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Penetrating Craniocerebral Injury Resultant from Gunshot Wounds: Gang-related Injury in Children and Adolescents

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ABSTRACT

WE PROSPECTIVELY AND retrospectively reviewed a series of 780 patients who presented to the University of Southern California/Los Angeles County Medical Center with a diagnosis of gunshot wound to the brain during an 8-year period. Of these, 105 were children ranging in age from 6 months to 17 years. Injuries were gang related in 76 (72%) children and adolescents. Stepwise linear regression analysis was used to formulate a predictive model of outcome in this population. Patient age ($F = 10.92$), sex ($F = 9.32$), occipital entry site ($F = 8.17$), bihemispheric injury ($F = 8.50$), and admission Glasgow Coma Scale ($F = 69.91$) were all found to correlate with outcome ($P < 0.05$). Significant differences between pediatric and adult populations were noted in transit time, entrance site, and age-related outcome. Occipital or assassination-type wounds were most common in children. In addition, a younger age was associated with poor outcome ($P < 0.0001$). We describe both the economic and racial trends in our population of patients in addition to weapon type and toxicological evaluation. The Department of Neurological Surgery is becoming directly involved in providing information to children at the junior high school level regarding gang activity and brain and spinal cord injury. In conjunction with the Community Youth Gang Services Organization and Think First Organization, we are attempting to integrate prevention through education and community mobilization. This is a plan aimed at informing and recovering the youth affected by gangs.

Penetrating craniocerebral injury in children and adolescents 17 years of age or younger is an increasing cause of emergent neurosurgical admissions to major metropolitan medical centers. In 1991, more than 25% of all gunshot homicide victims in Los Angeles were 19 or younger. In 1991, of 518 homicides in youths, 412 resulted from gunshot wounds. Unlike the rest of the country, more youths die from gunshot homicides in Los Angeles than traffic accidents.

Gang-related murders in Los Angeles County increased from 351 in 1980 to 771 in 1991. Sixty-four (31%) of these homicides occurred in children and adolescents 17 years of age or younger. The recent statistics regarding gunshot homicide victims in Los Angeles are presented in (Table 1). As of March 12, 1992, there were 105,520 known gang members that made up over 942 gangs in Los Angeles County (Los Angeles County Sheriff's Department). The percentage of fatal shooting in juveniles also increased from 12% in 1970 to 27% in 1992.

Year	Total Gang Murders (County)	Total Gang Murders (USC Catchment Area)	Juveniles (17 years or Less)
1987	387	79	21 (26.58%)
1988	452	96	20 (20.83%)
1989	554	116	24 (20.69%)
1990	690	170	44 (25.88%)
1991	771	207	64 (30.92%)

Table 1. Los Angeles Sheriff's Department Jurisdiction Juvenile Victims of Gang Murder

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We discuss our recent experience with penetrating craniocerebral injuries in children and adolescents; in addition, we define the predictive models of outcome in this population of patients and discuss the potential for intervention and prevention of this type of injury. We also discuss gang-related injuries and our experience with this subpopulation of patients in Los Angeles, given that it represents such a large percentage of patients in our series.

PATIENTS AND METHODS

All patients with penetrating missile injuries to the brain during an 8-year period were retrospectively or prospectively evaluated for selection into the study protocol. The criteria for inclusion included penetrating craniocerebral injury in patients 17 years old or younger and completion of computed tomographic (CT) studies at admission. We were also interested in looking at the outcome after penetrating craniocerebral injury in all patients. Thus, patients with additional systemic injuries were excluded from the study. All patients had CT scans performed within 3 hours of admission. During this period, 780 patients presented to the University of Southern California/Los Angeles County (USC/LAC) Medical Center. Of these, 105 were entered into our evaluation. Seventy-six (72%) of these injuries were gang related.

