IMPACT OF SOCIOECONOMIC DISPARITIES AND EDUCATION ON TRAUMA –INDUCED CLINICAL COMPLICATIONS

XINCHUN ZHOU
JAKE OLIVIER
D. OLGA MCDANIEL
University of Mississippi Medical Center,

ABSTRACT

Objective: This study is conducted to investigate the impact of social status including unemployment and education on the outcomes of clinical complications after traumatic injury.

Study design and methods: We included patients with unintentional blunt trauma who admitted to Surgical Intensive Care Unit (SICU). The patient's profile in terms of nature of injury (gun shot/knife stab wounds and motor vehicle collision), age and race were compatible with Level I trauma Center. A Statistical Analysis Software (SAS) program was applied to analyze effects of stratified Injury Severity Score (ISS), age, race, as well as preexisting social status on the outcome of clinical complications.

Results: Stratified ISS was linearly correlated to the rates of Systemic Inflammatory Response Syndrome (SIRS) and sepsis in both African American and Caucasian trauma patients, but the linear correlation of stratified age to the rates of SIRS and sepsis was only observed in the Caucasian population. The unemployed trauma patients had higher rates of clinical complications than the employed patients. African American trauma patients with lower education level had higher rates of sepsis in those with age ≥ 35 than those with age < 35 years. The age and race were confounding risk factors in the context of unemployment and education status influencing the outcome of clinical complications such as sepsis.

Conclusion: This study further substantiated the role of ISS in predicting clinical outcomes after traumatic injuries. Patient's age, ethnicity, education background and unemployment status were all considered as possible confounding risk factors, variably affecting the development of SIRS and sepsis after traumatic injury.

INTRODUCTION

Trauma is the leading cause of death among people age 15-44 and the fifth leading cause of death for all populations in the United States (Kochanek, 2004; Hoyert, 2005; Minino, 2006.) In addition to direct injury to vital organs, posttraumatic complications, such as systemic inflammatory response syndrome (SIRS) and sepsis are important mechanisms for trauma morbidity and mortality. SIRS, according to The American College of Chest Physicians and Society of Critical Care Medicine in 1990, is defined as a wide spectrum of inflammatory responses that occurs following traumatic injuries including head injuries, any kind of insults [gun shot or knife stab wounds, motor vehicle collision (MVC), falls, etc.], burn, surgery etc. Sepsis, on the other hand, is recognized as any kind of microbial infection that occurs in association with SIRS (Baine and Llewelyn, 2001). Therefore, SIRS occurs considerably more often than sepsis in hospitalized patients. In addition, both SIRS and sepsis increasingly occurs in hospitalized older patients, particularly older African American males. In the United States, there is about 750,000 sepsis cases reported annually (Wang, 2007), with a mortality rate ranging from 20-40% (Martin, 2003; Wang, 2007). In spite of medical advances, sepsis still remains the leading cause of death in non-cardiac intensive care unit patients (Moss, 2004). While the death rate from sepsis varies among populations, it is 4-fold higher in elderly patients and is expected to increase in aging populations (Angus, 2001). In addition, in severe sepsis, there is associated organ dysfunction, which is more common in older population with sepsis as compared with younger patients.

The ability to predict the occurrence and the severity of clinical complications immediately after trauma/injury

would be very valuable in rapid assessment of patient management, but remains a challenge because of multiple variables associated not only with patient's preexisting clinical conditions, as well as non-clinical, environmental and social status. At present, the injury severity score (ISS), calculated immediately after traumatic injury is the gold standard for predicting the occurrence of complications due to traumatic injury (Baker, 1974; Copes, 1998; Sullivan, 2003; Laird and Osborn, 2004; Sharma, 2005). A higher ISS value is associated with more clinical symptoms and longer recovery.

Currently used determinants to assess the outcome of trauma induced clinical complications, although have varying degrees of successes underestimate the prevalence of certain risk factors associated with the individual preexisting health disparities, ethnicity, and social status (Michaels, 2001).

