Murder & Medicine:
The Lethality of Criminal Assault 1960 - 1999

Anthony R. Harris, PhD
Department of Sociology, University of Massachusetts Amherst

Stephen H. Thomas, MD MPH
Division of Emergency Medicine, Harvard Medical School

Gene A. Fisher, PhD
Department of Sociology, University of Massachusetts Amherst

David J. Hirsch, BS
Emergency Medical Services, Lawrence Massachusetts

November 2001

Corresponding Author:
Dr. Anthony R. Harris
75 Munson Road
Chesterfield, MA 01012
413 296 8070 Home   413 296 8071 Fax
aharris@javanet.com

Murder & Medicine:
The Lethality of Criminal Assault 1960 - 1999

Abstract

Despite the proliferation of increasingly dangerous weapons and the very large increase in rates of serious criminal assault, since 1960 the *lethality* of such assault in the United States has dropped dramatically. This paradox has barely been studied and needs to be examined using national time-series data. Starting from the basic view that homicides are aggravated assaults with the outcome of the victim's death we assemble evidence from national data sources to show that the *principal* explanation of the downward trend in lethality involves parallel developments in medical technology and related medical support services that have suppressed the homicide rate compared to what it would be had such progress not been made. Against a baseline of 1960, we estimate that without this technology the U.S. would presently be experiencing 45,000 to 70,000 homicides a year instead of an actual 15,000 to 20,000. We estimate urban/rural-specific drops in lethality from 1964 to 1999 at between 54% to 76%, and annual weapon-specific drops in lethality at between 2.5% and 4.5%. We conclude with two county-level cross-sectional analyses covering two time periods (1976 to 1989 and 1994 to 1997) that show a strong relationship between lethality and a set of medical variables, including presence of a hospital, presence of a trauma center, and countywide membership within a coordinated regional trauma system. We argue that research into the causes and deterrability of homicide would benefit from a "lethality perspective" that focuses on serious assaults, only a small proportion of which end in death

Murder & Medicine:
The Lethality of Criminal Assault 1960 - 1999

According to Vital Statistics, the gold standard of U.S. natality and mortality measurement, since 1931 the U.S. homicide rate has not strayed more than 51% from its level of 9.2 per 100,000 population (Vital Statistics, 2000). By 1998 the Vital Statistics rate stood at 6.8, 26% lower than the 1931 level. In similar fashion, since the start of the FBI's national Uniform Crime Report (UCR) data series in 1931, the U.S. homicide rate as measured by UCR has not strayed more than 45% from its baseline level of 8.2 per 100,000 population. By 1998 the published rate stood at 6.3, 25% *below* its 1931 baseline. In comparison, by 1998 the UCR aggravated assault rate was about *700% higher than its 1931 baseline (*Uniform Crime Reports 1931-1997). UCR data show increases in rates of other violent crimes similar to those for aggravated assault. It is homicide that has, paradoxically, barely changed.[1]

Though nearly so, the paradox has not gone entirely unnoticed. Over the years a handful of criminologists have noticed the disparity between homicide and aggravated assault trends and speculated on its potential importance (*eg* Wolfgang, 1958; Morris and Hawkins, 1970; Wilson, 1985; Lattimore, 1997; Blumstein, 2000), but there is no systematic published national-level research on the topic. Considering the theoretical and policy related importance of the issues surrounding it, we think the trend needs to be examined using data that are national in scope and as broad in time span as possible, and placed squarely on the national agenda for discussion, policy debate, and long-term research. In the present research we go on to examine this paradoxical trend in criminal lethality, using recently available U.S. data on weapons use in assaults and homicides from 1964 to 1999 and countywide assault and homicide data from 1960 to 1997.

Though not explicitly concerned with describing or explaining national historical trends involving the aggravated assault/homicide paradox, previous criminological research that examines the link between medical resources and homicide, particularly Doerner's work (1983, 1986, 1988), provides a critical building block in our analysis (see also Barlow and Barlow, 1988; Giacopassi et al., 1992; Long-Onnen and Cheatwood, 1992). Relying on this research, we think the best starting point in explaining the homicide paradox involves the observation of parallel, dramatic developments in medical technology and related support services,[2] developments that may have functionally, and equally dramatically, s*uppressed* the homicide rate compared to what it would be had such progress not been made. If so, this success has ironically masked the perception that America continues to face extraordinarily high levels of criminal violence. Compared to 1960, the year our analysis begins, we estimate that without these developments in medical technology there would have been between 45,000 and 70,000 homicides annually the past five years instead of an actual 15,000 to 20,000.

The General Impact of Innovations in Trauma Care

Since World War II, and particularly since the Vietnam War of the 1960s and 1970s much has been published in medical journals concerning the development of emergency and trauma medicine as clinical specialties (Rosen and Anderson, 1998; Trunkey, 2000) with a particular emphasis on the differential mortality of trauma patients. Many of these studies document a dramatic overall decrease in trauma mortality over the second half of the 20th century (Sampalis et al., 1993; Norwood et al., 1995; Roberts et al., 1996; Rucholtz et al., 1998; O'Keefe et al., 1999; DeVivo et al., 1999). *Controlling for severity of injury, these studies show annual* *mortality drops ranging from 3% to over 16%.* Despite the greater difficulties of acuity-matching in penetrating trauma, such investigations have demonstrated that technological and other medical improvements (LeBlang and Dolich, 2000) have led to substantial mortality reduction (Murray et al, 1998; Parks et al, 1999; Ferrada and Birolini, 1999) among patients with penetrating trauma. There is thus a highly compelling base of medical evidence to justify the hypothesis that dramatic improvements in the reduction of trauma induced mortality in general have likely also characterized a parallel reduction in criminally induced trauma mortality.

Such evidence looks at a variety of factors affecting trauma mortality in general, including level of emergency medical care on scene, Basic Life Support (BLS) vs. Advanced (ALS) training of EMS personnel, police, and firemen, helicopter vs. ambulance transport, the trauma-care level and patient volume of the receiving hospital, urban setting vs. rural setting, penetrating vs. blunt trauma, the availability of on-site vs. on-call surgeons, and so on. Injuries in these mortality studies are not necessarily produced by violent assault, but include the results of accidents as well. Some studies document the impact on mortality of trauma centers and prehospital time (Sampalis et al., 1993; Norwood et al., 1995; Pepe and Eckstein, 1998; O'Keefe et al., 1999). Others focus on urban/rural differences in mortality from trauma (Rutledge et al., 1992; Esposito et al., 1995; Sampalis et al., 1997). And some follow general trends in trauma mortality in larger areas and/or over longer periods of time (Nardi et al., 1994; Roberts et al., 1996; Ruchholtz et al., 1998). In an important comparison to the present research, using cross-sectional time-series analysis and multivariate Poisson and negative binomial regression techniques Nathens et al. (2000) assess the impact of regionally organized trauma care systems on motor vehicle crash (MVC) mortality in the U.S. from 1979 through 1995.[3]

The Impact of Medical Advances on Homicide and Aggravated Assault

Prior to this medical research, several criminologists proposed that post-war medical advances were likely to suppress the homicide rate (Wolfgang, 1958; Morris and Hawkins, 1970; Rose, 1979; Hawkins, 1983; Wilson, 1985). In his 1958 study of homicide in Philadelphia in the early 1950s, Wolfgang noted that in both Philadelphia and the entire United States the homicide rate showed an overall decrease since its UCR-measured starting points in the early 1930s to the early 1950s. In explaining this trend, Wolfgang cited a bundle of medical/technological breakthroughs: (a) the ability to communicate quickly with the police via telephone and radio shortly after a potentially lethal attack, (b) the related ability to provide rapid transportation to a hospital after such an attack, and (c) newly enhanced levels of in-hospital care, such as the ability to stop infection through the administration of penicillin and other “modern wonder drugs.”[4]

In identifying a southern “culture of violence” that might be used to account for the South’s traditional regional leadership in homicide rates, Gastil (1971) observed in passing that statewide variance in physician rates and in hospital bed rates was inversely associated with variance in homicide rates. Doerner (1983) undertook the first study to focus explicitly on medical resources – including hospital beds, nurses, surgeries, and emergency room visits -- as key determinants of statewide differences in homicide rates. The results were mixed. Using as independent variables countywide measures of structural poverty (Loftin and Hill, 1974) and medical resources, Doerner and Speir (1986) extended Doerner’s 1983 study by looking at homicide in Florida’s 67 counties from 1968 to 1972. As their main dependent variable, Doerner and Speir used a new variable they constructed called *percent lethality,* or, simply, the ratio of recorded homicide cases to the number of recorded homicide and aggravated assaults. The results of this study added support to Doerner's theory that heightened levels of available medical care were associated with lower levels of homicide.

In 1988 Doerner refined the measurement of medical resources into more detailed components. The main dependent variable was again percent lethality. Limited to Florida counties for the period 1982 to 1986, the findings supported Doerner's earlier research. Especially noteworthy were the strong findings on the vital role of pre-hospital variables, most notably emergency transportation, in distributing lethality.[5] Though primarily limited to cross-sectional analyses of Florida counties for a few short multi-year intervals, the results of Doerner's research clearly support the present hypothesis that heightened levels of available medical care are associated with the paradoxically large increases in aggravated assault and virtually level trends in homicide observed for the U.S. during the second half of the 20th century.

In line with these findings, though limited to just one locale for just one year, Barlow and Barlow (1988) looked at emergency response times for aggravated assault and homicide cases in St. Louis in 1982. They observed a 4% mortality rate among patients who arrived at a hospital within 20 minutes of their injury, compared to a 20% mortality rate for patients arriving more than 20 minutes later. Moreover, this held true regardless of type of weapon or number of wounds.