After injury, all patients were evaluated immediately in the field by paramedics. Patients were intubated in the field and pressure support was initiated as indicated. Resuscitation was performed according to Advanced Cardiac Life Support protocol. Vital signs and neurological evaluation were documented at presentation and then every 5 to 10 minutes during transport to USC/LAC Medical Center. In addition, transit time from the initial arrival of paramedics at

the scene until the patients were transferred to USC/LAC Medical Center was calculated. Baseline Glasgow Coma Scale (GCS), trauma score, and vital signs were recorded at arrival at USC/LAC Medical Center.

At arrival, emergency care was initiated by the trauma team, including emergency room physicians, general surgeons, and neurological surgeons. Fluid resuscitation was continued with blood products and crystalloid and/or colloid solutions. Endotracheal intubation was performed in those patients with hemodynamic and/or respiratory compromise in addition to those patients with an admission GCS score of < 6. Mannitol and Lasix were given to patients with evidence of brain stem dysfunction. Patients began receiving broad spectrum antibiotics, tetanus toxoid, and anticonvulsants at admission. CT scans were performed as soon as possible once the patients were hemodynamically stabilized.

Intracranial pressure (ICP) monitors were placed in all patients with an admission GCS score of < 7, and ICP was continuously monitored for up to 10 days. Cerebrospinal fluid was drained intermittently for an ICP of > 20 mm Hg. Patients requiring operative intervention had surgery performed within 24 hours of admission. Surgical management began with the evacuation of any mass lesions and debridement of necrotic tissue and bony fragments at entrance and exit sites. Only superficial or local bone fragments were pursued and debrided. Deep parenchymal fragments and those not readily accessible were not removed. Metallic fragments were removed when accessible. Dural lacerations were either repaired primarily or through the use of fasciae patch grafts. Aggressive hemostasis was obtained at all wound sites. All wounds were copiously irrigated with bacitracin containing saline solutions. Intraoperative and perioperative antibiotics were administered intravenously to all patients.

A pentobarbital coma was instituted if continued elevations in ICP were recorded despite hypocapnia, diuresis, and ventriculostomy drainage. With continued elevations in ICP, despite the administration of pentobarbital, an occasional patient with a severely contused brain was taken to surgery for a frontal or temporal lobectomy of the damaged brain.

A full neurological evaluation of the patient was completed before discharge, and the patient was again evaluated at 6 months after discharge according to the Glasgow Outcome Score as follows: 1, death; 2, persistent vegetative state; 3, severe disability (conscious but disabled); 4, moderate disability (disabled yet independent); and 5, good recovery. Glasgow Outcome Scores of 1, 2, or 3 were considered to represent a poor outcome, whereas Glasgow Outcome Scores of 4 and 5 represented a good outcome. A CT scan was also obtained before discharge and at a 6-month follow-up in some cases. Follow-up data included details of a neurological evaluation and the patient's employment status. Patient information was obtained from paramedic, admission, Los Angeles County Coroner, clinic, and hospitalization records.

STATISTICAL METHODS

During an 8-year period, 105 children and adolescents met the criteria for entrance into the study and were included in our statistical analysis. Eighty-eight patients had prolonged follow-up. A total of 38 variables were recorded in this series. All variables were screened for outliers by using Grubbs' analysis. Continuous variables (age and transit time) were evaluated for normal distribution by using detailed frequency distribution analysis and Box-Cox analysis. The variable age was normalized by using a logarithmic transformation as in the previous study evaluating all the patients.

A forward and backward linear stepwise regression analysis (BMDP Statistical Software, Inc., Los Angeles, CA) was used to relate all independent variables to outcome (Glasgow Outcome Score). Two-group and matched *t*-tests were used to correlate all independent variables with outcome. The equality of group variances was evaluated by Levene's test. Levels of statistical significance were set at $P < 0.05$.

Based on our clinical experience, we were able to group distinct sets of variables into combined variables. In addition to reducing the number of possible models, this method for selecting variables allowed us to incorporate our clinical experience into the analysis. Grouped variables included the combination of bony and/or metallic fragmentation, multiple entry sites involving both hemispheres, and injuries involving multiple lobes with ventricular involvement.

