Significant Correlation of Trauma Epidemiology With the Economic Conditions of a Community

Marianne E. Cinat, MD; Samuel E. Wilson, MD; Stephanie Lush, MSN; Courtney Atkins, MHA

Hypothesis: Depressed economic conditions are associated with increased trauma and violent crime.

Design: Retrospective cohort study of prospectively collected data.

Setting and Interventions: Population and labor force data from 1992 to 2002 were obtained from the state Employment Development Department and the US Census Bureau. County data regarding the total number of trauma activations and mechanism of trauma were recorded. Crime statistics were obtained from the state Department of Justice and the Federal Bureau of Investigation. Correlation statistics were performed. Health care coverage for victims of penetrating trauma was also analyzed.

Main Outcome Measures: Correlation between unemployment rate, trauma epidemiology, and crime indexes.

Results: The correlation between the percentage penetrating trauma and the unemployment rate was $R = 0.92$ (Orange County, California) and $R = 0.95$ (Los Angeles County, California) ($P < .001$). The unemployment rate was also tightly correlated with Federal Bureau of Investigation crime indexes in both counties and in the state ($P < .001$). The overall county population was positively correlated with the total number of trauma occurrences in both counties ($P < .001$) but was negatively correlated with the number of penetrating traumas and crime indexes ($P < .001$). Seventy-five percent of penetrating trauma victims had no health care coverage or had state or county aid only.

Conclusions: The proportion of violent crime in a community is closely associated with the unemployment rate of that community and will vary longitudinally over time. The overall county population is less important. These data may be used for public policy initiatives regarding resource allocation to trauma centers, law enforcement planning, and programs aimed at crime prevention.

Arch Surg. 2004;139:1350-1355

During the last decade, the epidemiology of trauma patients evaluated at our trauma center has changed. One reason for this fluctuation may be changes in the socioeconomic conditions of our community. Previous studies1-5 have demonstrated that the rate of unemployment among trauma victims is higher than that among the general population. However, these studies include a limited number of patients evaluated during a short period. Few studies have evaluated the effect of the unemployment rate on trauma epidemiology longitudinally during many years in a given community.

This study was undertaken to evaluate the correlation between the unemployment rate, trauma epidemiology, and violent crime in our community. Our hypothesis was that depressed economic conditions would be associated with increased trauma and violent crime.

METHODS

This study was a retrospective cohort study of prospectively collected data. Data regarding the annual population, labor force, and unemployment rates for 2 urban counties in southern California from 1992 to 2002 were obtained from the state Employment Development Department and the US Census Bureau.

Crime statistics from 1993 to 2002 were obtained from the Department of Justice of the state of California and the Federal Bureau of Investigation. These included data on violent crime (homicide, rape, robbery, and aggravated assault), property crime, larceny, and arson.

County data regarding the total number of trauma activations annually at trauma centers in Orange and Los Angeles counties in southern California were obtained from the trauma center.
registry of the Emergency Medical Services Agency for each county. The mechanism of trauma was also recorded.

Data regarding payer mix were obtained for a subset of patients from the trauma registry at our institution (TraumaOne database; Lancet, Cambridge, Mass). A subgroup analysis was performed to evaluate the economic effect that the change in trauma epidemiology would have on our level I trauma center.

Data were compiled and reported as rates and as absolute numbers. Pearson product moment correlation coefficients were derived for paired observations. χ² Tests were used to compare groups with regard to payer mix. Linear regression analysis was used to define the association between the unemployment rate and penetrating trauma.

### RESULTS

#### ORANGE COUNTY

From 1992 to 2002 in Orange County, 32,477 trauma activations occurred at trauma centers; 4,529 of these were penetrating traumas. The annual rate of penetrating trauma ranged from 9.3% to 20.6% (Figure 1A).

From 1992 to 2002, the overall population of Orange County steadily increased from 2.48 to 2.93 million. During the same period, the labor force increased from 1.33 to 1.56 million. Labor force growth occurred mainly after 1996, at a rate of 3% per year. The number of unemployed workers was highest in 1993 at 89,700, declined to 38,300 in 2000, and rose again to 64,600 in 2002. The overall unemployment rate ranged from 2.5% to 6.7% (Figure 1A).

The correlation between the percentage penetrating trauma and the unemployment rate was calculated ($R=0.92$, $r^2=0.85$; $P<.001$) (Figure 1A). Linear regression analysis was performed to derive an equation (percentage penetrating trauma = [2.575 × percentage unemployment] + 0.03) to predict the rate of penetrating trauma based on the unemployment rate in Orange County (Figure 1B).