Though also limited to one locale, one of the more persuasive pieces of research on the medical care/lethality link to date is Giacopassi et al.'s (1992) retrospective study of homicide in Memphis at 3 points in time, 1935, 1960, and 1985. Several variables identified as potentially important by Doerner (1983) were examined by Giacopassi et al.: Percent lethality, percent of homicide victims dead on arrival at hospital (DOA), and survival time of non-DOA victims.

More or less consistent with national UCR data, from 1935 to 1985 lethality in Memphis dropped from 11.4% percent to 3.2%. Interestingly enough, the percentage of all homicide victims DOA rose from 52.4% percent to 74.4%. This increase might have been caused by an underlying trend toward more severe injury, and a thus a narrower time frame for obtaining medical help before death. On the other hand, if we assume that trauma care greatly improved during this time, across *all* victims of criminal injury we should actually expect to see a mean increase in duration (survival time) as the years go by. This means that *in a homicide only dataset*, such as Giacoppasi et al's, an increase in % DOA (with an accompanying decrease in the survival time of all the non-DOAs) simply -- though counterintuitively -- suggests an unobserved but increasing proportion of assault victims saved from death who "reside elsewhere," that is, in a *unobserved aggravated assault dataset*. [6]

The most geographically extensive, but again historically rather limited, research on the medical/lethality link to date has been Long-Onnen and Cheatwood's (1992). Using all 306 counties in five contiguous Eastern states Delaware, Maryland, Pennsylvania, Virginia, and West Virginia, the authors aggregate homicides and aggravated assaults over the period 1980 to 1985 to form the dependent variable, Doerner and Speir's "percent lethality." Relying on a variety of 1980 U.S. Census data on countywide medical resources and demographic/"structural poverty" variables, Long-Onnen and Cheatwood found significant medical resource effects on lethality.

On a related topic, Henke and Gundlach (1995) examined racial differences in access to emergency medical care and how that might affect life or death outcomes for victims of assault. Using datasets derived from homicide cases in Alabama from 1929 to 1985, Hanke and Gundlach argue that victims of black offenders, themselves likely to be black, received a lower level of care and were more apt to die than white victims. This leads to the rather provocative conclusion that if there is a markedly higher mortality rate among black assault victims, it would produce a markedly inflated observation of black v. white homicide victim and offender rates.

Besides these criminological studies, additional medical research exists on the specific distribution and nature of personal assaults. It has focused on estimating the population parameters of criminal injury by weapon type, population- and hospital-based survival rates by gunshot wounds and stabbings, and by self- vs. other- inflicted assault. The National Center for Injury Prevention at the CDC and the Center for Injury Control, both in Atlanta, have taken the lead in this regard (see. Annest et al., 1995; Annest and Mercy, 1998; Cherry et al., 1998; Ikeda et al., 1997; Mercy et al., 1998, Sinauer et al., 1996, see also Kellerman et al., 1998). For example, Beaman et al. (2000) estimate that in the U.S. in the period 1992 to 1995, an average of over 132,000 people per year suffered gunshot wounds that led to death or treatment in an emergency department. They observe an overall age-adjusted CFR (case fatality rate) for this population of 31.7% (95% CI 27.7% to 35.6%), but a CFR of only 11.3% for the subset reaching the emergency department alive (also see Rhee et al., 1998). In light of Henke and Gundlach's assertion (1995), it is worth noting these researchers report a 50% higher CFR for white victims of violent assault than black victims (29.5% v. 19.2%). Though such findings speak to the likelihood that medical advances have indeed suppressed the homicide rate as we propose, they do not explicitly assess the linkage.

Analysis Plan

We start with the view that homicides (defined as murders + nonnegligent manslaughters) are neither no more, nor no less, than aggravated assaults with the outcome of the victim's death (see particularly Zimring, 1968, also Pittman and Handy, 1964; Morris and Hawkins, 1970;

Cook, 1991, Polsby, 1995). Factors that affect whether an aggravated assault victim lives or dies necessarily have a critical impact on the recorded homicide. Such factors include:

Weaponry, *from fists and feet, to clubs, bottles, knives, and handguns to automatic assault weapons, through caliber, muzzle velocity and rate of fire.*

Injury Characteristics: *seriousness of injury(body location, blunt or penetrating trauma,etc.)*

Victim (Host) Characteristics: *from the health of the individual victim, through health and trauma-resilient demographic covariates, such as age and gender.*

Health Care Delivery: *from the likelihood of witness and discovery of injury, to ability to call 1st Arrival (EMS) specialists, their training, to time to 1st Arrival and equipment, to time to stabilize and triage, to Emergency Department(ED)/hospital/Trauma Center facility delivery, to facility personnel, expertise, and medical equipment.*

From this viewpoint, an increasing aggravated assault rate would not necessarily lead directly to an increasing homicide rate. Weaponry over time could change from generally less to generally more deadly, or vice-versa. Collinear with weaponry, seriousness of injury would be expected to vary. Victim, or host, characteristics could also vary systematically by time and place. For example, a shift toward younger victims would signal a greater mean victim ability to resist trauma-induced lethality and a minimizing of other co-morbid factors collinear with age.

A principal source of such variation in the lethality of violent assault also involves the delivery of health care. In modern America such factors would include the general proliferation (and occasional loss) of hospitals over the years, time to 1st Arrival and facility delivery by geographic area (urban/rural), regional development of Trauma Centers, by Level and System Coordination, and quality of care and equipment varying by local counties, including level of road infrastructure and traffic density.

Our analysis starts with an overall look at changes in the lethality of criminal assault in the U.S. from 1960 to 1999. We then assess the possible link between these changes and changes in weaponry. Finally, using national countywide data on the presence of physicians, hospitals, trauma centers, and membership in regionalized trauma care systems, we explore the link between lethality and the presence of medical resources. The analyses will show that, on a nationwide scale, there has been a continuous drop in lethality since 1960 and that this drop is primarily attributable to developments in trauma care. A number of the alternative explanations of the decline in lethality will be examined and found to have, at best, a modest influence. Before presenting these analyses we identify our data sources, define and evaluate our measures, and describe the statistical model we employed to estimate changes and variation in the lethality rate.

Data Sources

A number of UCR and other data sources were used in our analyses.

The first dataset used contains annual UCR national-level rates of homicides and aggravated assaults known to the police from 1960 to 1999. The second UCR dataset used contains annual national-level counts of homicides and aggravated assaults known to the police from 1964 to 1999 broken down into 4 weapons types: firearm, knife/cutting implement, bodily (hands, fists, feet), and other (including blunt instruments, but also explosives, fire, poison, etc.)

The third dataset contains annual UCR police-agency based counts of aggravated assaults and homicides aggregated to the county-level for the years 1960 to 1997 (Chilton and Weber, 2001). These data are used in our concluding analyses of the countywide relationship between lethality and medical resources for two time periods, 1976-80 and 1994-97. Unlike the first two UCR datasets, this dataset involves counts of arrests, not offenses known to the police. In the concluding analyses, two multi-year samples of this UCR dataset were merged with data from the National Center for Health Statistics (1976) and the U.S. Census (1994) on county specific medical resources, population, and geographic size. Data on the presence of county trauma centers (Sheps Rural Studies Center, University of North Carolina, 2000) and on the county's status as part of a larger state/regional trauma system (Bazzoli and Madura, 1993) were added. Independently of any trend data, these detailed, local medical data allow for additional evaluation of the validity of the present measure of lethality.

Measure of Lethality and Its Validity

Lethality is defined as the ratio of homicides (murders + nonnegligent manslaughters) to homicides plus aggravated assaults identified in annual UCR data. There is little question about the validity of the UCR-derived homicide count, the sole term in the numerator of the measure and, along with the aggravated assault count, the second term in the lethality denominator. Though the UCR offenses known-based national homicide rate falls consistently about 5% below the gold standard Vital Statistics (NCHS) rate in the period examined, the correlation of the UCR offenses known-based national homicide rate with the Vital Statistics homicide rate is extremely high (r = .9947). Thus, while compared to the Vital Statistics homicide count, the UCR offenses known count leads to a systemic 5% or so underestimate of criminal lethality,[7] the difference is more or less constant across time and for the purpose of symmetry does not seriously vitiate the use of UCR counts.

A more complicated set of issues concerns the use of aggravated assaults as an historically unbiased measure of life-threatening, criminally induced injury. Though used in this way in a major, recent NIJ exploration of homicides in 8 cities from the mid-1980s to the early-1990s (Lattimore et al, 1997), the shortcomings inherent in UCR aggravated assault data are well known (see Abt Associates, 1984; Biderman & Lynch 1991; Maltz, 1999; Blumstein, 2000). These shortcomings basically concern variation in citizens' perceptions and reporting of violent acts – especially among acquaintances, friends, and intimates – as criminal assaults rather than as civil problems, as well as substantial long term and jurisdictional *de facto* discretion in the police use of the aggravated assault category to record known assaults ranging from criminal threats of injury with weapons, to assaults producing very minor injuries, to assaults producing potentially lethal trauma (Allen, 1986).

If there were no historically significant changes in this "noisy" mix and in its historical reporting and recording, we would simply be left with a situation of more or less constant measurement overestimation orthogonal to observed increases in serious, assault induced injury. Whether such changes in the "noisy" mix have or have not *actually* occurred is currently an unresolved empirical matter. But there are reasons to think such changes *may have* occurred. For example, it has been argued that over the years of the present study period general public tolerance for violence as a routine part of civil life has decreased (Zimring & Hawkins, 1997; Rosenfeld, 2000), thus leading to the citizen reporting and/or police recording of (a) an ever-more complete UCR census of actual criminal assaults with or without injury and (b), an ever-more "diluted" level of truly serious injury in that census. Since the first Minneapolis Spousal Assault experimental results were published in 1984 (Sherman & Berk, 1984), a matter of particular concern in this regard has been the question of whether the police have increasingly treated domestic violence incidents as criminal matters, thus both differentially accreting the aggravated assault count arrest count over time – if not also the "offenses known count" – and possibly "diluting" its aggregate seriousness (Garner et al., 1999; Blumstein, 2000).