We review in the manuscript the current non-clinical risk factors that might have impact on the occurrence of clinical complications and outcomes. Epidemiological studies based on the data from National Hospital Discharge Survey over the period from 1979 to 2003 in the United States indicated that black and other non-white groups were significantly at higher risk of developing sepsis after trauma injury (Esper, 2006). African Americans had a 35% higher rate of traumatic brain injury (Jager, 2000) and a higher risk for death due to all injury outcomes, except death due to suicide, as compared with Caucasians (Cubbin, 2000; Wong, 2002). Individual's educational background has also been an influential factor associated with incidence of traumatic injury and mortality from all causes (Wong, 2002; Whilock, 2006). Moreover, socioeconomic status affects people psychologically, socially and physically. People in the lowest occupational level as well as those with unemployment had a

4-fold higher risk of injury due to MVC (Whilock, 2006) as compared to those that were employed. At the population level, a 1% rise in unemployment was correlated with approximately 6000 excess deaths annually in the United States (Jin, 1995).

Education has always been associated with health disparity issues and has proven to have impact on the development of common diseases. In the United States, cohort studies have demonstrated that mortality rates from common cause as well as specific life threatening diseases are higher in individuals with lower educational status (Steenland, 2002). For example, in 1995, the mortality rate from chronic diseases for men with less than 12 years of education was 2.5-fold and for women, 2-fold higher than the individuals with higher education (Pamuk, 1998). Diabetes, hypertension and cardiovascular disease are more common in individuals with lower levels of education (Paeratakul, 2002). A CDC survey showed that in 2004, among adults age 25-64 with less than high school education, the death rate from motor vehicle crashes was 30.1 per 100,000 people; in individuals with high school degree, the rate was 23.4, and for those with at least some level of college education, the rate was 9. (CDC wonder, updated 2007). However, such correlation of between the level of education and clinical complications such as sepsis in individual undergone traumatic injury has not detailed.

Up to date, many investigators including us have emphasized the impact of preexisting clinical conditions such as diabetes, hypertension and renal or heart disorders on the occurrence of traumatic injuries. However, few have stratified either a single or combined effects of preexisting non-clinical risk factors on the outcome of trauma induced clinical complications such as sepsis and multiple organ dysfunction syndromes (MODS). Therefore, the study described in the

manuscript investigated the association of levels of education and the status of unemployment as risk factors on the outcome of clinical complications such as sepsis among patients with unintentional blunt trauma.

METHODS

Patients

All patients were admitted to the surgical intensive care unit at the University of Mississippi Medical Center during period of 2004- 2006. The patients, who required staying in the hospital at least 24 hours, were included in this study.

Data source

The information was obtained from patient charts and the laboratory database. A telephone follow-up was supplemented for the inquiry of incomplete personal information about educational level and employment status, when was not indicated in the charts.

Definitions and disparity identification

The ISS, initially described by Baker SP, 1974, is an anatomical scoring system that represents an overall severity of the injury. SIRS was defined by two or more of the following conditions that occurred in a same time frame: temperature > 38oC or < 36oC; heart rate > 90 beats/minute; respiratory rate > 20 breath/minute or $PaCO_2$ < 32 torr; WBC > 12,000/mm3 or <4,000/mm3, or >10% immature segmented WBC (band) (Muckart, 1997). Sepsis was defined as coexistence of SIRS with infection verified by laboratory positive cultures. Employment status and level of education were obtained from admission registration and supplemented by telephone interview. Demographics such as patient age, gender and race were obtained from patient's charts.

Statistical Analysis

Patients' health disparity data, age, race, gender and presenting ISS were analyzed using a SAS program to determine the effect on the clinical outcomes. Statistically significant p value was set at $p \leq 0.05$.

