

Serum Lipid Profile Could Predict the Inception and Impacts of Violent Behaviors among Acute Psychiatric Inpatients

Pei-Ju Liao^{1,2}, PhD; Chi-Hsiang Chen³, MD; Hung-Yu Chan³, MD;
Happy Kuy-Lok Tan³, PhD; Kuang-Hung Hsu⁴, PhD

Background: The prediction of violence among psychiatric inpatients using biophysiological indicators is warranted for re-examinations longitudinally. This study aims to explore factors associated with the occurrence of violence and subsequent medical impacts in psychiatric inpatients.

Methods: Inpatients diagnosed with either schizoaffective disorder or bipolar mania were admitted to acute wards in a professional psychiatric care setting. A longitudinal analysis was applied to construct predictive models with blood biochemistry tests upon admission. Medical records and an administrative database were used for analyses.

Results: Triglycerides were found to be a significant predictor of violence inception, which demonstrated a multivariate-adjusted odds ratio of 0.988 per mg/dL increment. Psychiatric inpatients with a higher level of triglycerides were less likely to have violent behaviors while more serious medical impacts were found once violence occurred. The elevated medical expenses derived from violence were negatively correlated with the level of cholesterol upon admission. A U-shape relationship was found between medical impacts and the combination of serum triglycerides and cholesterol.

Conclusion: The study provides useful predictors for early pre-screening of potential violence cases among acute psychiatric inpatients and therefore offers various angles for future strategic management of care plans in psychiatric medical settings.

(*Chang Gung Med J* 2012;35:382-91)

Key words: violence, lipid profile, psychiatric care, medical impacts

The violence of psychiatric patients is a crucial issue for health care providers when additional medical expenses occur following inception.^(1,2) Alleviating adversely aggressive conduct in psychiatric patients is one of the top priorities of psychiatric medical teams in medical settings. Psychiatric inpatient attacks are not rare events in a psychiatric staff's regular practice, in spite of the implementa-

tion of many interventions, such as environment constraints, frequent security checks, violence management training, and chemical/physical restraints. Violence also represents an important barrier to discharge.

Many researchers have attempted to explore factors associated with the occurrence of violence among psychiatric inpatients. Although risk

The first two authors contributed equally to this work.

From the ¹Department of Health Care Administration, Oriental Institute of Technology, New Taipei City, Taiwan; ²Department of Business Administration, National Taiwan University, Taipei, Taiwan; ³Department of General Psychiatry, Taoyuan Psychiatric Center, Taoyuan, Taiwan; ⁴Department of Health Care Management, Chang Gung University, Taoyuan, Taiwan.

Received: Sep. 7, 2011; Accepted: Feb. 10, 2012

Correspondence to: Prof. Kuang-Hung Hsu, Department of Health Care Management, Chang Gung University, 259, Wenhua 1st Rd., Gueishan Township, Taoyuan County 333, Taiwan (R.O.C.) Tel: 886-3-2118800 ext. 5486; Fax: 886-3-2118138; E-mail: khsu@mail.cgu.edu.tw

appraisal research indicates that violence is predictable in some populations, there is no reliable indicator or guideline that is currently globally accepted.⁽¹⁾ Previous studies have shown potential risk factors related to inpatient violence, including gender,⁽²⁾ age, lower education level,⁽²⁾ acute psychosis,⁽³⁾ poor impulse control,⁽⁴⁾ history of recent assaults,⁽⁵⁾ neural and neuropsychological abnormalities,⁽⁶⁾ life events,⁽⁷⁾ and alcohol or substance abuse.^(5,7) There have been few, if any, studies addressing biophysiological factors in predicting subsequent violence among psychiatric inpatients. If the characteristics of a high risk group for future violence can be predetermined, then effective interventions can be designed.