There is no question that serious, criminally induced trauma would be best measured by medically-trained personnel using validated injury scales such as ISS to rate seriousness of injury. Absent such data, however -- *but based on the strong and compelling findings in the general medical literature that clearly document recent drops in trauma mortality* -- the best question at this point may *not* be whether aggravated assaults known to the police are a problem-free proxy of serious criminal injury, but rather, "are there currently better alternatives?"

The one alternative we know of, reaching back to only 1973 – and then experiencing years of development and change – involves the use of National Crime Survey (NCS/NCVS) data based on victims self-reports of crime, including aggravated assaults. Since lethality based on NCS/NCVS aggravated assaults during the first dozen or so years of the victim survey's development (1973-1985) correlate negatively (r = -.15) with lethality based on UCR aggravated assaults known to the police, using such estimates would clearly produce different lethality results than those observed using UCR estimates.[8] In that NCS/NCVS too suffers from an inability to clearly distinguish life threatening from minor injury, and in the absence of a simple, direct and valid measure of serious criminal injury -- or a gold-standard against which we could assess their relative virtues -- no UCR or NCVS proxy measure can be judged as fault-free. Though a full-blown discussion of any such discrepancy is outside the scope of the current paper, for present purposes, we stress several major points in justifying our present choice of the UCR measure.

One, despite its many uses in measuring crimes unknown to the police, NCS/NCVS has been widely recognized as having continuously undersampled high-risk-for-crime groups, ranging from the black underclass, to families that recompose and/or move frequently, to prisoners, to the homeless, and to other hard-to-reach populations. For example, in a study of twenty-six U.S. cities O'Brien (1983) finds that whereas urban % African-American is positively correlated at .47 with UCR assault rates and .43 for UCR rape rates, it is negatively correlated at -.45 with NCVS assault rates and -.26 NCVS rape rates. Slightly weaker but parallel findings occur when % Poor is used by O'Brien instead of % African American (see also Reiss and Roth's extensive critical review (1993) for the National Research Council).

Two, NCS/NCVS incident underestimation is likely to have been generally exacerbated for violent crimes, including aggravated assault, and particularly so with respect to repeated or series violence by non-strangers (counted as one victim incident in NCVS; NIJ, 1996). For example, a recent NIJ/CDC national study (1998) estimates 2.9 times as many 1995 attempted and completed rape victimizations for victims 18 and over compared to the NCVS finding for victims 12 and older (about 987,000 vs. about 340,000 incidents) and 3.8 times as many 1995 physical assaults (both estimates include weapons threats) as the 1995 NCVS finding for victims 12 and older (about 13,800,000 vs. about 3,600,000). *This undercount of violent victimization is especially critical because it appears to underestimate – even more severely – assaults that have high a potential for lethal outcomes.* Cook (1985, 1991), for example, concludes that NCS/NCVS underestimates the number of gunshot victims *known to the police* by a factor of three.

Three, a modest (and rare) opportunity to assess construct validity in comparing an NCVS based measure of lethality to a parallel UCR measure is provided using recently available public data from national samples of U.S. Hospital Emergency Departments started in 1992 (National Hospital Ambulatory Medical Care Surveys, 1992 to 1998). Using an independent, 3rd measure of criminal aggravated assault counts -- *injury requiring a hospital visit or stay* – produces a 3rd annual lethality measure that is negatively correlated with the parallel NCVS based annual lethality measure (-.58), on the one hand thus challenging the validity of the NCVS measure and, on the other—since this 3rd measure is strongly positively correlated with it (r=.91) – offering our UCR based measure of lethality some external validation. This is fully in line with

Reiss' early observation regarding possible NCVS/UCR divergence to the effect that "the more serious the crime in terms of injury to the victims….the more likely….[it is] to become a police case report" (1985). [9]

Statistical Analysis

Generally, homicide is a rare event in a county and its monthly or annual countywide distributions are best characterized as overdispersed Poissons. Under that circumstance, ordinary least squares analysis of homicide rates is inappropriate. In examining count distributions undoubtedly similar to those for motor vehicle crash deaths we used negative binomial regression with robust standard errors in estimating the impact of year and other predictors on lethality. Explicitly, this meant specifying the raw homicide count as dependent in the regressions, with the natural log of the lethality denominator (homicides + aggravated assaults) as an offset in the calculations. In the concluding analysis incorporating medical variables as predictors, we also used negative binomial regression but clustered on county to obtain robust standard errors. Statistical analyses were produced using Stata 6.0 software (Stata Corp., College Station, TX).

Analysis I: National Drops in Lethality 1960 - 1999

Figure 1 shows aggregate U.S. homicide rate (HR), aggravated assault rate (AR), and lethality rate (LR) trends for 1960 to 1999 based on annual UCR national-level rates of homicides and aggravated assaults known to the police. The homicide series varies from a low of 4.6 in 1962 and 1963 to a high of 10.2 in 1980. From 1960 to 1999, it increases from 5.1 to 5.7, – a rise of 12%. Assault rates vary from a low of 85.7 in 1961 to a high of 441.8 in 1992. For the entire period they increase from 86.1 to 336.1 – a rise of 290%. This means an almost undisturbed drop in lethality during the 40-year period. It is worth noting that the second of the two periods of greatest lethality drops, 1960-1965 and 1973-1978, occurs on the heels of the American involvement in Vietnam, quite likely the kind of post-war period of great gain in trauma care identifed by medical historians (Rosen and Anderson, 1998; Trunkey, 2000.)

-- Figure 1 About Here --

There are 916,380 aggravated assaults and 15,533 homicides in the 1999 data. If the aggregate 1960 lethality level (.056) described these data, we would have instead observed about 880,000 aggravated assaults and about 52,000 homicides – or about 3.4 x the 15,500 or so actually observed. To put this finding in context it would be useful to look at parallel national findings on trauma mortality from a different cause of injury.

In recent years the number of annual deaths from motor vehicle crashes in the nation has typically run two to three times the number of deaths from homicides, with severe trauma the overwhelmingly clear cause in both cases. Figure 2 indicates that strikingly similar processes may have occurred in lowering the motor vehicle crash death rate in just about the same proportions (66% for criminal lethality and 67% for motor vehicle crash lethality) during the period 1960 to 1995 (National Safety Council, 1997; see also Forde and Giacoppasi, 1999)**.** Since some medical researchers have argued that the MVC mortality rate is an inverse function of population density (Brodsky and Hakkert, 1983; Bentham, 1986; Maio et al., 1990; Clark and Cushing, 1999) it is worth noting that -- by increasing the chances of life-threatening injuries being witnessed and reported -- overall increases in population density over time could help explain the drop in MVC lethality (and possibly the drop in criminal lethality).

--Figure 2 About Here –

The national lethality trend in Figure 1 is not governed simply by drops in large metropolitan areas. Figure 3 shows the trend for 4 different FBI-identified population groups stratified by level of urbanization. The stratified trends connect mean annual lethality rates. For the entire period, lethality in each stratum drops by more than 50%: from .074 to .021 in rural counties, .050 to .011 in small cities, .044 to .018 in large cities, and from .043 to .020 in very large cities (with more than 250,000 population).

-- Figure 3 About Here --

As would be expected based on the general medical findings on trauma mortality, rural counties consistently show the highest level of lethality. But Figure 3 also suggests there is a nonlinear relationship between urbanization level and criminal lethality. In the largest or Group I cities, lethality is quite high. It decreases by about 21% across the period as we move from Group I to smaller Group II cities. Moving from Group II to small or Group III-VI cities produces an additional drop in lethality of 24%. But, across the period, at the mean, rural county lethality runs about 100% higher than at the small city level. Although we cannot assess the hypothesis, we suspect this has to do with the net outcome of two trends: (1) level of urbanization is parabolically related to the use of deadly weaponry in aggravated assaults, with proportions of highly deadly pistol usage dropping off by dwindling city size but increasingly replaced by growing proportional use of long guns (rifles and shotguns) in rural areas, and (2), level of urbanization is directly related to the greater availability of and proximity to medical resources.[10]

By 1999 three important changes have occurred. Figure 3 shows the first and second; (1) each population stratum shows a mean lethality rate about one half to one quarter of its 1964 baseline and (2) there is an ever decreasing gap between rural and city lethality levels. While we do not currently have good enough historical medical data to assess the hypothesis, as shall be argued in the last of our analyses, we think a likely explanation of this involves the differential proliferation of medical resources into U.S. rural areas during the period.

The third important change cannot be seen in Figure 3; there has been a general shift in the U.S. population away from rural counties towards a greater concentration in suburban and urban counties. Clearly changes in both the component structural *and* in the compositional population (input mix) parameters of the aggregate national LR have occurred and contributed to lowering the homicide rate.

Finally, Figure 3 shows two increases in lethality for the largest or Group I cities, the first from 1966 to 1973, and the second from 1988 to 1992. U.S. Department of Justice (2000) data on weapons use in criminal assault confirms that both periods were marked by substantial increases in the proportions of assaults (aggravated assaults + homicides) involving firearms. We cannot break these data out simultaneously by urbanization level and weaponry mix but do know that the second period, 1988 to 1992, marked the worst of the crack cocaine/automatic firearm epidemic lasting from 1985 to 1993 – largely an inner-large city problem (Blumstein, 2000). In our view, these peripheral findings add weight to the validity of the present measure of criminal lethality rather than tending to invalidate it.[11] In coinciding with the Lattimore et al's findings on lethality in 8 cities cited earlier for approximately the same time period (NIJ, 1997), we suspect that with respect to the overall lethality trends examined they are limited in their apparent anomalousness to metropolitan areas during the "crack epidemic" just described.

