In contrast, the clearest example of such a potential use of HR would be the early administration of propranolol to limit initial biological reactions, such as fear responses or overconsolidation of traumatic memories; these may contribute to PTSD development (48, 49). Our finding suggests that HR is a useful means to study fear conditioning models of trauma response.

Experiencing a sense of the life threat during an MVA was an independent predictor for the development of psychiatric morbidity at 4–6 wks after the MVA. This finding is consistent with previous reports (7, 32, 50, 51). Although all patients sustained physical injuries and met stressor criterion A-1 for DSM-IV, only 27 of the 100 patients had actually experienced a sense of life threat during the MVA. This finding is similar to the 24.5% of injured patients reported by Schnyder et al. (32) who experienced a sense of the life threat. Many patients in this population, particularly those with memory loss concerning the MVA, did not fulfill stressor criterion A-2 of PTSD for DSM-IV. This problem often occurs in studies of severely injured patients. Despite this problem, the patients' subjective appraisals of their trauma are important in the development of trauma-related psychiatric morbidity.

It is no surprise that early core symptoms of PTSD, as assessed by the IES-R intrusion subscale, play a significant role in our predictive model. The predictive value of intrusion has been demonstrated in numerous traumatic stress studies and has also been confirmed with accident victims (7, 52, 53).

The final model could not include the predictive value of women, family history of psychopathology, nondriver's position, or ISS. Missing correlations between these variables and psychiatric morbidity and PTSD syndrome may be in part due to a lower statistical power to detect the association or assessment methodology. As for psychiatric family history, Schnyder et al. (32) reported biographical risk factors to be predictive of postaccident psychiatric morbidity. It was suggested that patients who were injured while occupying a nondriver's position may be thought of as victims, compared with the persons who caused the accidents. Thus, a nondriver's position might make patients susceptible to subsequent psychiatric morbidity. Regarding ISS, early studies reported that severe lower limb injury, including open leg fractures, was associated with long-term disability and poor quality of well-being in trauma patients (5, 54). Furthermore, Holbrook et al. found that penetrating trauma predicted subsequent PTSD among trauma patients (51).

The present study has some limitations. First, the results were obtained from only one teaching hospital in the suburbs of Tokyo. According to our clinical impression, the proportion of MVA occurring during motor sports or leisure time was higher in our sample than that seen in central Tokyo. Second, the dropout rate of the present study was relatively high; however, it is comparable with that of previous studies (55–57). Third, the results were based on a small number of participants. Fourth, many patients have to be excluded due to age (<18 or >70) and traumatic brain injury (TBI), and this limits generalizability and clinical relevance of the study. However, children, adolescents, and old people may have their specific additional problems in dealing with an MVA (e.g., children and adolescents: needing parents' consent to participate, issue of legal responsibility; old people: preexisting somatic multimorbidity, cognitive impairments including dementia) and should therefore be studied separately. Although TBI is a common problem in the intensive care unit, TBI symptoms mimic PTSD and depression symptoms (organic vs. psychogenic inability to recall the event, concentration problems, etc.), which would make it difficult to interpret the findings. Further studies are needed to address these issues.

CONCLUSION

This study found that one third of patients with MVA-related injuries had developed new, trauma-related psychiatric illnesses at 4–6 wks after injury in Japan. It is suggested that the incidence of MVA-related PTSD in Japan is different from that in the United States and France. A combination of a sense of the life threat, elevated HR, and IES-R intrusion allowed for significant prediction of psychiatric morbidity and PTSD at follow-up.

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