The relationships between hyperlipidemia and cardiovascular disease mortality were established in the 1990s.⁽⁸⁾ However, a meta-analysis of six primary prevention trials revealed no statistical association between lowering cholesterol concentration and reducing violent death.⁽⁹⁾ Elevated cancer mortality and an increasing incidence of other adverse events, including suicide, accidents, and violence, were found in another study, which demonstrated that lowering cholesterol levels can prevent cardiovascular diseases.⁽¹⁰⁾ Scholars in Japan have reported similar findings, confirming the association between lower cholesterol levels and increased likelihood of suicide attempts.⁽¹¹⁾ A German group has also observed a significant association between lower cholesterol levels and a higher occurrence of violent behaviors.⁽¹²⁾ On the contrary, another study has demonstrated that men with cholesterol levels equal to or lower than 160 mg/dl did not have an increased number of suicide attempts.⁽¹³⁾ However, a significant decrease in the serum triglyceride level in the group with low cholesterol was observed among subjects who had attempted suicide in another study. In addition to cholesterol, levels of triglycerides are a lipid indicator and could be a predictor of violent behaviors. However, a Taiwanese study has demonstrated no statistical significance between lipid profiles and depression disorders among menopausal women.⁽¹⁴⁾ The complicated mechanism and unsettled phenomena among lipid profiles and violent behaviors for different populations warrant further investigations. Thus, the objectives of the current study are to explore the association of these lipid indicators and the occurrence of inpatient violence, as well as to

investigate the effects of these indicators on subsequent medical expenses.

METHODS

Study samples

The study samples were recruited from among inpatients who were admitted into the acute units of a public mental hospital from January 1st, 2005 to December 31st, 2005. According to previous reports, clozapine significantly reduces aggressive behaviors in the treatment of schizophrenia.⁽¹⁵⁾ To avoid the confounding effect of treatment, the present study excluded schizophrenia from the analysis. After careful review of the medical chart, all subjects were not prescribed clozapine. The patients included in this study met the following operational definitions: (1) schizoaffective disorder or bipolar I disorder; (2) the most recent episode met manic criteria; (3) violence was defined as assaulting behaviors that necessitated seclusion and restraint. Psychiatric inpatients that were diagnosed with organic brain syndrome, alcohol/substance-induced psychotic disorders, dementia, autism or its related disorders were excluded from this study. The diagnosis of psychiatric disorders was assured by a group of senior practitioners and reconfirmed by subsequent clinical observations.

Under review, monitoring, and approval by the Institute Review Board, 99 patients with a total of 123 patient visits who were admitted to the acute ward were asked to fast overnight after their admission and were taken their blood specimen. Violent events were followed and investigated longitudinally in the two-month period upon patient admission. Parallel analyses were performed to further validate the data by including and excluding one of the 99 patients who had a history of heart disease, and concluded that the effect of this case was not significant and had no skew effects in this study.

Measures

Medical expenses were classified as length of hospital stay, total medical expenses, and itemized medical expenses including drugs, consumables, and treatments. Extra medical expenses were derived from violent behaviors and a positive association between severity of violence and extra medical expenses was anticipated. Injuries and intensive care following violent behaviors resulted in increases in

all itemized medical expenses such as surgery/treatments, diagnosis/tests, medications, and consumable glossaries.

Data analysis

The chi-square test was used to investigate the statistical significance of categorical variables between groups, while a two-sample t test was applied to analyze the differences in numerical variables between study groups. Because of the dependent nature of a few observations in this study, Generalized Estimating Equations were employed for the following multivariable regression analyses. A conditional logistic regression model and a Poisson regression model were used to calculate multivariable adjusted odds ratios as the strength of association in the likelihood and frequency of violence occurrence. Length of stay and medical expenses were logarithmically transformed before analysis because of a right skew distribution. Conditional linear regression analysis was applied to construct models associated with the subsequent medical expenses. For stratified analyses, the levels of triglycerides and cholesterol were dichotomized into high and low groups according to the average value. As in the predictive model on violence, the level of triglycerides was a significant predictor of violent inception. The following analyses with a combination of triglycerides and violence provide evidence of the subsequent medical impacts. Due to the previous causality model, violence was an intermediate variable after examination of the relationship between triglycerides and medical impacts (length of stay and medical expenses). Under such conditions, it was not suitable to treat both triglycerides and violence as independent variables so stratified analysis with a combination of triglycerides (high and low) and violence (yes and no) was performed in the subsequent multivariable models. A *p* value less than 0.05 calculated with two-tailed tests was regarded as statistically significant. The Statistical Package for the Social Sciences version 16.0 (SPSS Inc., Chicago, Illinois, U.S.A.) was used to perform the statistical analyses.