The absolute number of penetrating trauma activations also tightly correlates with the absolute number of unemployed persons ($R=0.96$, $r^2=0.92$) (Figure 1C). The number of blunt trauma activations tightly correlates with the county workforce (Figure 1D).

The unemployment rate was tightly correlated with the Federal Bureau of Investigation crime index ($R=0.94$), homicide rate ($R=0.92$), property crime rate ($R=0.93$), and larceny rate ($R=0.95$) in Orange County (Table 1). The overall county population was positively correlated with the labor force, total trauma occurrences, and percentage blunt trauma. Conversely, the overall county population was negatively correlated with penetrating trauma and indexes of violent crime (Table 2).

#### LOS ANGELES COUNTY

From 1992 to 2002 in Los Angeles County, 161,838 trauma activations occurred; 47,161 of these were pen-
The annual rate of penetrating trauma ranged from 21% to 42% (Figure 2A).

From 1992 to 2002, the population of Los Angeles County grew from 9.05 to 9.81 million. The labor force grew from 4.05 to 4.88 million. This growth occurred after 1996 for both. The number of unemployed workers was highest in 1992 at 441,400, declined to 255,300 in 2000, and rose again to 331,900 in 2002. The overall unemployment rate ranged from 5.4% to 9.8% (Figure 2A).

The correlation between the percentage penetrating trauma and the unemployment rate was calculated ($R=0.95$, $r^2=0.88; P<.001$) (Figure 2A). Linear regression analysis was performed to derive an equation (percentage penetrating trauma $= [3.148 \times \text{percentage unemployment}] – 0.81$) to predict the rate of penetrating trauma based on the unemployment rate in Los Angeles County (Figure 2B).

The absolute number of penetrating trauma activations tightly correlates with the absolute number of unemployed persons ($R=0.88$, $r^2=0.77$) (Figure 2C). The number of blunt trauma activations tightly correlates with the county workforce (Figure 2D).

The unemployment rate was tightly correlated with the Federal Bureau of Investigation crime index ($R=0.95$, $r^2=0.90; P<.001$), homicide rate ($R=0.93$, $r^2=0.86$), property crime rate ($R=0.96$, $r^2=0.92$), and larceny rate ($R=0.94$, $r^2=0.88$) in Los Angeles County (Table 1).

The overall county population was positively correlated with the labor force, total trauma occurrences, and percentage blunt trauma. Conversely, the overall county population was negatively correlated with penetrating trauma and indexes of violent crime (Table 2).

## PAYER MIX

Trauma patients were divided into 2 groups based on trauma mechanism: penetrating and blunt. Payer status was categorized into 3 groups. Patients with a blunt mechanism of trauma had a more favorable insurance profile than those who sustained penetrating injury (Figure 3).

### Table 1. Correlation of County Unemployment Rates With Crime Indexes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Orange County R Value</th>
<th>Los Angeles County R Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Bureau of Investigation crime index</td>
<td>0.94</td>
<td>0.95</td>
</tr>
<tr>
<td>California crime index</td>
<td>0.92</td>
<td>0.96</td>
</tr>
<tr>
<td>Violent crime index</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td>Homicide</td>
<td>0.92</td>
<td>0.93</td>
</tr>
<tr>
<td>Rape</td>
<td>0.70</td>
<td>0.92</td>
</tr>
<tr>
<td>Robbery</td>
<td>0.90</td>
<td>0.95</td>
</tr>
<tr>
<td>Aggravated assault</td>
<td>0.75</td>
<td>0.94</td>
</tr>
<tr>
<td>Property crime index</td>
<td>0.93</td>
<td>0.96</td>
</tr>
<tr>
<td>Larceny index</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td>Arson index</td>
<td>0.83</td>
<td>0.94</td>
</tr>
</tbody>
</table>