Results

Demographic and Clinical Characteristics

A total of 234 trauma patients, 113 (48.29%) African American and 121 (51.71%) Caucasian were studied. Demographics and the disparity profiles are shown in Table 1. African American patients were slightly younger than Caucasians. There was no significant difference in the mean ISS between the two groups. Overall, the male African American patients d higher risk of developing SIRS as compared with male Caucasian patients ($p < 0.001$). Among multiple trauma/injury causes, the motor vehicle collision (MVC) stood out. However, in African American male patients the incidence was almost equal for MVC (45.78%) and gun shot/knife stab wounds (39.76%). There were more females injured due to the MVC than males in both groups (African American: 73.3% vs. 45.88%, in Caucasian: 92.11% vs. 72.99%). The study also evaluated the

Table 1
Demographic and clinical characters of the patients

	African American		Caucasian	
	Female (n=30)	Male (n=83)	Female (n=38)	Male (n=83)
Age (mean ± SD)	33.9 ± 2.6	35.7 ± 1.5	39.3 ± 3.1	44.3 ± 2.0
ISS (mean ± SD)	24.5 ± 2.3	22.7 ± 1.4	26.6 ± 1.8	23.5 ± 1.3
Complications				
Sepsis (%)	11 (36.7)	32 (38.6)	19 (50.0)	38 (45.8)
SIRS (%)	10 (33.33)	40 (48.2)	11 (29.0)	20 (24.1) a
Type of injury				
MVC (%)	22 (73.33)	38(45.78)	35 (92.11)	60 (72.29)
GSW/KSW (%)	6 (20.0)	33(39.76)	0	7 (8.43) b
Others (%)	2 (6.67)	12(14.55)	3 (7.89)	16 (19.3)
Employment	n=29	n=75	n=35	n=77
Unemployed (%)	16 (55.2)	40 (53.3)	28 (80.0)	29 (37.7) c
Employed (%)	13 (44.8)	35 (46.7)	7 (20.0)	48 (62.3)
Education	n=17	n=47	n=17	n=42
≤ HS (%)	9 (52.9)	41 (87.2)	9 (52.9)	30 (71.4) d
> HS (%)	8 (47.1)	6 (12.8)	8 (47.1)	12 (28.36)

a: The rate of SIRS in African American male patients vs Caucasian male
patients, $p < 0.001$, OR = 2.93 and 95% CI, 1.517-5.657
b: GSW/KSW in African American male patients vs Caucasian male patients, p
< 0.001, OR = 7.166 and 95% CI, 2.993-17.08.

c: Unemployed Caucasian female patients vs unemployed Caucasian male patients, p < 0.001, OR =6.621 and 95% CI, 2.607-16.721.
d: > high school education in female patients vs male patients, p = 0.006, OR = 3.506 and 95% CI, 1.514-8.132.

unemployment status to the occurrence of traumatic injuries. There was about 2-fold increase in unemployment rates in Caucasian female patients as compared to males (80% vs. 37.7%, respectively, p < 0.001). Among African American patients, the difference was minimal. While analyzing the influence of the level of education on the occurrence of trauma, it was found that people with lower level of education had much higher incidence of trauma than those with higher education (Table 1.). Interestingly, there was an increased percentage of female patients with higher education than male patients in both African American and Caucasian populations (p=0.006). While the reason was undetermined, it might be explained by the fact that women with higher education have multiple carriers and social life style placing them at higher risk.

Analysis of Clinical Complications by Stratified Iss and Age

Trauma induced Clinical complications were analyzed based on a stratified ISS (0-14, 15-28 and ≥ 29) and age (≤ 20, 21-39, 40-59 and ≥ 60) in African American and Caucasian patients as showed in Table 2. In both ethnic groups, sepsis and SIRS were significantly associated by increased level of ISS. The correlation between ISS and clinical complications seemed to be linear. Patients with a higher ISS had a greater risk of developing sepsis and SIRS. However, when adjusted by age, a linear correlation was observed only in Caucasian population with sepsis (p = 0.0066) as well as with SIRS (p < 0.0271). Such association was not found in African American population. It was assumed that small sample size limited statistical significance of the association.