RESULTS

Ninety violent episodes in 43 patients occurred during the study period. These patients were classi-

fied as the violent group in this study. Fifty-six patients who had no violent behavior during the same study period were classified as the non-violent group. Seventeen inpatients were admitted to the acute wards twice, 2 patients were admitted 3 times and one patient was admitted 4 times in a year. A total of 99 patients were examined in the current analysis. There was a statistically significant difference in triglyceride level between the study groups, 113.84 mg/dL (95% CI 45.75 mg/dL to 181.93 mg/dL) and 83.63 (95% CI 46.73 mg/dL to 130.36 mg/dL) in the non-violent and violent groups, respectively (*p* = 0.006). Bipolar manic patients had a higher likelihood of violent behavior, with a violence rate of 55.9% (as opposed to 16.1% in the affective schizoaffective patients) (*p* < 0.0001). No statistical differences were found for sex, age, height, weight, body mass index, cholesterol, educational level, and rate of substance abuse between the study groups (Table 1). Analyses by generalized linear models demonstrated that the level of triglycerides was significantly negatively associated with the occurrence of violence (OR = 0.988, 95% CI 0.979 to 0.996) and the frequency of violence (OR = 0.987, 95% CI 0.977 to 0.997) in multivariable adjusted models (Table 2).

Further analyses of the effect of medical expenses stratified by violence and lipid profile demonstrated that elevated levels of medical expenses were found in patients with the following characteristics: higher triglycerides with violent behavior, lower cholesterol, no co-morbidity with diabetes mellitus, diagnosis of schizoaffective disorder, and young age (Table 3). Analyses of itemized medical expenses demonstrated results similar to those for total medical expenses.

Interactions and patterns of association were examined by stratifying triglyceride levels and cholesterol levels. A 'U-shape' relationship for total medical expenses was found among strata of lower triglycerides-lower cholesterol, higher triglycerides-lower cholesterol, lower triglycerides-higher cholesterol, and higher triglycerides-higher cholesterol in the violent group. The multivariable-adjusted length of hospital stay was found to be 62.77 days, 45.77 days, 43.21 days, and 41.62 days, from the highest to the lowest, in the violent patient groups with higher triglycerides-higher cholesterol, lower triglycerides-lower cholesterol, lower triglycerides-higher choles-

Table 1. Comparison of Patient Characteristics between the Violent and Non-violent Groups

Characteristics		Nonviolent (n = 56)	Violent (n = 43)	p value [†]
Sex	Women	24 (42.9%)	21 (48.8%)	0.349
	Men	32 (57.1%)	22 (51.2%)	
Age (years)		36.79 (25.92, 47.66) [‡]	36.21 (24.72, 47.70)	0.799
Education (years)		11.76 (8.71, 14.81)	10.88 (7.76, 14.00)	0.168
Height (cm)		163.30 (155.46, 171.14)	164.10 (155.93, 172.27)	0.625
Weight (Kg)		67.05 (52.91, 81.19)	67.27 (52.51, 82.03)	0.939
BMI		25.16 (19.92, 30.40)	24.88 (20.34, 29.42)	0.783
Diabetes mellitus	No	54 (96.4%)	39 (90.7%)	0.399
	Yes	2 (3.6%)	4 (9.3%)	
Hypertension	No	51 (91.1%)	39 (90.7%)	1.000
	Yes	5 (8.9%)	4 (9.3%)	
Cholesterol (mg/dL)		176.07 (132.64, 219.5)	174.88 (138.89, 210.87)	0.885
Triglycerides (mg/dL)		113.84 (45.75, 181.93)	83.63 (46.73, 120.53)	0.006*
Major diagnosis	Affective schizophrenia	26 (46.4%)	5 (11.6%)	< 0.001*
	Bipolar mania	30 (53.6%)	38 (88.4%)	
Substance abuse	No	51 (91.1)	37 (86.0%)	0.525
	Yes	5 (8.9%)	6 (14.0%)	
Frequency of violence	0	56 (100.0%)		
	1		17 (39.5%)	
	2		16 (37.2%)	
	3		3 (7.0%)	
	> 4		7 (16.3%)	