### Table 2. Correlation of Total County Population With Trauma and Crime Indexes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Orange County R Value</th>
<th>Los Angeles County R Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor force</td>
<td>0.98</td>
<td>0.95</td>
</tr>
<tr>
<td>Unemployed persons, No.</td>
<td>–0.63</td>
<td>–0.77</td>
</tr>
<tr>
<td>Unemployed persons, %</td>
<td>–0.74</td>
<td>–0.68</td>
</tr>
<tr>
<td>Total trauma activations</td>
<td>0.81</td>
<td>0.97</td>
</tr>
<tr>
<td>Blunt traumas, No.</td>
<td>0.92</td>
<td>0.93</td>
</tr>
<tr>
<td>Blunt traumas, %</td>
<td>0.91</td>
<td>0.77</td>
</tr>
<tr>
<td>Penetrating traumas, No.</td>
<td>–0.72</td>
<td>–0.74</td>
</tr>
<tr>
<td>Penetrating traumas, %</td>
<td>–0.96</td>
<td>–0.39</td>
</tr>
<tr>
<td>Federal Bureau of Investigation crime index</td>
<td>–0.92</td>
<td>–0.74</td>
</tr>
<tr>
<td>California crime index</td>
<td>–0.94</td>
<td>–0.74</td>
</tr>
<tr>
<td>Violent crime index</td>
<td>–0.97</td>
<td>–0.71</td>
</tr>
<tr>
<td>Homicide</td>
<td>–0.92</td>
<td>–0.63</td>
</tr>
<tr>
<td>Rape</td>
<td>–0.93</td>
<td>–0.61</td>
</tr>
<tr>
<td>Robbery</td>
<td>–0.93</td>
<td>–0.75</td>
</tr>
<tr>
<td>Aggravated assault</td>
<td>–0.97</td>
<td>–0.80</td>
</tr>
<tr>
<td>Property crime index</td>
<td>–0.93</td>
<td>–0.73</td>
</tr>
<tr>
<td>Larceny index</td>
<td>–0.93</td>
<td>–0.74</td>
</tr>
<tr>
<td>Arson index</td>
<td>–0.93</td>
<td>–0.70</td>
</tr>
</tbody>
</table>

Violence in North America has become a public health emergency. More than 111,000 Americans are severely injured by penetrating trauma each year, with an estimated cost of $126 billion annually. Furthermore, a recent study by the International Collaborative Effort on Injury Statistics revealed that the homicide rate in the United States was 4 times greater than that in 11 other developed nations. We must understand the roots of urban violence to begin to develop effective programs aimed at prevention.

This study illustrates a tight association between the unemployment rate and the rate of penetrating trauma occurring within a community. Although previous studies have shown a high rate of unemployment among patients who are admitted for trauma, few have evaluated the direct effect that evolving social conditions have on local medical centers and law enforcement agencies. Interestingly, a previous study, published since the submission and acceptance of the abstract of this article, documented a similar strong association between penetrating trauma and the unemployment rate at 2 level I trauma centers in a Midwest city. This association does not appear to be unique to our region; it is likely applicable to most communities throughout the country.

Despite the similarities, there are unique features to each community analyzed in this study. The rate of penetrating trauma in Orange County is much lower for a given unemployment rate (factor of 2.6 times) than it is in Los Angeles County (factor of 5.1 times). In Orange County, the unemployment rate is more closely correlated with the property crime index, larceny index, homicide rate, and robbery rate than it is with rape and aggravated assault. In Los Angeles County, all crime indexes are closely correlated with the unemployment rate (Table 1).

This variation between counties illustrates a complex interaction of various factors within any given community.
munity. In 1997, the importance of “place” was analyzed when evaluating the dynamics of trauma in an urban American city. The investigator found that the relative importance of 3 factors (poverty-violence, unemployment, and stability) varied depending on the region of the city evaluated. This stressed the importance of place when assessing the effect of social conditions on human behavior. Although the overall correlations are similar, the relative response rates for each region or “cluster” may be different. It is important to evaluate each community individually.

In an attempt to capture the relationship of socioeconomic conditions of various types of violent crime, trauma center activations and Federal Bureau of Investigation crime indexes were used. This allowed us to capture violent crime that may not have been reported to police (ie, trauma center activations) and violent crime that may not require trauma center activation (ie, Federal Bureau of Investigation crime indexes). Both databases provide a different, yet overlapping, perspective. Furthermore, although crime statistics are useful, hospital-based studies of assault may be more accurate than studies based on reported crime, because of a lack of police reporting of minor assaults. In a study in England, four fifths of assaults were not reported to the police. Therefore, hospital-based investigations may be of benefit to identify risk factors and community variations in response to socioeconomic changes.