Table 2
Clinical complications stratified by ISS and age

	African American N=113		Caucasian N=121	
	n (%)	p value	n (%)	p value
Sepsis				
ISS		0.0011		<0.0001
0-14	6 (19.4)		4 (12.9)	
15-28	21 (48.8)		10 (22.2)	
≥ 29	29 (61.7)		28 (73.7)	
Age		0.8664		0.0066
≤ 20	6 (46.1)		2 (16.7)	
21-39	19 (51.4)		16 (26.7)	
40-59	23 (45.1)		21 (56.8)	
≥ 60	8 (40.0)		3 (60.0)	
SIRS				
ISS		0.0001		0.0021
0-14	13 (41.9)		19 (61.3)	
15-28	33 (76.7)		37 (82.2)	
≥ 29	40 (85.1)		36 (94.7)	
Age		0.8505		0.0271
≤ 20	8 (61.5)		6 (50.0)	
21-39	27 (73.3)		51 (85.5)	
40-59	36 (70.6)		30 (81.1)	
≥ 60	15 (75.0)		5 (100.0)	

Impact Of Unemployment On The Outcome Of Clinical Complications

The information was sought with the notion that unemployment might be a confounding risk factor to the cause of trauma and post trauma-induced clinical complications. Generally, studies are directed towards the impact of loss of employment on the mortality rates, due to heart attack, stroke and suicide. Among the study population, overall, 113 (53.32%) patients were unemployed. As shown in Figure 1, the unemployment rates were higher among patients with SIRS and sepsis, however, with only a borderline statistical significance (p=0.053, OR=1.19). Nonetheless, an odd ratio of approximately 1.2 was indicative of a positive association. In addition, the impact of unemployment on the outcome of clinical complications was sustained when the data were stratified on the basis of race and age (Figure 1.). A significant difference was observed in Caucasian patients (p = 0.036), but not in African American

Figure 1
An overall analysis of the impact of unemployment
on clinical complications
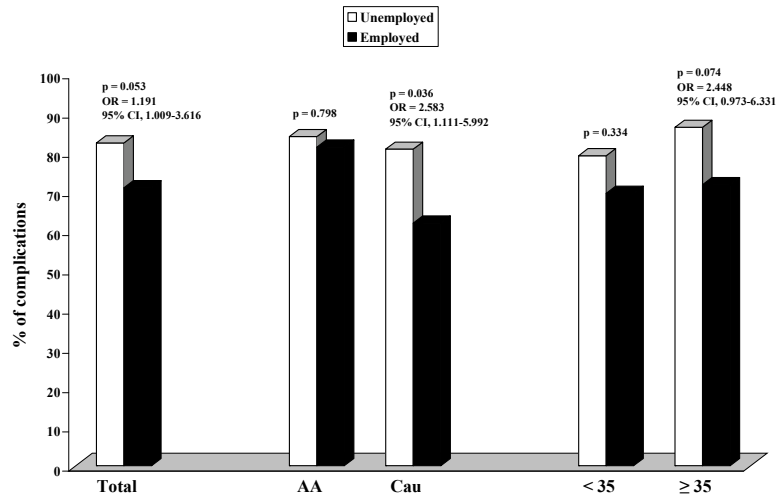
patients with trauma. When adjusted by the age, unemployment was much higher among patients older than age 35 year (p=0.074, OR=2.45, 95% CI: 0.97-6.33).

If unemployment reflecting the outcome of clinical complications after trauma injury, should it be considered a risk factor in the development of clinical complications after traumatic injuries? Thus the role of unemployment was assessed for each outcome measures (SIRS and sepsis) in Table 3. The frequency occurrence of the SIRS were higher in African American patients than in Caucasian unemployed patients, and higher in younger than age 35 years than in older unemployed patients. A borderline significant difference was found between younger and older African American trauma patients (p = 0.059). The SIRS is an immunological response that is often triggered by trauma

and environmental factors, either protecting the individuals against pathogenic antigens, or causing complexity in immune function leading to clinical complications followed by organ failure and death.

Sepsis occurred with a higher frequency in unemployed Caucasian than in unemployed African American trauma patients; and the frequency was

Table 3

Differential impact of unemployment on the outcome of clinical complications in the context of age and ethnicity