Abbreviations: BMI: body mass index. *: $p < 0.01$; †: Discrete variables, such as sex, diabetes mellitus, hypertension, major diagnosis, and substance abuse, were analyzed with the chi-square test. Continuous variables, such as age, education, height, weight, BMI, cholesterol, and triglycerides, were analyzed with the two-sample t-test; ‡: 95% confidence interval.

terol, and higher triglycerides-lower cholesterol, respectively (Fig. 1). The multivariable-adjusted total medical expenses were NT\$ 91201.27, NT\$ 81148.15, NT\$ 73791.76, and NT\$ 71877.54 from the highest to lowest, in the violent patient groups with higher triglycerides-higher cholesterol, lower triglycerides-lower cholesterol, higher triglycerides-lower cholesterol, and lower triglycerides-higher cholesterol, respectively (Fig. 2). Statistical significance was found for both length of stay and total medical expenses for both the violent group and non-violent group in the higher triglycerides and higher cholesterol stratum.

DISCUSSION

The current study demonstrated a significant relationship between triglycerides and violent behavior among psychiatric inpatients, which is informative for future clinical practice and research. First, the serum level of triglycerides can be treated as an early detection biomarker for the future occurrence of violence among psychiatric inpatients upon admission. Second, medical expenses can be predicted by modeling with the lipid profile and other indicators, helping to lower costs for health care management.

Table 2. Generalized Linear Models for Factors Associated with Occurrence and Frequency of Violence

Independent variables		Violence restrained [†]			Frequency of violence [‡]		
		Parameter estimate	OR	95% CI	Parameter estimate	OR	95% CI
Sex	Women	–	–		–	–	
	Men	0.166	1.181	(0.522, 2.669)	0.006	1.006	(0.455, 2.226)
Age	(each increment)	0.007	1.007	(0.966, 1.050)	–0.002	0.998	(0.972, 1.026)
Education years	(each increment)	–0.016	0.984	(0.857, 1.130)	0.063	1.065	(0.964, 1.177)
BMI	(each increment)	0.003	1.003	(0.912, 1.103)	–0.007	0.993	(0.925, 1.067)
Major diagnosis	Affective schizophrenia	–1.193*	0.303	(0.124, 0.742)	–0.275	0.759	(0.271, 2.124)
	Bipolar mania	–	–		–	–	
Diabetes mellitus	No	–	–		–	–	
	Yes	–0.179	0.836	(0.119, 5.896)	–0.855	0.425	(0.139, 1.300)
Hypertension	No	–	–		–	–	
	Yes	0.121	1.129	(0.177, 7.187)	0.076	1.079	(0.368, 3.165)
Cholesterol (mg/dL)	(each increment)	0.005	1.005	(0.992, 1.017)	0.004	1.004	(0.995, 1.012)
Triglycerides (mg/dL)	(each increment)	–0.012*	0.988	(0.979, 0.996)	–0.013*	0.987	(0.977, 0.997)

Abbreviations: BMI: body mass index. *: $p < 0.05$; †: Analyzed with conditional logistic model; ‡: Analyzed with Poisson regression model.

The association between serum lipids and violent tendencies or suicidal behavior has been rather inconsistently documented in previous studies. In particular, a negative association between the level of cholesterol and aggressive behavior has been frequently found.^(9,12,16,17) Engelberg proposed physiological explanations for the correlation between cholesterol and suicide behaviors.⁽¹⁸⁾ Because cholesterol is an important ingredient of the neuron cell membrane, it plays an important role in transporting neurotransmitters and in modulating their effects. Lower levels of cholesterol have been associated with central serotonergic dysfunction, resulting in impulsiveness and aggressiveness.⁽¹⁵⁾ However, the association between levels of serum triglycerides and aggression behavior is rather inconclusive so far. High levels of triglycerides have been found to be associated with some related manifestations, including agitation or confusion, hostility, and hostile acts.^(15,16,19,20) On the other hand, another study detected lower levels of serum triglycerides among aggressive women.⁽²¹⁾ This finding appears to be in agreement with research showing an association between elevations in the serum