RESULTS

General population characteristics

We reviewed a series of 780 patients who presented to USC/LAC Medical Center with a diagnosis of gunshot wound to the brain during a 6-year period. One hundred patients were evaluated prospectively, whereas the paramedic, admission, Los Angeles County Coroner, clinic, and hospitalization records of 680 were reviewed retrospectively.

In our series, 105 patients ranged in age from 6 months to 17 years (mean, 15 yr). The general population characteristics of the current study are presented in Tables 2 and 3.

Study	Barlow et al., 1982 (1)	Ordog et al., 1986 (18)	Ordog et al., 1987 (17)	Beaver et al., 1990 (3)	Sarnaik et al., 1989 (14)	Present Study
Sex	83% M 17% F	47% M 53% F	91% M 9% F	77% M 23% F		91% M 9% F
Race						
Black		21	213			17
Hispanic		13	41	68		84
White			1	64		3
Asian						1
Age	0-16	0-9	0-15	0-16	1-16	0-17
Transit time	30 min				30 min	29 min
Hospitalization Days	24 d	11 d	11.7 d			14.1 d
Patient number	108	34	285	132	14	105
Central nervous system injuries	9	13	10	81	14	105
Motivation						
Homicide	29%	42%*		46%		5%
Accident	60%	27%		25%		5%
Suicide	1%			22%		4%
Unknown			16%	5%		9%
Theft		6%				
Drug-related						1%
Gang		42%*	80% > 10 yr			72%

* Gang homicide.

Table 2. Population Characteristics

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-related injuries	76
Suicide	4
Random assault	8
Police inflicted	1
Accidental	5
Drug related	1
Unknown	10
Total	105

Table 3. Motivations

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There was distinct evidence of assaults occurring within racial groups in our series. In 1991, gang-related homicides in Hispanics were intraracial in 92% of cases and extraracial in 8%. Gang-related homicides in blacks were intraracial in 72% of cases and extraracial in 28% (Table 4). In addition, drug use did not correlate in a statistically significant manner with gang-related homicides. There were no significant differences in the use of cocaine, phencyclidine, or morphine between the victims of gang-related and nongang-related homicide. Victims of nongang-related homicide were more likely to be under the influence of alcohol ($P < 0.01$). A potential conclusion is that these assaults represent planned and/or premeditated crimes as opposed to spontaneous assaults resulting from drug or alcohol use.

Suspect/victim	1987	1988	1989	1990	1991	Total
Black vs black	39	68	49	35	48	239
Black vs Hispanic	8	18	11	7	16	58
Black vs white	2	2	1	1	3	9
Hispanic vs Hispanic	14	28	45	88	182	357
Hispanic vs black	3	2	5	3	9	22
Hispanic vs white	2	8	2	3	7	22
White vs white	0	0	0	0	0	0
White vs Hispanic	0	0	1	0	1	2
White vs black	0	0	0	1	1	2
Total	66	126	114	138	267	

Table 4. Gang-related Homicides by Ethnicity in Los Angeles County

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These injuries resulted from various types of firearms (Table 5). Handguns continue to be the most common source of injury in gang-related homicides. Most important is the marked increase (from 54 in 1987 to 146 in 1991) in homicides resulting from the use of handguns. We are also seeing an increase in the use of the AK47 automatic rifle, with an increase from 8 homicides in 1987 to 13 in 1991. Despite the continuing trend in the use of assault rifles in combination with drive-by shootings, we additionally noted an increase in walk-up or "pointblank" assaults in our population. The majority of these patients have systemic injuries or do not survive their initial injuries. Entrance sites were frontal in 30%, temporal in 23%, parietal in 19%, and occipital (assassination-type injuries) in 28%. Through and through injuries were present in 23%. The number of patients suffering assassination-type injuries increased from 1 in 1987 and 0 in 1988 to 6 in 1989 and 1990 and 4 in 1991.