Previous investigations have suggested that unemployment is not a direct cause of violence but rather that unemployment increases criminal offenses of material gain only. In this study, the unemployment rate was closely correlated with the property crime index and larceny index in Orange and Los Angeles counties. Unemployment may cause the rate of property crime to increase, and the rate of penetrating trauma reflects this occurrence. This analysis revealed several interesting social phenomena. In the early 1990s, when economic conditions were poor, there was little movement of people into Orange or Los Angeles counties (Figures 1D and 2D). However, as jobs were created, there was an influx of laborers into both counties, with the resultant increase in

Figure 2. Los Angeles County. A, A tight correlation between the unemployment rate and the percentage of penetrating trauma was found from 1992 to 2002 ($R = 0.85$, $P < .001$). B, Linear regression analysis was used to demonstrate the relationship between unemployment and penetrating trauma (percentage of penetrating trauma $= [5.148 \times \text{percentage of unemployment}] - 0.81$). C, A tight correlation also exists between the absolute number of unemployed persons and the number of penetrating trauma activations ($R = 0.88$). As the number of unemployed persons increases, the number of penetrating trauma activations increases. D, Conversely, the county workforce population tightly correlates with the number of blunt trauma activations ($R = 0.98$). From 2000 to 2002, the numbers in both categories increased.

Figure 3. Penetrating trauma patients (A) have significantly less health care coverage than blunt trauma patients (B), placing a potential financial burden on medical centers caring for these patients ($P < .001$).

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overall population. While this increase in population was associated with a higher number of total traumas and blunt trauma, it was negatively associated with the number of penetrating traumas in both counties (Table 2). Therefore, although the population of a community grows significantly, intentional trauma rates do not increase if socioeconomic conditions are favorable. However, when socioeconomic conditions are poor, the number of unemployed persons increases and violent crime and trauma also increase.

The effect a depressed economy has on trauma centers and the health care system is illustrated in the payer mix analysis performed in this study. During the last 2 decades, the establishment of trauma systems has improved patient outcome following injury. This requires significant resources to be dedicated by hospitals designated as trauma centers. As the socioeconomic status of a community declines, unemployment rates rise and the number of people without health care insurance increases. Nearly 40% of patients with penetrating trauma in this study had no health insurance coverage; another 35% had limited coverage from state or county aid. Therefore, a higher proportion of penetrating trauma adversely affects the financial status of hospitals caring for the injured patient. 

There are potential weaknesses to this study. The relationship between unemployment and violence is complex. The existence of a direct causation cannot be determined. Theoretically, it is assumed that an unemployed person resorts to crime to support himself or herself. This may be true. However, other factors such as frustration, poverty, resentment, boredom, and low educational attainment may also contribute. In addition, some other variable may be causing an increase in unemployment and violent crime. Finally, the employment status of the perpetrators of the penetrating trauma in this study is not known. Although more penetrating trauma was occurring in the community, it is not known if the individuals committing the assault were unemployed or employed. This is referred to as ecological fallacy. In other words, if a gang-related homicide takes place in an area where large proportions of people are unemployed, one cannot assume that the individuals involved in the homicide were also unemployed.

Although a direct cause and effect cannot be definitively established by this study, the findings show a strong association between the unemployment rate and the rate of penetrating trauma and violent crime in 2 communities. This association needs to be investigated further. The discussions that follow this article are based on the originally submitted manuscript and not the revised manuscript.

**Acknowledgment:** We acknowledge Diana Porral, BS, University of California Irvine Medical Center, and Christy Preston, RN, Los Angeles County Emergency Medical Services Agency, for their assistance in providing data for the manuscript.

**References**

Jonathan Hiatt, MD, Los Angeles, Calif: Wealthier is healthier. You can take it to the bank. Virtually every ailment that afflicts mankind occurs with greater frequency or in a more severe form when times are bad, and the victims are poor. The work just presented emphasizes the point that traumatic injury is no exception to this fundamental rule. In an interesting and provocative paper, Drs Cinat, Wilson, and colleagues tell a tale of 2 counties as they analyze relationships among 10-year statistics regarding unemployment, crime, and trauma mix. Their stated purpose was “to evaluate the correlation between unemployment rate and trauma epidemiology to test the hypothesis that depressed economic conditions would be associated with increased trauma and violent crime.”