triglyceride level and reductions in violent and suicidal behaviors.^(22,23) Although many studies have proposed mechanisms from the perspectives of genomes, metabolic pathways, the genesis of hormones and related health effects, the relationship between the level of serum triglycerides and human aggression remains unclear. The present study has demonstrated the independent effect of the triglyceride level on aggressive behaviors among psychiatric inpatients. These findings extend beyond previous evidence of the association between cholesterol and aggression. A significant advantage of the present study is the firmness of temporality since we collected the lipid profile on admission followed by the inception of violence. In addition, a relationship between triglycerides and aggressive behaviors has been found mostly in western populations and in populations with other health statuses, but not in Asian populations. A recent European study demonstrated that total cholesterol had a significant negative relationship with inpatient suicidal behavior and inpatient violent behavior.⁽²⁴⁾ Additionally, triglyceride levels were a significant marker of inpatient

Table 3. Factors Associated with Overall Medical Expenses

Independent variables		Length of stay [‡]		Total expenses [‡]	
		Parameter estimate	95% CI	Parameter estimate	95% CI
Sex	Women	–		–	
	Men	0.191	(–0.080, 0.462)	0.181	(–0.072, 0.435)
Age	(each increment)	–0.014*	(–0.026, –0.002)	–0.012*	(–0.022, –0.001)
Education years	(each increment)	–0.020	(–0.073, 0.033)	–0.013	(–0.059, 0.034)
BMI	(each increment)	0.021	(–0.003, 0.045)	0.018	(–0.003, 0.039)
Major diagnosis	Affective schizophrenia	0.331*	(0.012, 0.649)	0.356 [†]	(0.089, 0.623)
	Bipolar mania	–		–	
Diabetes mellitus	No	–		–	
	Yes	–0.636*	(–1.166, –0.106)	–0.523*	(–1.026, –0.020)
Hypertension	No	–		–	
	Yes	–0.131	(–0.708, 0.447)	–0.228	(–0.698, 0.241)
Cholesterol (mg/dL)	(each increment)	–0.004*	(–0.006, 0.000)	–0.003*	(–0.005, 0.000)
Triglycerides ≤ 89 & no violence restrained		0.241	(–0.166, 0.647)	0.467*	(0.111, 0.823)
Triglycerides > 89 & violence restrained		0.432	(–0.024, 0.888)	0.627 [†]	(0.239, 1.015)
Triglycerides ≤ 89 & violence restrained		0.129	(–0.262, 0.521)	0.458 [†]	(0.133, 0.784)
Triglycerides > 89 & no violence restrained		–		–	

Abbreviations: BMI: body mass index; *: $p < 0.05$; †: $p < 0.01$; ‡: Logarithmic transformation before analysis.

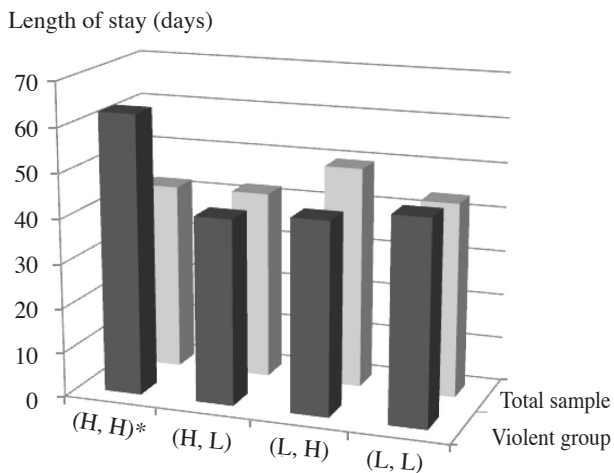


Fig. 1 Total length of stay of psychiatric patients in the violent and non-violent groups stratified by triglycerides and cholesterol. H: high level; L: low level. Note: Labels in parentheses are (level of triglycerides, level of cholesterol). *: Statistical significance between the violent and non-violent groups ($\chi^2 = 4.767$, $df = 1$, p value = 0.029) was performed with Generalized Linear Model adjusted by sex, age, BMI, education, diagnosis, diabetes mellitus, and hypertension.