Analysis 2: National Drops in Lethality & Weaponry 1964-1999

A major rival explanation of the observed overall lethality drop in the period examined is provided by the "ever diluting aggravated assault mix" hypothesis discussed earlier – that is, a growing proportion of assaults of a minor nature. The best way to assess this would involve examining the seriousness of aggravated assault injuries over time. Absent this alternative, this rival might be indirectly assessed by examining the question of simultaneous changes in the underlying lethality of the mix of weapons used in aggravated assaults.

If this rival explanation is correct, we should expect to see very little change in the lethality *per se* of specific weapons types over time, but marked increases in the proportionality of less lethal weaponry in criminal assaults.[12] In considering these rival explanations, however, we need to be pre-cognizant of critical findings from the Center for Disease Control and Center for Injury Control studies cited earlier: (1) trauma from gunshot wounds is by far the most likely of all criminally induced trauma to be lethal and (2) the great bulk of criminally induced mortality is from firearms. Thus, any overall *net* change in lethality would therefore be far more sensitive to changes one way or the other in the firearm component of the distribution.

To estimate net weapons-specific lethality drops for the period more precisely, we turned to regression analysis. Table 1.1 displays results from the negative binomial regression of homicides on year by weapon type. In this approach, the logs of weapon-specific denominators (homicides + assaults) are offsets and thus serve as lethality denominators. Robust standard errors are used. The table shows similar drops in lethality overall and by weapon type: the drops for the generally blunt weapons categories "other" and "bodily" are estimated at about 3.5% to 4.5% per year (p<0.001), while the generally more deadly penetrating weapons categories of knives and firearms show drops of about 2.5% to 3.0% per year (p<0.001).

-- Table 1 About Here --

Table 1.2 shows percentage distribution and lethality by weapon type of all potentially lethal assaults (aggravated assaults + homicides) during the whole period. Knife/cutting weapon assaults represent the smallest (23.4%) and "other" assaults the largest (27.8%) proportions of assaults. Firearm assaults are by far the most lethal form of assault (LR=.0846) and, by almost an order of magnitude, bodily (or personal) assaults (LR=.010) the least lethal.

Table 1.3 shows weapons-specific percentage distributions and lethality levels at the beginning and at the end of the period. From 1964 to 1999 there is an overall drop in lethality of 67.4%, with weapons specific drops ranging from 61.3% (knives) to 80.5% (bodily).

During this time, while there is nearly a 400% increase in all assaults by all weapons between 1964 (167,431 total assaults) and 1999 (813,802 total assaults), *there is clearly a marked change in the proportional composition of the weaponry mix:* the firearm component increases by 11% (from 16.9% to 18.7%), the knife component actually decreases by 54% (dropping from 39.3% to 17.3%), while bodily and “other” weapon assaults increase by 34% and 55% respectively (see Table 1.3). Examining this same change by looking instead at across-time changes within weapon types is instructive. From this perspective, from 1964 to 1999 the bodily assault and the “other” (primarily blunt) weapon assault count show very large increases of 550% (233381 assaults in 1999 vs. 35894 assaults in 1964) and 652% (282091 vs. 37489 assaults) respectively, while the firearm assault count increases by “only” 438% (152456 vs. 28322) and the knife assault count by a “meager” 122% (145874 vs. 65726).

These findings suggest that, indeed, the overall increase in the aggregate aggravated rate over the 40 year period has been differentially “padded” by assaults with less lethal weapons (and consequently less serious injury) and, as such, the observed overall drop in lethality based on the weaponry aggregate results at least in part from either an increase in actual but relatively non-life threatening assaults (brawls) and/or the increased reporting/recording of such hitherto unreported/unrecorded incidents as criminal aggravated assaults. In short, these data *appear* to support the rival hypothesis that aggravated assaults have increasingly captured relatively mild -- or at least less potentially lethal – assaults and artificially deflated historical levels of lethality.

But, while it is true that an increasingly large proportion of aggravated assaults have less lethal potential, two observations severely weaken the threat the rival hypothesis poses to the lethality hypothesis. The first is that Table 1.1 shows *significant drops in lethality for all weapon types, from firearm assaults to bodily assaults – that is, from the most lethal to the least lethal weapons.* The second observation develops the first and is tied to the CDC's implied admonition to pay particular attention to the firearm component; since 1964 in our data firearms account for between 55% to 70% of all homicides. *Thus, while there has been an historically differential buildup of relatively nonlethal assaults within the aggravated assault total, limiting the analysis to firearm only assaults* (i.e., applying their lethality level of .155 in 1964 to the estimated firearm assault total of about 189,000 in 1999), *would have lead to almost double the number of homicides in 1999 -- from 15500 total homicides from all causes to 29300 homicides from firearms alone!* In short, proportions of weapons assaults that are firearm related tend to govern the homicide outcome of all weapons assault and, as medical success is attained in differentially minimizing the mortality of non-firearm assault, so too will proportions of all assaults that are firearm related increasingly govern the homicide outcome of assault.

To assess the "waning seriousness of assault" rival more specifically, we adjusted the overall lethality drop (67.4%, Table 1.3, column f) to reflect the underlying downward shift in weapon lethality. Unadjusted overall lethality in 1999 was .015396. Multiplying 1999 weapons specific lethality levels by their 1964 proportions then summing the resulting components yields a weapons-adjusted lethality level of .01579. This number is used to produce an adjusted or net lethality drop of 66.6% ((.04724-.01579)/(.04724)). The remainder of the unadjusted lethality drop, or 0.84% (67.6% - 66.6%), can be attributed to that portion of the unadjusted lethality drop due to the "dilution" in weaponry. Thus, in all, 1.2% of the (unadjusted) overall lethality drop (67.4%/66.6%) can be attributed to a shift in weaponry and the remaining 98.8% to a drop in lethality *per se*.

Several conclusions are in order. One, the findings reported in Tables 1.1 – 1.3 are consistent with the general lethality hypothesis and with more specific expectations based on medical research. There are significant drops in lethality for all categories of weaponry, with the largest drops in the blunt trauma categories and the smallest drops in the penetrating trauma categories. Insofar as knife and firearm assaults account for about 82% of all known homicides in this period – with firearms alone accounting for almost 64% -- significant decreases in the lethality of the penetrating weapons categories appear to be extremely influential in suppressing the overall transformation of lethal to "ordinary" aggravated assaults. Two, only about 1% of the overall decrease in criminal lethality during the period can be attributed to compositional shifts in weaponry. Three, if the 1964 weaponry mix characterized the 1999 weapons-specific lethality level (overall .0154) there would have been about 45,000 homicides instead of the actual 15,500 observed -- a severity-adjusted difference almost 3x larger than the actual count. Adjusting homicide figures in this fashion for the highest-ever assault total in U.S. history – 1993 --would have produced about 67,000 homicides instead of the 23,500 or so actually observed.

Analysis 3: County Level Lethality & Medical Resources 1976-1980 & 1994-1997

Assessment of the lethality/medical resource link at the national level is no substitute for assessment at the local level; what counts after a potentially lethal wound has been inflicted is proximity to actual medical resources, not the national level of medical care. This suggested the use of historical countywide detail on offenses known as well as on medical resources. Though, unfortunately, such criminal data were not currently available, an arrest-based alternative was, allowing for two separate multi-year analyses (1976-1980 and 1994-1997) of the criminal lethality/medical resource link. [13]

Developed by Chilton and Weber, the UCR data used in creating this dataset contains annual UCR police-agency based counts of arrests (not offenses known to the police) for aggravated assault and homicide. The agency reports were aggregated first across months to get yearly totals, and then across agencies to get county totals. Each year, in aggregating agency-year arrests to the county level, we did not include agencies that reported fewer than the full 12 months of that year. Agencies were excluded from the aggregate counts only for the years in which they reported fewer than 12 months of data. Applying this criterion produced a total of 75,274 annual countywide arrest totals for homicide and aggravated assaults.[14]

For the first period, 1976 to 1980, lethality data were merged with countywide medical resource data from a 1975 federal survey of all U.S. hospitals (National Center for Health Statistics, 1979) producing an N of 10,557 county-years. For the second period, 1994 to 1997, lethality data were merged with 1990-1994 U.S. Census data on countywide medical resources, population, and geographic size (U.S. Census, 1994), then with 1994 countywide data on the presence of trauma centers (Sheps Rural Studies Center, 2000) and with 1993 data on the county's status as part of a larger state/regional trauma system (Bazzoli and Madura, 1993). This yielded an N of 8493 county-years.

Lethality was regressed against a number of countywide medical variables ranging from number of RNs to number of blood banks to annual number of surgeries. As might be expected among components of an integrated health care delivery system, preliminary analyses revealed substantial multicollinearity among the medical variables. Because our primary interest is not precise estimation of the effects of different medical resources, but to show that the lethality rate, at any given point in time, depends on the availability of medical resources, we included only those medical variables that are the most strongly related to lethality.[15]

The medical resource variables included in the 1976 – 1980 analysis are number of hospital admissions, number of hospitals that provide open-heart surgery, number of hospital affiliated physicians, number of hospital beds in the county. A dummy variable was used to indicate whether the county had no hospitals. It was coded 1 to indicate the presence of any hospital in the county. The 1994 – 1997 analysis includes a slightly different set of medical resource variables. Data on hospital admissions were not available, but we were able to add two indicators of the availability of trauma care in the county. One dummy variable represents the presence of a Trauma Center in the county; the other indicates whether the county participates in a statewide Trauma Care System. The number of physicians in period two includes all physicians in the county and is not limited to hospital affiliated physicians.