	1987	1988	1989	1990	1991	Total
Handgun	54	78	65	112	146	455
Rifle	7	2	4	3	5	21
Shotgun	6	4	11	7	13	41
Machine gun	6	6	8	8	1	29
AK-47	8	5	9	14	13	49
Unknown	8	5	12	16	11	52
Total	91	100	109	160	189	

Table 5. Gang-related Homicides by Weapon Used

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Predictive models of outcome

Stepwise linear regression analysis was used to formulate a predictive model of outcome in this population. Patient age ($F = 10.92$), sex ($F = 9.32$), occipital entry site ($F = 8.17$), bihemispheric injury with intraventricular involvement ($F = 8.50$), and admission GCS score ($F = 69.91$) were all found to correlate with outcome ($P < 0.05$). In addition to the significant differences between pediatric and adult populations in transit time and entrance site, we determined a significant difference in age-related outcome. In children, younger age was associated with poorer outcome ($P < 0.0001$).

Long-term follow-up data were obtained in 88 patients. Glasgow Outcome Scores based on admission GCS are provided in (Table 6). Four patients with admission GCS scores of 3, 4, or 5 and good outcomes will be discussed in a future publication.

Admission Glasgow Coma Scale	Glasgow Outcome Score					Total
	1	2	3	4	5	
3	23	0	0	1	0	24
4	16	1	1	2	0	20
5	1	1	0	1	0	3
6-7-8	1	1	5	1	0	8
9-10-11-12	0	0	0	3	2	5
13-14-15	0	0	2	9	17	28
Total	41	3	8	17	19	88

Table 6. Outcome after Penetrating Craniocerebral Injury in Children and Adolescents

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DISCUSSION

Predictive models of outcome

A number of series have evaluated outcome, both retrospectively and prospectively, after either closed (14) or penetrating craniocerebral injury (4,7,9,16,21,22). We have formulated predictive models of outcome for both children and adults. We have additionally analyzed both populations for the significant differences between the two.

In the current series patient age, sex, occipital entry site, bihemispheric injury with intraventricular involvement, and admission GCS were all found to correlate significantly with outcome by linear regression analysis. Logistic regression models of outcome were significant for the inclusion of subarachnoid hemorrhage and GCS score <7 ($P < 0.0001$). Other predominantly adult series have reported the correlation of admission GCS score (4,26), bilateral

hemispheric injury, and intraventricular hemorrhage with outcome (2,5,20,24). Subarachnoid hemorrhage has also been found to correlate with outcome after closed and penetrating head injury (6,12). Although suicide is more likely to be fatal, motivation did not reach the statistical significance required to be included in our model.

We were unable to include pupillary diameter at admission in our model because of the large number of denervation and/or penetrating injuries to the orbit in this population. The presence of disseminated intravascular coagulation, as defined by a low fibrinogen level (less than 150 mg%) and abnormal values of two hematological parameters (platelet count, prothrombin time, partial thromboplastin time, or fibrin degradation products), was also not included. The presence of disseminated intravascular coagulation in patients with trauma, penetrating or otherwise, has been found to be associated with an increased mortality of 85% (13). Although predictive, it remains nonspecific to this population and was not included.

The difference in age-related outcome between pediatric and adult populations in our series is likely representative of the large number of suicides present in our adult population (53), as compared with younger children and infants (one of four suicides in our series) who, in our series, are usually injured as a result of gang-related crime (predominantly as bystanders) or murder-suicide. The number of suicides in our series was distinctly different from that of Beaver et al. (3), in which the incidence of suicide at 22% was much higher in children and adolescents. The difference in transit times between pediatric and adult populations represents the fact that gang-related injuries in Los Angeles are usually witnessed, and thus notification of emergency agencies tends to be more rapid. Our transit times were consistent with those in other pediatric series (approximately 30 min). Transit times in adults, in whom suicidal injury is more prevalent, tend to be longer.

We are aggressive in our management of children and adolescents suffering both penetrating and nonpenetrating injuries to the brain. All patients with admission GCS scores of less than 7 have ventriculostomies. A pentobarbital coma is instituted if continued elevations in ICP are recorded, despite hypocapnia, diuresis, and ventriculostomy drainage. With continued elevations in ICP, patients with a severely contused brain are taken to surgery for a frontal or temporal lobectomy of the damaged brain.