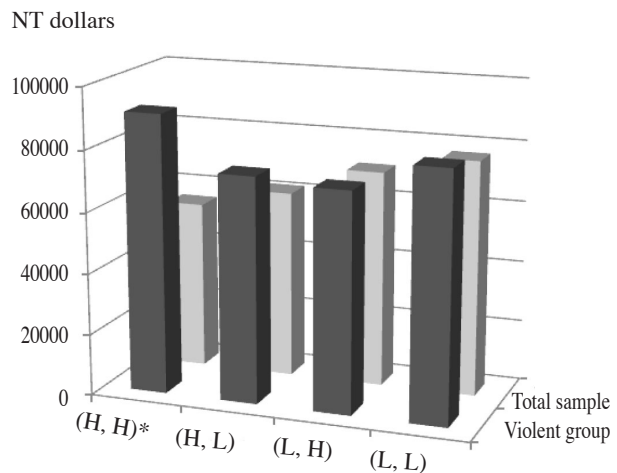


Fig. 2 Total medical expenses of psychiatric patients in the violent and non-violent groups stratified by triglycerides and cholesterol. H: high level; L: low level. Note: Labels in parentheses are (level of triglycerides, level of cholesterol). *: Statistical significance between the violent and non-violent groups ($\chi^2 = 10.202$, $df = 1$, p value = 0.001) was performed with Generalized Linear Model adjusted by sex, age, BMI, education, diagnosis, diabetes mellitus, and hypertension.

self-mutilation and self-mutilation in combination with suicidal behavior at 3 and 12 months of follow-up. Discrepancies in ethnicity may play an important role in the differences between these western studies and our findings. At least one Japanese study has demonstrated an association between total cholesterol and suicide attempts based on Asian ethnicity.⁽¹¹⁾ This study has provided evidence on the effect of triglycerides on violence in Taiwanese psychiatric patients and found it consistent with other western observations. The discrepancy between these two Asian studies may be attributable to disease categories.

To eliminate the confounding effects derived from a medication history, this study collected information from inpatients' medical charts. Medications related to serum lipids and aggressive behaviors were examined. With further examination of a patient's history before admission, the possible effects of medications on the lipid profile were eliminated among study subjects because of cessation of usage. This observation was consistent with previous reports describing psychiatric patients admitted elsewhere. Patients who discontinued medications were hospitalized because of manic or suspicious symptoms such as hyperactive reactions, oral-intake refusal, deterioration of self-care and insomnia. Based on quality assurance procedures and multivariable adjustment, this study found a predictive value of a 1 mg/dL increase in serum triglycerides associated with a 0.988 increase in the occurrence of violent behaviors. When psychiatric inpatients' triglyceride level was lower, e.g., below the average level of 89 mg/dL, they exhibited an elevated likelihood of violent behavior during inpatient stays. The observations of this study are not novel in theory, but they may provide an important reference for future clinical observations and practices.

Despite the role of triglycerides in predicting violent behavior, further analysis of the effect of violence on medical expenses also demonstrated prominent effects of the lipid profile. The link between triglycerides, cholesterol and medical expenses deserves more intensive discussion and verification in the future. In the present study, extreme or skewed medical expenses were found in patients who concurrently had lower cholesterol and lower triglycerides, and patients with higher cholesterol and higher triglycerides. After the adjustment of confounding

variables, the serum lipid profile showed that violence was significantly associated with total medical expenses, as well as items such as medications, consumables, and treatments. Thus, we assume that the health care providers used more medication and short-term injections to control violence. Health care teams might also use insurance reimbursable equipment to manage violence, including physical restraints and seclusion in an isolated room. The association between violence and elevated consumption of medical resources is easy to understand and justify, according to the analysis and conclusions. In addition, this study demonstrated a higher incidence of violence among bipolar manic patients than of schizophrenia affective patients. However, more severe consequences of violence were observed among schizophrenia affective patients than that bipolar maniac ones. Based on our clinical observations, we believe that the phenomena are consistent with the nature of the disease pattern. The violent behaviors in schizophrenia affective patients were more aggressive and required more clinical resources. Overall, the novel effect of the lipid profile on medical expenses is interesting and deserves further discussion.