Arguably missing from the regression analyses are a number of potential "control" variables known to be related to the homicide rate, such as percent black, county is in the South, county is rural or urban, and resource deprivation (an index composed of several variables measuring income levels and income inequality, taken from Land et al. (1990)).[16] But these variables are not included in the main analysis for two related reasons: One, they are known as predictors of homicide rather than lethality *per se* (that is, whether or not an aggravated assault eventuates in death); Second, the correlation of any of these variables -- such as percent black -- with lethality would be spurious and attributable to their correlation with the factors – such as weaponry and access to and quality of medical care – already identified as causes and conditions of lethality. That is, including these variables lethality would beg the theoretical question. [17]

Table 2 presents the results of the negative binomial regressions of lethality on county-level medical variables in the periods 1976 – 1980 and 1994 – 1997. Consistent with the medical literature associating higher levels of hospital volume with higher levels of trauma mortality, Table 2 shows a significant positive link between countywide volume of patient intake and higher levels of lethality in Period 1 (0.68% increase per 1000 admissions, $p<.001$). However, this effect appears to be fully offset by resources in the form of hospital beds (5.5% decrease per 1000 beds, $p<.05$). For Period 2, the impact of hospital beds on lethality turns unexpectedly positive. In the absence of hospital admissions data, we believe the unexpected positive association between hospital beds and lethality for Period 2 is an artifact of the "beds" alone measure having turned into a proxy for hospital admissions (volume).

-- Table 2 About Here --

For every physician affiliated with a county hospital in Period 1, there is a significant reduction in that county's lethality rate, estimated at 4.3% per 100 hospital-affiliated physicians ($p<.01$). In Period 2, the addition of 100 physicians to a county's population is associated with a much smaller drop of about 1.4% ($p=.05$), but countywide "number of doctors" is a different measure in this period. Since we are now considering their presence at large within a county, not their availability as a direct trauma care resource in hospitals and emergency departments per se (as we were in 1976-1980 period), the smaller effect should be expected.

For every open-heart surgery facility – a surrogate for high level of care (HLC) county hospitals in the period -- there is a significant 1.5% reduction in that county's criminal lethality ($p<.001$). Assuming underlying across-period stability in the HLC array, for every HLC facility in the 1990s period there is a significant 1.2% drop in lethality ($p=.001$).

The impact of simply having a hospital in the county is also significant, lowering lethality by an estimated 11.2% each year in Period 1 ($p<.05$). For the 1990s period, that impact is greater still, decreasing county lethality by about 24% a year ($p<.001$). *It is worth stressing that in both periods the presence of a hospital in a county had a much greater effect on lethality than the effect of the "high level of medical care surrogate*." Though it may not be so in the future, as counties without hospitals disappear, in our study period a hospital within reach during the "golden hour" after potentially lethal injury may have been the paramount medical factor in lowering lethality, not whether the county's brand new trauma center had the latest in medical technology.

For the 1990s period, the sample for which we have trauma center and system data, the countywide presence of a trauma center is associated with a reduction of 7.0% in lethality levels, but the finding is not significant ($p=.149$). This null finding is puzzling, but not altogether surprising. As the medical literature shows, at a minimum, knowing a trauma center's startup date is important; for many years after implementation, individual centers may become "magnets" for trauma cases with high fatality rates, channeling and concentrating their distribution from previously broader, regional dispersions (Hammond and Breckenridge, 1999; O'Keefe et al., 1999; Nathens et al., 2000). In estimating trauma center effects it would also be helpful to know *which* level of trauma care these trauma centers represent, and whether, and how, they are certified. We did not have these data. [18]

We did, however, have data bearing on an equally important national health care concern. That is, whether regional systematization of trauma care – including coordination of triage and interhospital transfers – is effective in reducing trauma mortality. The data in Table 2 strongly support this view. Being part of a regionalized trauma system reduces criminal lethality levels by an additional 16% (p<.000) over and above the drops associated with presence of a hospital.

Conclusion

In three analyses of lethality trends, over time, by type of weapon, and across counties, we have garnered considerable support for the hypothesis that advances in emergency medical care have greatly and increasingly reduced the lethality of violent assaults, with observed annual drops in such lethality range from 2.5% to 4.5%. *This finding is thoroughly consistent with general medical findings on trauma which, while rigorously controlling for severity of injury, find annual drops in trauma mortality ranging from 3% to over 16%* (see section on the General Impact of Innovations in Trauma Care).

As a proxy for serious, life-threatening injury, we have no doubt that aggravated assaults recorded by the police are a blunt instrument in general and one that may suffer from historical biases that inflate the observation of drops in criminal lethality. Almost certainly the entirety of the measured drop in criminal lethality between 1960 and 1999 is not due to progress in emergency medical care and technology alone. Increases in the rate of police personnel and resources available to record aggravated assault, along with other non-lethal crimes, have likely increased over time. As noted, though some may still call it medical progress, another portion of the drop may be accounted for by population shifts away from isolated medical resource-poor counties to resource-rich counties. And additional, though likely small, portions of the overall decrease in criminal lethality can be attributed to compositional shifts in weaponry (Table 1) [19] and to drops in the age of victims. [20]

In observing essentially the same historical aggravated assault/homicide paradox as we observe, Blumstein (2000) speculates that since the mid 1980s there may have been a significant inclusion of a less lethal mix of domestic violence cases into the police count of aggravated assaults. This inclusion would also serve to "inflate" the lethality denominator during the last third of our 1960 to 1999 study period, leading in turn to attaching too much importance to the "medical resource" explanation of the lethality decline.

To some extent – since during most of the period (1964 to 1999) we were able to observe changes in the weaponry mix in criminal assault – we may already have accounted for domestic violence "inflation" by having adjusted for the drop in the overall lethality of the weapon mix. Additional evidence bearing on the question of "inflation" can be found in data captured by the new National Incident Based Reporting System, or NIBRS (NIJ, 1992). Detailed NIBRS data from 9 states in 1995 were used in the FBI's recent study, "The Structure of Family Violence: An Analysis of Selected Incidents" (FBI, 2000). In these data, family violence -- part of a superset that contains the "domestic violence" speculated on by Blumstein -- comprised 23.8% of all aggravated assaults, with non-family violence comprising the 76.2% remainder. Major injury was indeed reported more frequently in non-family aggravated assaults than in family aggravated assaults, but the difference was small (24.4% v. 20.5%). In addition, insofar as family aggravated assaults in 1995 still represented a relatively small proportion of all aggravated assaults (23.8%), the increasing inclusion of domestic aggravated assaults in all aggravated assaults from the mid 1980s to the end of the 1990s is not likely to have "artificially diluted" the lethality ratio by more than 5% to 10%. [21]

Following Allen's (1986) and Doerner and Speier's (1986) admonitions, the addition of controls for seriousness of injury in future lethality-related research would obviate many of the problems encountered in the present research.[22] Ideally such research would also measure fatality on a case by case basis, with proper adjustment for demographic (host) characteristics, would geocode the distance of the injury site from the nearest receiving health care facility, and along with temporal correlates of the process, would attempt to measure the quality and effectiveness of all medical hands and resources laid on the case from time of injury.

The “lethality perspective” suggests that research on homicide causation and prevention might be facilitated by focusing on potentially lethal criminal actions rather than on completed homicides *per se*. The relative rarity of homicides, and the fact that they are made even more rare by medical intervention, may make homicide data alone a less reliable vehicle for studying etiology and prevention than the combination of homicides and assaults.

Adopting a “lethality perspective” raises many policy relevant questions. For one, if there is unequal access to and/or use of medical treatment in the case of life-threatening injury, there is reason to wonder whether African-Americans and other disadvantaged groups have not been significantly over-represented in homicide rates, systematically differentiated not by lethal intent, but by levels of their victims’ medical care (see Hanke and Gundlich, 1995). For another, why limit the study of the impact of major social/gun control legislation – such as the Brady Bill (Ludwig and Cook, 2000) or extending the public right to carry concealed handguns (Loftin et al., 1991; McDowall et al., 1995) – to homicide when the critical criterion should be the occurrence of potentially lethal assault with a firearm, *not* a victim’s death (witness Brady’s own survival)?