	African American			Caucasian		
	Age < 35	Age ≥ 35		Age < 35	Age ≥ 35	
	N = 56	N = 48	p	N = 42	N = 70	p
Unemp	n = 33	n = 23		n = 42	n = 70	
NC a	n (%)	n (%)		n (%)	n (%)	
	6 (18.2)	3 (13.04)	0.732	7 (24.14)	4 (14.3)	0.504
Sepsis	8 (24.4)	13 (56.52)	0.024 c	12 (41.4)	17 (60.7)	0.189
Emp.	n = 23	n = 25		n = 13	n = 42	
NC	n (%)	n (%)		n (%)	n (%)	
	5 (21.74)	4 (16.0)		6 (41.65)	15 (35.71)	
SIRS	13 (56.52)	10 (40.0)		1 (7.69)	9 (21.43)	
Sepsis	5 (21.74)	11 (44.0)		6 (46.15)	18 (42.86)	

a: NC, no complications
b: Younger unemployed African American had a higher rate of SIRS than the older, p = 0.059, OR = 3.012, and 95% CI, 1.024-9.358).
c: Older unemployed African American patients had a higher rate of sepsis than the younger, p = 0.024, OR = 4.036, and 95% CI, 1.314-12.57).

higher in older unemployed patients. Statistically, only older African American patients were at higher risk of developing

sepsis as compared with younger patients (p = 0.024, OR=4.0, and 95% CI: 1.3-12.6). However, a low inter-correlation was found among the employment status and trauma-induced clinical complications (unemployment vs. employment with sepsis: African American, 56% vs. 44%; Caucasian, 60.7% vs. 42.86%), which was statistically not significant.

Impact of Education on the Outcome of Clinical Complications

Univariate association of age (< 35 or ≥ 35), race and education (high school degree or less vs. greater than high school degree) are given in Table 4. Among a total of 113 patients, 89 (68.46%) had an education level of high school or less, and 34 (31.54%) had an education level of greater than high school degree. Patients with lower education (high school degree or less) and older than age 35 had a higher rate of sepsis. However, it was only statistically significant in African American patients (p=0.02, OR=5.06, and 95% CI: 1.4-18.1). Overall, a weak inter-correlation was found among the level of education and clinical variables. However in African American patients, age was a confounding risk factor reflecting the clinical outcome in the context of education. In spite of limitation in the study sample size, it was apparent that among older population, the outcome of SIRS and sepsis were reversely associated with the level of education (Table 4.)(≤ HS vs. >HS: SIRS, 35.3% vs. 71.42%; sepsis, 52.9% vs. 28.57%). The data indicated that in less educated older patients, once they develop the SIRS due to a posttraumatic injury, they become susceptible to the development of sepsis. Whereas older African American patients with higher education level are more likely to recover from the SIRS, and less likely to develop other clinical complications.

Table 4

Impact of education on the clinical complications after traumatic injury

Edu.	African American			Caucasian		
	Age <35 value	Age ≥ 35	P	Age < 35	Age ≥ 35	P value
	N = 40	N = 24		N = 20	N = 29	
	(n=33)	(n=17)		(n=14)	(n=25)	
≤ HSa						
NC	7 (21.2)	2 (11.76)		3 (21.43)	4 (16.0)	1.0
	0.236					
SIRS	20 (60.6)	6 (35.3)	0.081	6 (42.85)	9 (36.0)	1.0
Sepsis	6 (18.2)	9 (52.94)		5 (35.7)	12 (48.0)	0.678
	0.021b					
> HS	(n=7)	(n=7)		(n=6)	(n=14)	
NC	1 (14.28)	(0.0%)	1.0	3 (50.0%)	4 (28.57)	1.0
SIRS	4 (57.14)	5 (71.42)	1.0	1 (16.6)	2 (14.31)	1.0
Sepsis	2 (28.57)	2 (28.57)	1.0	2 (33.3)	8 (57.14)	0.62

a: HS, high school;

b: Older African American patients with less education level had a higher rate of sepsis than the younger, p = 0.021, OR = 5.06, 95% CI: 1.421-18.096.