Considering the effect of the lipid profile on medical expenses among violent cases, the impact of violence was deduced by examining the resource consumption required during the management of these episodes. The current data demonstrated a statistically significant association between violence and various types of medical expenses, regardless of age, sex, and other underlying diseases. Violent cases led to longer hospital stays and increased medical expenses in the group with lower triglycerides-lower cholesterol. The U-shape relationship between medical expenses and the lipid profile may reflect effects of both the occurrence and severity of violent behavior. The prediction and prevention of such violence by lipid profile examination on admission could be valuable for health care management. The early establishment of desensitization environments or behavior modification programs for potentially violent patients could reduce the occurrence and the impact of violence. Furthermore, lipid monitoring or adjustment via medication should be seriously considered.

The significance of this study lies in the predictability of violence, which has been regarded as

very difficult or impossible, because of several constraints. First, the incidence of violence is often underreported because of incomplete records, resulting from insufficient or non-standardized documentation. Some clinical staff who are assaulted feel as though they are partially to blame for the violence or believe that being attacked by patients is inherent to the psychiatric profession.⁽²⁵⁻²⁷⁾ Fortunately, because of the reimbursement incentives under the national health insurance system in Taiwan, the study setting of this research was relatively complete. Second, suggestions are being considered for designing a routine recording system in psychiatric patient care settings. Third, although risk evaluation instruments of violence have been widely published, there is still no standard format or guidelines for assessing potentially violent behavior. However, the major findings in this study offer a simple and useful predictive battery of markers for the inception and impact of violent behavior among psychiatric inpatients, which could provide a potential design for a more efficient and caring environment. Fourth, the study subjects were collected from a professional psychiatric care center in northern Taiwan, the representativeness of such patient cohort in terms of Taiwanese psychiatric patients remains an enigma. Future justifications are warranted. Lastly, the measurement of the lipid profile in this study was based upon a single biophysiological test of patients on admission to the hospital. The relationship between changes in the lipid profile and violent behavior inception must be determined by repeated measures in future research.

Acknowledgement

We are indebted to the Healthy Aging Research Center (EMRPD1A0871) at Chang Gung University, which provided helpful assistance in the statistical analyses.

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以血脂肪型態預測急性精神疾病住院病人暴力行爲之發生與衝擊

廖珮茹^{1,2} 陳其翔³ 詹宏裕³ 陳快樂³ 許光宏⁴

背景： 利用生化生理指標預測急性精神疾病住院病人暴力行爲之發生為臨床診療之重要議題，本研究以精神專科醫院之住院病人為主要研究對象，追蹤其住院期間發生暴力行爲之相關生理因子及其後續醫療照護之衝擊。

方法： 本研究以某精神專科醫院之情感性精神分裂症及雙極性躁症住院病人為主要分析樣本；以縱貫式分析來建構暴力行爲發生之血液生化指標預測模型，研究以患者之病歷紀錄及健保申報資料進行分析。

結果： 三酸甘油脂為暴力行爲發生之顯著預測指標，其濃度高者較不易發生暴力行爲，勝算比為 0.988，但三酸甘油脂高者發生暴力行爲後，對醫療照護之衝擊卻較為嚴重。暴力行爲發生後之醫療資源耗用與入院時病患血清中膽固醇濃度呈現負相關。發生暴力行爲的急性精神疾病住院病人，其三酸甘油脂、膽固醇二種血脂的組合型態與其產生的醫療衝擊呈現 U 型關係。

結論： 本研究提供簡單實用的預測因子模型來篩檢可能發生暴力行爲之急性精神疾病住院病患，結果可提供未來精神疾病專科醫療院所規劃照護方案及醫療管理決策參考。
(長庚醫誌 2012;35:382-91)

關鍵詞： 暴力行爲，血脂肪型態，精神疾病照護，醫療衝擊

廖珮茹、陳其翔並列第一作者。

¹亞東技術學院 醫務管理系；²台灣大學管理學院 商研所；³行政院衛生署桃園療養院 一般精神科；⁴長庚大學 醫務管理學系

受文日期：民國100年9月7日；接受刊載：民國101年2月10日

通訊作者：許光宏教授，長庚大學 醫務管理學系。桃園縣333龜山鄉文化一路259號。Tel: (03)2118800轉5486;

Fax: (03)2118138; E-mail: khsu@mail.cgu.edu.tw