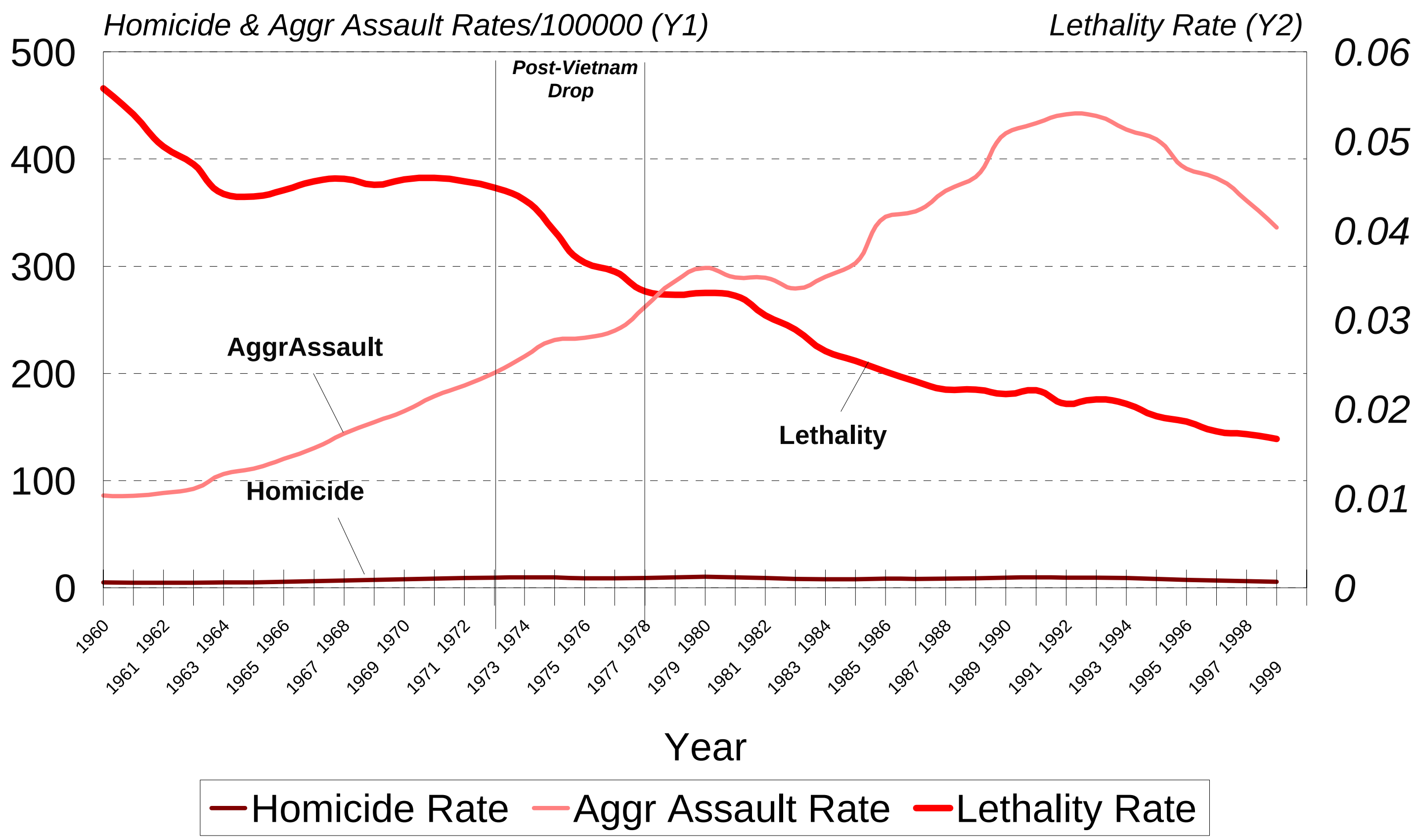
In sum, the lethality perspective would address these basic research and policy questions: *(1) rather than homicide, what are the factors directly shaping aggravated assault? and 2), rather than homicide, do (new) laws, such as the Brady Bill, and threats of sanction, such as the death penalty or longer prison terms, directly deter aggravated assault?* The ominous rise of semi-automatic weapon use in assaults in the last 20 years may signal an ever-decreasing opportunity to make and to observe additional inroads in the transformation of homicide into assault. At some point in contesting the outcome of criminal assault to the body, weaponry may yet trump medicine.

Figure 1.

Homicide Rate (HR), Aggravated Assault Rate (AR) & Lethality Rate (LR)*

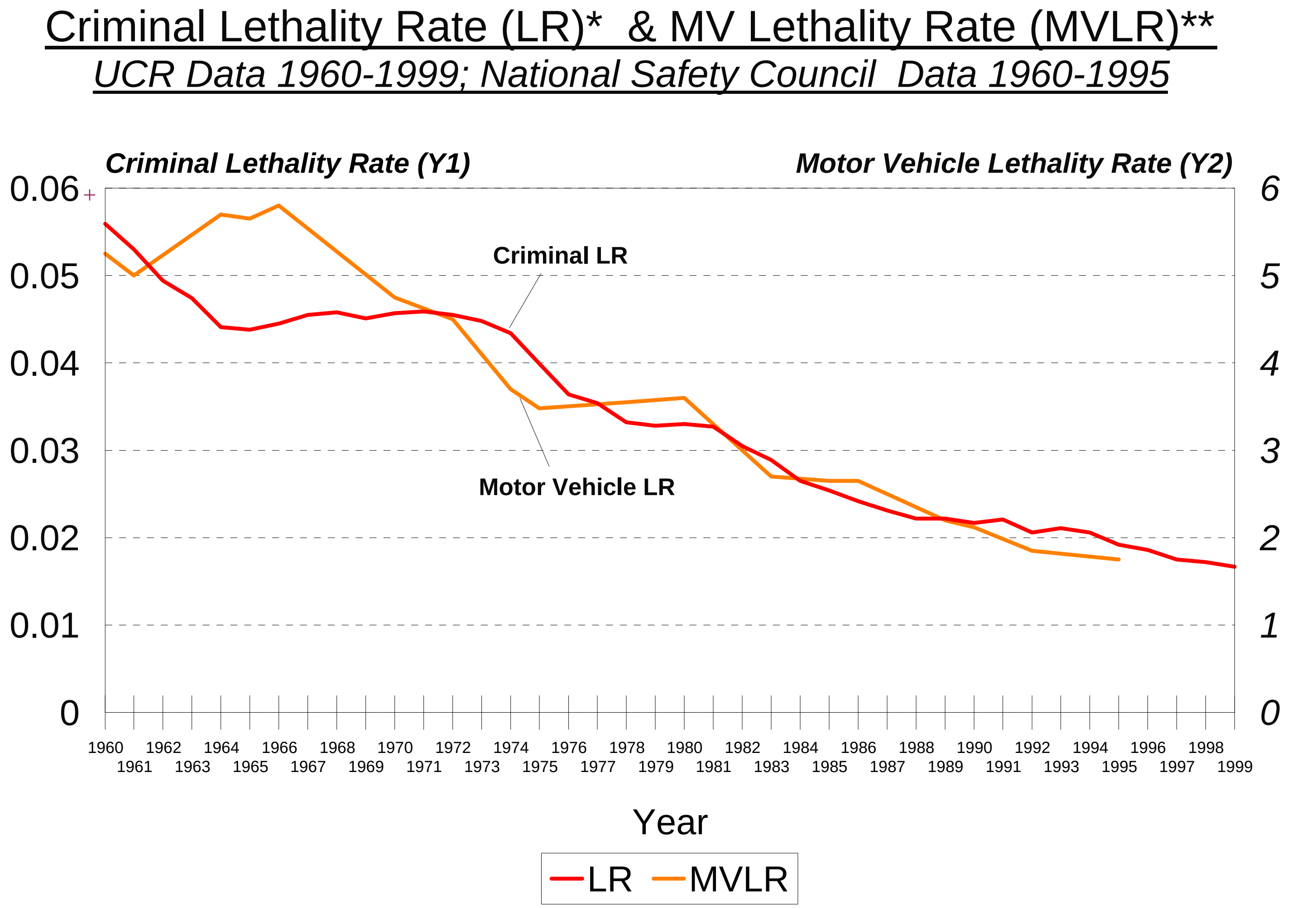
Annual National-Level UCR Offenses Known Data 1960-1999

(Sourcebook of Criminal Justice Statistics, 2001)



HR = (Homicides+NonNegligent Manslaughters) per 100,000 Pop; AR = Aggravated Assaults per 100,000; LR = HR/(HR+AR)

Figure 2.



LR= Homicides/(Aggravated Assault+Homicides); ** MVLR = MV Traffic Injury Deaths per 100,000 Vehicle Miles

Figure 3.

Lethality By Year & Level of Urbanization:

Annual UCR Population Group-Level Data 1964 -1999; 3-Yr Moving Averages

(Uniform Crime Reports, 1960 to 1999)