DISCUSSION

In the current study of patients with unintentional blunt trauma, we have shown an association of trauma/ injury-induced clinical complications such as sepsis, with unemployment and education status. Through multivariate analysis, ISS and age were linearly related to the rate of sepsis and SIRS in trauma patients. Nonetheless, age was a risk factor only in Caucasian trauma patients. The ISS association in this study was consistent with other reports (Baker, 1974; Copes, 1998; Laird and Osborn, 2004; Sharma, 2005) and further substantiating the role of the ISS in predicting the occurrence of post-traumatic complications. Although age has been shown to be an important contributor

to the incidence of sepsis (Angus, 2001; Martin, 2003), our study showed that the rates of occurrence of sepsis and SIRS in our Surgical Intensive Care Unite (SICU) reflected significantly by age only in Caucasian population (Table 2). This pattern was not observed in African American trauma patients where there was almost a similar rate of sepsis or SIRS in each stratified age group. Whether this is due to a true unique age-specific pattern in the occurrence of clinical complications in African American trauma patients or because of an inadequate sample size distribution, needs further investigation.

We also found that low socioeconomic factor such as unemployment was reflecting the outcome of clinical complications. Unemployment status have been shown affecting on individual's social, psychological and physical conditions. It has also been related to an overall mortality rates (Jin, 1995), cardiovascular diseases (Bunn, 1979; Brenner, 1983) and suicide (Platt, 1984); unless otherwise stated there is no report indicating a correlation between unemployment and trauma/injury induced clinical complications such as sepsis. Our study indicated that the patients who are unemployed are at a higher risk of developing post-traumatic clinical complications. The impact of unemployment was greater on Caucasian patients than on African American patients. Furthermore, older patients were at a higher risk as compared with younger than age 35 years. Such variation in the population could be influenced by the quality of social-behavior among the populations. African Americans have benefited from socio-cultural aspects of the community. An effective source of social support provides optimism for coping with unexpected consequences such as unemployment-caused stress and helps to some degree a faster recovery. In this case, Caucasian individuals with long term unemployment might become more isolated from family and environment, consequently, when a traumatic

injury occurs, in association with a lack of social support and resources, he/she becomes more depressed and the stress from unemployment might contribute to the changes in the immune system, in response to trauma/injury, promoting the development or progression of clinical complications such as sepsis. Although such interpretation was not investigated, but it was evidenced from our study population that trauma patients who had more visiting family members and friends with social support and affiliation demonstrated better clinical outcome.

In injury prevention studies, a few have suggested the influence of education on the type and the severity of injury and morbidity (Cubbin, 2000), potential life expectancy (Wong, 2002) and infants injury/mortality (born from mothers with less education, Vitale, 2006). So far no details have been addressed on the impact of the level of education on post-traumatic clinical complications. Education has always had a great impact on the individuals' socioeconomics, employment status and the quality of health care. Particularly, the latter has been well documented for many health measures in various countries. However, direct relationship between the level of education and the outcome of clinical complications after traumatic injury is complex and has not been clarified. A variety of potential mechanisms including family background, poor health in childhood, learning resources, environment etc., might influence the relationship. In our study, there was clinical outcome relevance between the patients with education levels of less than high school or high school degree and patients with greater than high school degree, comparing the rates of SIRS and sepsis. Unfortunately, we failed to reveal a statistically significant difference, although a tendency of higher sepsis rate in patients with lower education was noted. When the comparison was made within African American trauma patients who had lower level of education, the rate of

sepsis was significantly higher in patients of age $\geq$ 35 years as compared with patients of age < 35 years. Why such pattern of association was not observed in Caucasian group, is unclear. An educated Caucasian individual might less likely to discuss the diagnosis of their previous infection and acute diseases. Such health disparity might predispose an individual to recurrent clinical conditions after traumatic injury, although evidence related to such explanation has been controversial. As reported by others previously, the effect of education in health is broad, including personal socioeconomic status, physical and psychological satisfactions and recognition of disease processes, and life expectancy.

This study revealed the impact of an individual's social status, including education and unemployment in an age and ethnicity stratified group on the outcome of clinical complications such as sepsis after a traumatic injury. It is our understanding that social status that lead to post trauma/injury-induced clinical complication are not always consequences of an inappropriate social behavior, such as excessive use of alcohol and drugs (Soderstrom CA, 2001; Plurad D, 2008), also due to common factors that often could be corrected by raising awareness of the risk factors by educational and social interventions. Such interventions could allow enhancement of educational achievements and social competence. Studies towards the development of public resources with teaching and job training facilities associated with the local trauma centers may provide a successful approach, to such population dilemma.

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