Sarnaik et al. (19) evaluated the role of aggressive ICP control in the management of 11 comatose children with penetrating craniocerebral gunshot wounds. Five children had an admission GCS score of 3 or 4, were moribund at admission, and died within 12 hours. Three patients with admission GCS score of 14 or 15 underwent supportive care and surgical debridement and recovered without neurological sequelae. The remaining six children were comatose at admission with a GCS score of 5 to 7. All were comatose at admission with low GCS scores and bullets that crossed the sagittal plane. Other findings included bullets that crossed the coronal plane, the presence of mass effect, and ventricular or posterior fossa involvement. All six patients were aggressively managed with mechanical hyperventilation, mannitol osmotherapy, pentobarbital, and surgical decompression. Four patients survived and underwent neurobehavioral and intellectual assessment. All were reported to have significant deficits in language, visuospatial perception, attention, and concentration. Of interest was that all of these patients had recovered adequate enough cognitive and behavioral function to undergo rehabilitation and develop a degree of independence. The authors concluded that aggressive measures should be taken in the management of these patients, although their series was not large enough to statistically relate response to aggressive ICP management and outcome.

Kaufman et al. (10) emphasized the relationship of chronically elevated ICP to penetrating craniocerebral injury. They also observed long-term memory deficits, language, and visuospatial perception in six patients undergoing neurobehavioral and intellectual assessment (8).

Population characteristics

All studies evaluating populations of children suffering from this type of injury will be biased by their catchment areas. In our review of the pertinent literature, it became evident that the motivation for these injuries was very dependent on the geographic location and population being studied. Our series consists of a large urban, inner-city population in East Los Angeles County. The population in our immediate catchment area is approximately 94% Hispanic, 3% Asian, 2% Caucasian, and 1% black. This region is known for its large number of gang members and gang-related violence. Thus, it is inevitable that a large number of our cases will result from gang-related injuries. The short duration of the transit times is indicative of the location of our facility within a large metropolitan community. It is also interesting, as mentioned above, that transit times were lower in gang-related as opposed to nongang-related assaults.

Of interest is another series that also consists of a large urban, inner-city population from Los Angeles County. King/Drew Medical Center has a catchment area in South Central Los Angeles that is 50% Hispanic and 50% black. In this report of a series of 255 children, only 10 had gunshot wounds to the brain. The distribution of these patients (85% black and 15% Hispanic) was not reflective of that in the catchment area. Male patients predominated (91%). In patients older than 10 years, 80% of the injuries were directly or indirectly gang related. In children under age 10, injuries resulted from neglect and intrafamily conflicts (17). A study of 9 cerebral gunshot wounds in 108 children from Harlem Hospital reported that many children ranging in age from 12 to 16 years are involved in the distribution of drugs and are exposed to potential assaults (1).

Other studies of children who reside outside of large urban, inner cities vary markedly with regard to the motivation behind the injury, the weapon type, and the incidence of injuries in children. A study from the University of Maryland reviewed 132 children with firearm injuries and reported that 70% of these fatal injuries occurred in the home (3). Keck et al. (11) in a review of firearm fatalities in Oklahoma found that rifles were the most frequently used weapon; their use occurred in 52% of the cases. This finding is directly related to the largely rural population of patients in that state and the accessibility of these firearms in the household. The effects of gun control should also be noted. A study from the University of Heidelberg reported a series of 46 patients between 1976 and 1982. Only four of these patients were children (23). Although earlier series regarding children reported on the large incidence of accidental gunshot fatalities (15), a number of more recent studies are determining that homicide is becoming the most likely motivation behind these injuries.

Pediatric series

A recent series reported a male to female ratio of 3:1 in 82 children under 16 years who suffered penetrating craniocerebral injuries. No racial distribution was found. Deaths resulted from homicide in 46%, accident in 25%, and suicide in 22%. More than 70% of the deaths occurred at home. The authors conclude that a child who has sustained a firearm injury is likely to know the perpetrator, be killed in the home by a readily available, unsecured firearm, and die from a severe head injury (3).