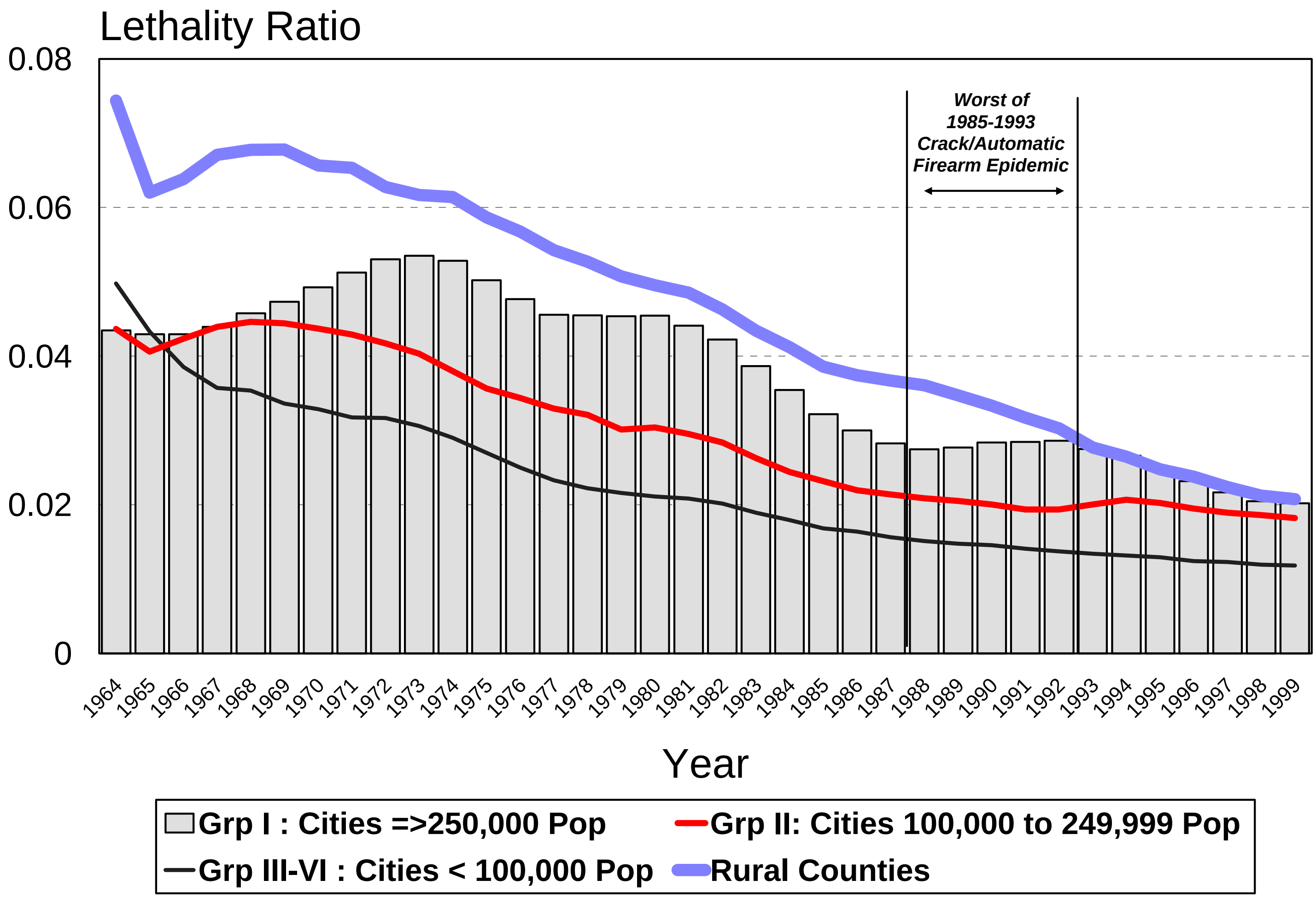


Table 1. *Declines in Lethality By Weapon Type 1964-1999*

1.1 Regression of Lethality on Years By Weapon Type 1964-1999

	Coefficient	StdErr	t	P>|t|	[95% Conf. Interval]		Wald chi2 (1)	P>|F|
FireArms	-0.0302	0.0012	-25.54	0.000	-0.0324	-0.0278	652.35	0.000
Knives	-0.0273	0.0029	-9.44	0.000	-0.0329	-0.02163	89.06	0.000
Other	-0.0347	0.0014	-25.40	0.000	-0.0374	-0.0320	645.05	0.000
Bodily	-0.0448	0.0012	-37.01	0.000	-0.0472	-0.0424	1369.70	0.000
Overall	*-0.0338*	*0.0014*	*-24.03*	*0.000*	*-0.0366*	*-0.0310*	*577.53*	*0.000*

1.2 Breakdown of Yearly Assaults & Lethality by Weaponry for 1964 – 1999*

	Mean Homicides	Mean AggrAssaults	Totals	Mean % of Yearly Total	Mean Yearly Lethality
FireArms	10876.17	137213.1	148089.3	23.58%	0.0846
Knives	3021.89	130951.2	133973.1	23.42%	0.0241
Other	1785.36	183955.1	185740.4	27.83%	0.0118
Bodily	1329.75	159607.8	160937.5	25.16%	0.0104
Overall	*17013.17*	*611727.2*	*628740.3*	*100.00%*	*0.0315*

1.3 Breakdown of Monthly Assaults & Lethality by Weaponry 1964 & 1999*

	a.	b.	c.	d.	e.	f.	g.
	1964 % Assaults	1964 Lethality	1999 % Assaults	Unadjusted 1999 Lethality	Weapons Proportion Shift	Lethality Drop	Adjusted 1999 Lethality Components**
FireArms	16.92%	0.1551	18.73%	0.0539	10.70%	-65.21%	0.0091
Knives	39.26%	0.0292	17.93%	0.0113	-54.33%	-61.34%	0.0044
Other	22.39%	0.0213	34.66%	0.0058	54.80%	-66.83%	0.00131
Bodily	21.44%	0.0223	28.68%	0.0043	33.77%	-80.52%	0.0009
Overall	100.00%	0.0472	100.00%	0.0154	**Overall Lethality Drop:**	**-67.41%**	0.0158

Assaults = Homicides + Aggr Assaults

*****g = a x d***

Adjusted Lethality Drop: **-66.56%**

Drop Due to Weapons Shift: **-0.84%**

% of Overall Drop Due to Lethality Drop: **98.75%**

% of Overall Drop Due to Weapons Shift: **1.25%**

Table 2. ***Regression of Lethality on County-Level Medical Variables 1976-1980 & 1994-1997***

Period 1: 1976-1980	**Coeff.**	**Semi-Robust Std.Err.**	**z**	**P>|z|**		**[95% Conf.**	**Interval]**	**N Obs=**	10557
								N Groups=	2739
No. Hospital Admissions	6.82e-06	1.10e-06	6.21	0.000		4.67e-06	8.97e-06	**Obs per Grp:**	
No. Hospitals w Open Heart Surgery (HLC)	-0.0153	0.0028	-5.45	0.000		-0.0207	-0.0098	**min**	1
No. Hospital Affiliated Physicians	-0.0004	0.0002	-2.64	0.008		-0.0008	-0.0001	**avg**	3.9
No. Hospitals Beds	-0.0001	0.0000	-2.16	0.031		-0.0001	-5.15e-06	**max**	5
Presence of Any Hospital (Dummy)	-0.1124	0.0501	-2.24	0.025		-0.2106	-0.0143	**Wald Chi2(5) =**	59.81
Presence of a Trauma Center (Dummy)*	-	-	-	-		-	-		
Part of Trauma Care System (Dummy)*	-	-	-	-		-	-		
Constant	-2.3678	0.0466	-50.81	0.000		-2.4591	-2.2764	**Prob> Chi2 =**	0.0000

**Data not available for Period 1.*

Period 2: 1994-1997	**Coeff.**	**Semi-Robust Std.Err.**	**Z**	**P>|z|**		**[95% Conf.**	**Interval]**	**N Obs=**	8493
								N Groups=	2559
No. Hospital Admissions**	-	-	-	-		-	-	**Obs per Grp:**	
No. Hospitals with Open Heart Surgery (HLC)	-0.0111	0.0036	-3.06	0.002		-0.0181	-0.0039	**Min**	1
No. Physicians	-0.0001	0.0001	-1.96	0.050		-0.0003	-9.84E-08	**Avg**	3.3
No. Hospital Beds	0.0002	0.0001	4.64	0.000		0.0001	0.0003	**Max**	4
Presence of Any Hospital (Dummy)	-0.2367	0.0615	-3.84	0.000		-0.3573	-0.1160	**Wald Chi2(5) =**	61.26
Presence of a Trauma Center (Dummy)	-0.0704	0.0489	-1.44	0.149	ns	-0.1662	0.0253		
Part of Trauma Care System (Dummy)	-0.1563	0.0376	-4.16	0.000		-0.2299	-0.0826		
Constant	-2.8522	0.0586	-48.65	0.000		-2.9672	-2.7373	**Prob> Chi2 =**	0.0000

***Data not available for Period 2.*

REFERENCES

Abt Associates. (1984) *Final Draft of Interim Report National UCR Conference*. Cambridge, MA: Abt Associates.

Allen, R.B. (1986) Measuring the severity of physical injury among assault and homicide victims. Journal of quantitative criminology, 2, 139-156.

Annest, J.L.& Mercy, J.A. (1998) Use of National data systems for firearm-related injury surveillance. American journal of preventative medicine, 15,17-30.

Annest, J.L., Mercy, J.A., Gibson, D.R., & Ryan, G.W. (1995) National estimates of nonfatal firearm-related injuries: Beyond the tip of the iceberg. Journal of the American Medical Association, 273, 1749-54.

Atrostic, B.K., Bates, N., Burt, G. et al. (October 1999) Nonresponse in Federal household surveys: new measures and new insights. Joint Program in Survey Methodology. Interagency Council on Statistical Policy, Consortium University of Maryland, University of Michigan, and Westat.

Barlow, H. & Barlow, L. (1988) More on the role of weapons in homicide violence. Medicine and law,7, 347-58.

Bazzoli, G. & Madura, K.J. (1993) *Inventory of Trauma Centers*. Chicago, Il: Hospital Research and Educational Trust.

Beaman, V., Annest, J.L., Mercy, J.A., et al. (2000) Lethality of firearm-related injuries in the United States population. Annals of emergency medicine, 35, 258-66.

Bentham, G. (1986) Proximity to hospital and mortality from motor vehicle traffic accidents. Social science and medicine, 23, 1021-6.

Biderman, A.D. & Lynch, J.P. (1991*) Understanding Crime Incidence Statistics: Why the UCR Diverges from the NCS.* NY: Springer-Verlag.

Biewener, A., Holch, M., Muller, U. et al. (2000) Effect of logistic and medical emergency resources on fatal outcome of severe trauma. Unfallchirung,103, 137-43.

Block, C.R., Block, R.L., & the Illinois Criminal Justice Information Authority. (1998) Homicides in Chicago, 1965-1995 (4th ICPSR version # 6399) Chicago: Illinois Criminal Justice Information Authority (producer), 1998. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 1998.

Blumstein, A. (2000) "Disaggregating the violence trends," in *The Crime Drop in America*, (Eds.) Blumstein, A. & Wallman, J. (Chapter 2). Cambridge, U.K.: Cambridge University Press.

Boyd, C.R., Tolson, M.A., & Copes, W.S. (1987) Evaluating trauma care: the TRISS method. Journal of trauma, injury, infection, and critical care, 27, 370-3.

Brodsky, H., Hakkert, A.S. (1983) Highway fatal accidents and accessibility of emergency medical services. Social science & medicine, 17, 731-40.

Bureau of Justice Statistics. (1997) Age patterns of victims of serious violent crime. Washington, DC: web site www.ojp.usdoj.gov/bjs.

Bureau of Justice Statistics. (1999) Homicide trends in the United States 1999. Washington, DC: web site www.ojp.usdoj.gov/bjs.

Bureau of Justice Statistics. (2000) Homicide trends in the U.S. (from *FBI, Supplementary Homicide Reports, 1976-1999).* www.ojp.usdoj.gov/bjs.