The authors showed, both in Los Angeles and Orange counties, that penetrating injury ratios declined in virtual lockstep with the decline in unemployment. In the language of the hypothesis, improving economic conditions were tightly associated with a decrease in penetrating trauma. Was the converse true? Perhaps, but less dramatically so. Unemployment certainly rose after the year 2000, but the penetrating trauma ratio stayed relatively constant, which raises the question as to whether the injury curve had flattened for reasons unrelated to economics.

Some illumination is provided by looking at the total number of penetrating trauma victims rather than the fraction by mechanism. In Orange County, this number indeed rose with unemployment, supporting the authors’ hypothesis. But in Los Angeles County, the number of penetrating victims turned up before unemployment, suggesting a more complex relationship. It may be that the hypothesis could be better tested by examining the total number of violent injuries, both blunt and penetrating, although that would be more difficult to do. The entire analysis might be simplified by calculating violent injuries as a fraction of the total population rather than the trauma population, which I believe would then give you a true rate of violent injury. If these are quibbles over nomenclature, my apologies.

Another of the authors’ observations concerns the relationship between payer mix and mechanism of injury. Simply stated, blunt pays; penetrating doesn’t. We know from many reports that penetrating trauma has the potential to generate large, even chronic, costs that eventually are passed on to society. Dr Cinat has shown that these costs may increase in times when tax revenues are depressed and society is least able to absorb them.

I have questions for Dr Cinat in 2 areas. First, do you plan any further analysis? Specifically, have you looked at costs and receipts to see whether the trauma center’s balance sheet really does mirror the economic trends? It seems that might add further elucidation of the economic link between penetrating trauma and violent crime. Medical centers caring for a disproportionate number of penetrating victims rather than the fraction by injury. If these are quibbles over nomenclature, my apologies.

In closing, may I commend the authors for undertaking this important epidemiologic review? Whatever the causes, we live in a violent age. The trauma network is a critical link in our line of defense, a national treasure that is constantly threatened by shifting economic fortunes. To the extent that we analyze these fortunes and better anticipate our needs, we serve our patients and our communities. The trauma network was invented by surgeons, sustained by surgeons, and surgeons must take a vital role in defense of its long-term health.

Jan K. Horn, MD, San Francisco, Calif: I enjoyed this paper very much, and being a trauma surgeon, this strikes a lot of chords with me. The economic situation is certainly a big factor in the rates of trauma that we see. Other things can affect it, and the most striking example that I am reminded of was the Loma Prieta earthquake and the night that I spent on call. We had an unprecedented amount of penetrating injuries that seemed to occur as a result of that event.

Now, one of the first slides that you showed was the gun injuries around the world, comparing the rates among different countries. Yet, the United States still has some of the lowest levels of unemployment comparatively to some of those other countries. It would seem that that is a contradiction, that the rates of gun violence are higher in a country that has lower rates of unemployment and a better economic situation. Can you explain this global paradox?

Dr Cinat: As both discussants point out, the etiology of violence in our communities is truly complex. In this study, we have only analyzed a single association, specifically, the relationship between the unemployment rate and the rate of penetrating trauma in 2 counties in southern California. Although the tight correlation is compelling, unemployment is clearly not the only factor involved. In any type of correlative study, one must be careful not to confuse association with causation. Clearly, unemployment and violence are associated, but we cannot state that unemployment directly causes an increase in violence.

As Dr Horn points out, the United States has a very high rate of gun injuries as compared to other countries, despite a lower unemployment rate. This illustrates the complexity of the situation. Deeper cultural issues beyond unemployment exist in the United States that seem to increase the rate of violence that we see. Canada, for instance, has nearly 3 times the number of guns per capita in their country yet has a fraction of the violent crime and murder. Understanding the exact cultural influences in the United States that promote violent behavior is complex. Unemployment is one piece of that puzzle, but there are clearly much broader cultural issues at work here.

Dr Hiatt suggests that we evaluate actual costs and receipts at our trauma center over the same period of time. This certainly could be the basis for another manuscript and would further elucidate the association between the economic conditions of a community on the financial viability of trauma centers.

Finally, Dr Hiatt asked how this data could be used. Perhaps crime prevention programs should focus on education and employment, offering opportunities for productivity in society. Law enforcement resources may need to be adjusted in difficult economic times to accommodate the increase in violent crime. Medical centers caring for a disproportionate number of underinsured patients need to receive support to defray costs during difficult economic times.

This study reveals only the tip of the iceberg when evaluating the interface between medical care, social policy, and the cultural issues that drive violence in this country. Further work and understanding of the complex interactions is necessary before effective change can be made.