A study of gunshot wounds in 108 children (9 cerebral injuries) from Harlem Hospital reported that 60% were accidental and 40% intentional. Eighty-three percent of the patients were male, and 82% were between the ages of 12 and 16 years. Sixty-five percent were shot by known assailants, and 35% were injured in shootouts. Of interest was that 53% of the guns belonged to the children themselves. Police-inflicted wounds represented 8% of this series. Interestingly, in 13 cases, additional individuals were shot (1).

Accidental deaths in children are most often secondary to the easy accessibility of guns, the inability of children to separate imaginary weapons from real ones, and gun malfunction. Twenty-two caliber handguns are most often involved in these types of injuries (25). A subsequent study of children under the age of 10 suffering gunshot wounds is consistent with this study. Thirty-four children seen over a 7-year period were reviewed, and the most frequent cause of injury was gang related (42%). Accidental injuries were present in 15%. The authors stress that gunshot wounds in children are becoming more frequent in Los Angeles. They also note that the incidence of gunshot wounds in children in the inner city is increasing dramatically (18).

Potential intervention and prevention

The three predominant motivations for these injuries in children and adolescents are homicide, suicide, and accident. The actual percentage of injuries resulting from any of these motivations will be based upon the population being studied in any specific series. The number of these injuries, despite motivation, can potentially be reduced by limiting the availability of firearms, whether it be in the home or through the institution of legal reform. Given the large number of gang-related injuries in our series, we have attempted to specifically address those children who are susceptible to involvement or are already involved in gangs.

It is interesting to note that in 1991 there were 1215 vehicular deaths, as opposed to 1554 gunshot homicides in Los Angeles. This is in contrast to the national statistics in which vehicular accidents cause 19.1 deaths per 100,000, as opposed to 5.2 deaths per 100,000 for gunshot wounds. Thus, an individual in Los Angeles County is more likely to die from a gunshot wound than an automobile accident. During the last 5 years, 466,453 handguns were sold legally in Los Angeles County. This is the equivalent of one for every 19 residents. An increase in the awareness of the problem of gunshot fatalities in children has occurred nationwide over the last year.

The Department of Neurological Surgery is becoming directly involved in providing information to children at the junior high school level regarding gang activity and brain and spinal cord injury. In conjunction with the Community Youth Gang Services Organization and the Think First Organization, we are not only able to reach a larger audience of adolescents, we can also relay multiple messages. Specifically, we are continuing to provide presentations under the auspices of the Think First Program. These presentations have been modified to integrate the Community Youth Gang Services Organization message of integrating prevention, intervention, and community mobilization, combined with support from various justice agencies, to prevent such injuries. This is a plan aimed at informing and recovering youth affected by gangs. Unintentional firearm deaths are more common among children and young adults. These deaths may be addressed by preventive measures beyond those available for pediatric firearm suicide and homicide (3).

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COMMENTS

Levy et al. have demonstrated a major health problem of inner cities, namely penetrating craniocerebral injury, as well as one of its primary causes-gang-related violence. Obviously, it is important to understand the cause of a problem in order to develop a strategy for its prevention. Another article mirroring the problem of gunshot-related injuries in children in Los Angeles reports that half of the adolescents suffering spinal injuries were injured by gunshot wounds and that this problem has been increasing (2).

There are many aspects of the problem to consider when trying to develop a strategy to prevent gunshot wounds. These include: the general situation (joblessness, poverty); the specific situation (the street); the perpetrator (indifference, control); the wounding object (gun, bullet); and the victim (location, behavior). Attempts to educate potential perpetrators of homicides as well as potential victims about the problem and how to prevent it are certainly efforts neurosurgeons should be involved with.

Gun control is an issue of great controversy. Those opposing gun control have cited the second amendment as protecting the right of ownership. However, the proviso of that amendment is "a well-regulated militia, being necessary to the security of a free state," and it no longer holds true. Indeed, the preamble of the Constitution notes that the purpose of government is to "ensure domestic tranquility," justifying gun control. The argument has been raised that guns are necessary for self-protection. However, it has been clearly shown that guns are far more lethal than other weapons and that the availability of guns leads to an increased incidence of homicide, suicide, and accidents. Indeed for every person shot in self-protection by a gun in a home, many more become victims of accidents, suicides, and homicides (3).

There have been many proponents of gun control (1). These include former Presidents Nixon, Ford, Carter, and Reagan; Senator Barry Goldwater; and Supreme Court Justices Warren Burger and Lewis Powell, not to mention James Brady. Indeed the following statements of Martin Luther King, Jr., and Robert F. Kennedy were prophetic.

By ... our readiness to allow arms to be purchased at will and fired at whim; by allowing our movie and television screens to teach our children that the hero is one who masters the art of shooting and the technique of killing ... we have created an atmosphere in which violence and hatred have become popular pastimes.

Martin Luther King, Jr.

November 1963

We have a responsibility to the victims of crime and violence... It is a responsibility to put away childish things-to make the possession and use of firearms a matter undertaken only by serious people who will use them with the restraint and maturity that their dangerous nature deserves and demands.

Robert F. Kennedy

July 1967

In a recent article, Mark Rosenberg of the Centers for Disease Control and Prevention stated:

Academic medical centers have an important responsibility not only to lead the effort to change things but to let people know that this epidemic of violence is not a fact of life but a problem to be solved.... the problem is so urgent that we must begin now-we must start on all fronts and we must start together. Academic medical centers have been leaders on other health issues. Now they are urgently needed to save our communities, our youth, and ourselves (4).

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COMMENTS

The term “mind-boggling” is the best phrase that comes to mind after reviewing this article. The article is impressive from two aspects. First, it successfully attempts to obtain significant information from the overall patient group so as to provide firmer data for assessing these injuries and evaluating their outcome. In their management of these patients, the authors approach the lesions with evacuation of significant masses, debridement of superficial bone fragments and necrotic tissue, and debridement of entrance and exit wounds. They do not pursue deep parenchymal fragments or those not readily accessible. Dural openings were closed either primarily or with a fascial patch graft. They stressed optimal hemostasis and wound irrigation with appropriate antibiotics. Postoperative intracranial pressure monitoring is routine with intracranial pressure control, supplemented with phenobarbital if needed. Using linear regression analysis to evaluate the subgroupings, the authors found that younger children did less well, patients with occipital entry sites did less well, patients with bihemispheric injuries and intraventricular involvement did less well, and that patients with an admission Glasgow Coma Scale score below 7 also did poorly. It should be noted that this group of patients is significantly different from the one reported by Beaver et al. (1). In those cases, the vast majority occurred at home and were likely related to a child finding an available, unsecured firearm.

The second contribution, and in my opinion the most important, is to simply quantify the extent of this problem in 1993 and present it in such a fashion as to produce an almost overwhelming impact on the reader. Selecting 105 children from the 780 total patients presenting with gunshot wounds of the brain to the USC/LAC Medical Center during an 8-year period, the authors found that 64% of these wounds were gang related. A high percentage of these were assassination-type occipital wounds. Amazingly, in Los Angeles County, gunshot wound homicides cause more youths to die than do traffic accidents. Moreover, the authors note the study of children under the age of 10 by Ordog et al. (2), stressing that these childhood gunshot wounds are becoming steadily more frequent in Los Angeles, especially in the inner city.

What a tragedy and ridiculous waste! There must be a way that we can do better with this disease, which most other civilized countries simply do not have. Obviously, the underlying causes are broad and societal as well as related to gun control. Nonetheless, we are now dealing with something equivalent to an extremely serious, highly infectious communicable disease, one that must be approached nationally in a systematic and systemic preventive medicine manner. A program to deal with this problem will also have to be adequately funded and budgeted to really have a meaningful impact. I salute the group from Los Angeles County and the Community Youth Gang Service Organization in their efforts to try to reach these kids beforehand. We in neurosurgery must join with our colleagues in pediatrics and in emergency medicine to more vigorously develop a national presence and to verbalize the necessity of dealing with this problem if we are to make some impact.

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