Carlson, S. (1998) Uniform Crime Reports: Monthly weapon-specific crime and arrest time series, 1975-1993. (1st ICPSR Version # 6792). Kalamazoo, MI: Western Michigan University (producer) 1998. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 1998.

Centers for Disease Control and Prevention. (1994) Morbidity and Mortality Weekly Report. Deaths resulting from firearm- and motor-vehicle-related injuries--United States, 1968-1991. 43, 37-42.

Centers for Disease Control and Prevention. (2000) Firearm Injury Surveillance Study, 1993-1998, Morbidity and Mortality Weekly Report. National Center for Injury Prevention and Control. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 2000.

Champion, H.R, Copes, W.S., Sacco, W.J. et al. (1990) The major trauma outcome study: Establishing national norms for trauma care. Journal of trauma, 29, 623-9.

Chen, B., Maio, R.F., Green, P.E., & Burney, R.E. (1995) Geographic variation in preventable deaths from motor vehicle crashes. Journal of trauma, 38, 228-32.

Cherry, D., Annest, J.L., Mercy, J. et al. (1998) Trends in nonfatal and fatal firearm-related injury rates in the United States, 1985-1995. Annals of emergency medicine, 32, 51-9.

Chilton, R. & Weber, D. (2000) Uniform Crime Reporting Program [United States]: Arrests by age, sex, and race for police agencies, 1960-1997. (3rd ICPSR Version # 2538, forthcoming) Amherst, MA: University of Massachusetts (producer), 2000. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 2000.

Clark, D.E. & Cushing, B.M. (1999) Predicting regional variations in mortality from motor vehicle crashes. Academic emergency medicine, 6, 125-30.

Cook, P. (1985) The case of the missing victims: gunshot victims in the National Crime Survey. Journal of quantitative criminology 2, 265-277.

Cook, P. (1991) "The technology of personal violence," in *Crime and Justice: An Annual Review of Research 14,* (Ed.) Tonry, M. Chicago: University of Chicago Press.

Cook, P. & Laub, J.H. (1998) "The epidemic in youth violence," in *Youth Violence,* Vol. 24, (Eds.) Tonry, M. & Moore, M.H. Chicago: University of Chicago Press.

DeVivo, M.J., Krause, J.S., & Lammertse, D.P. (1999) Recent trends in mortality and causes of death among persons with spinal cord injury. Archives of physical medicine and rehabilitaion, 80, 1411-19.

Doerner, W. (1983) Why does Johnny Reb die when shot? The impact of medical resources upon lethality. Sociological inquiry, 53, 1-15.

Doerner, W. (1988) The impact of medical resources upon criminally induced lethality: A further examination. Criminology, 26, 171-9.

Doerner, W. & Speir, J. (1986) Stitch and sew: The impact of medical resources upon criminally induced lethality. Criminology, 24, 319-30.

Esposito, T.J., Sanddal, N.D., Hansen, J.D., & Reynolds, S. (1995) Analysis of preventable trauma deaths and inappropriate trauma care in a rural state. Journal of trauma, injury, infection, and critical care, 5, 955-62

FBI. (2000) *The Structure of Family Violence: An Analysis of Selected Incidents.* Washington, D.C.: U.S. Government Printing Office.

Ferrada, R., Birolini, D. (1999) New concepts in the management of patients with penetrating abdominal wounds. Surgery clinics of North America, 79, 1331-56.

Forde, D.R. & Giacoppasi, D. (1999) Rates of traffic fatalities and homicides. Psychological reports, 85, 65-6.

Fox J.A. (2000) Uniform Crime Reports [United States]: Supplementary homicide reports, 1976-1997 (1st ICPSR Version # 2832). Boston, MA: Northeastern University College of Criminal Justice (producer), 1997. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 2000.

Garner, J., Hickman, L., Simpson, S. et al. (1999) *Encouraging Arrest for Domestic Violence in Maryland: An Evaluation*. Department of Criminology and Criminal Justice. College Park, MD: University of Maryland.

Gastil, R. (1971) Homicide and a regional culture of violence. American sociological review, 136, 412-27.

Giacopassi, D., Sparger, J., & Stein, P. (1992) The effects of emergency medical care on the homicide rate: Some additional evidence. Journal of criminal justice, 20, 249-59.

Hammond, J.S. & Breckenridge, M.B. (1999) Longitudinal analysis of the impact of a level I trauma center designation at a university hospital. Journal of the American College of Surgeons, 188, 217-224.

Hanke, P., Gundlach, J. (1995) Damned on arrival: A preliminary study of the relationship between homicide, emergency medical care, and race. Journal of criminal justice, 23, 313-23.
Hawkins, D.F. (1983) Black and white homicide differentials: Alternatives to an inadequate theory. Criminal justice behavior, 10, 407-440.

Ikeda, R.M., Gorwitz R., James S.P. et al. (1997) Trends in fatal firearm-related injuries, United States 1962-1993. American journal of preventative medicine, 13, 396-400.

Kellermann, A.L., Somes, G., Rivera, F.P. et al. (1998) Injuries and deaths due to firearms in the home. Journal of trauma, 45, 263-7.

Kleck, G. (1991) *Point Blank: Guns and Violence in America.* New York: Aldine de Gruyter.

Land, Kenneth C., Patricia L. McCall, and Lawrence E. Cohen. (1990) Structural covariates of homicide rates: are there any invariances across time and social space?" American Journal of Sociology 95, 922-963.

Lattimore, P.K., Trudeau, J., Riley, K.J. et al. (1997) Homicide in Eight US Cities: Trends, Content and Policy. National Institute of Justice. U.S. Dept of Justice. Washington D.C. http://www.ojp.usdoj.gov/nij.

LeBlang, S.D. & Dolich, M.O. (2000) Imaging of penetrating thoracic trauma. Journal of thoracic imaging, 15, 128-35.

Loftin, C. & Hill, R. (1974) Regional subculture and homicide: An examination of the Gastil-Hackney thesis. American sociological review, 39, 714-24.

Loftin, C. McDowall, D., & Wiersema, B., & Cottey, T.J. (1991) Effects of restrictive licensing of handguns on homicide and suicide in the District of Columbia. New England journal of medicine, 325, 1615-20.

Long-Onnen, J. & Cheatwood, D. (1992) Hospitals and homicide. An expansion of current theoretical paradigms. American journal of criminal justice, 16, 57-74.

Ludwig, J. and Cook, P.J. (2000) Homicide and suicide rates associated with the implementation of the Brady Bill,. Journal of the American Medical Association, 284, 585-91.

Maltz, M. (1999) *Bridging Gaps in Police Crime Data*. Bureau of Justice Statistics. Washington D.C.: U.S. Department of Justice.

Maio, R.F., Burney, R.E., Lazzara, S., & Takla, R.B. (1990) Correlation between motor vehicle mortality rate and density of medical resources. Prehospital and disaster medicine, 5, 335-9.

McDowall, D., Loftin, C., & Wiersema, B. (1995) Easing concealed firearm laws: Effects on homicide in 3 states. Journal of criminal law and criminology, 86, 193-206.

Messner, S.F., Anselin, L., Hawkins, D.F. et al. (1998) An atlas of the spatial patterning of county-level homicide, 1960-1990. National Consortium on Violence Research. Carnegie Mellon University. Pittsburgh.

Mercy, J.A., Ikeda, R., & Powell, K.E. (1998) Firearm-related injury surveillance. An overview of progress and the challenges ahead. American journal of preventative medicine, 15, 6-16.

Morris, N. & Hawkins, G. (1970) *The Honest Politician's Guide to Crime Control.* Chicago: University of Chicago Press. .

Muelleman, R.I. & Mueller, K. (1996) Fatal motor vehicle crashes; variations of crash characteristics within rural regions of different population densities. Journal of trauma, 41, 315-20.

Murray, J.A., Berne, J., & Asensio, J.A. (1998) Penetrating thoracoabdominal trauma. Emergency medicine clinics of North America,16, 107-28.

Nagy, K.K., Smith, R.F., Roberts, R.R. et al. (2000) Prognosis of penetrating trauma in elderly patients: A comparison with younger patients. Journal of trauma, 49, 190-4.

Nardi, G,, Massarutti D., Muzzi R. et al. (1994) Impact of emergency medical helicopter service on mortality from trauma in north-east Italy. A regional prospective audit. European Journal of Emergency Medicine, 1, 69-77.

Nathens, A.B., Jurkovich, G.J., Cummings, P. et al. (2000) The effect of organized systems of trauma care on motor vehicle crash mortality. Journal of the American Medical Association, 283, 1990-4.

National Center for Health Statistics. (1979) Master Facility Inventory: Hospital survey, 1976. (1st ICPSR Version #7630) National Center for Health Statistics (producer), 1979. Ann Arbor, MI: Inter-University Consortium for Political and Social Research. (distributor) 1979.

National Center for Health Statistics. (1992 to 1999). Advanced Data Reports. National Hospital Ambulatory Medical Care Survey. U.S. Department of Health and Human Services. Centers for Disease Control and Prevention. Division of Data Services. MD: Hyattsville.

National Institute of Justice. (1992) *UCR's (Uniform Crime Reports) Blueprint for the Future.* Washington, DC: U.S. Government Printing Office.

National Institute of Justice. (1996) Victim costs and consequences: a new look. Washington, DC: U.S. Government Printing Office.

National Safety Council. (1997) Accident Facts. Itasca, IL: NSC.

Norwood, S., Fernandez, L., & England, J. (1995) The early effects of implementing American College of Surgeons Level II criteria on transfer and survival rates at a rurally based community hospital. Journal of trauma, 39, 240-4.

Parks, R.W., Chrysos E., & Diamond, T. (1999) Management of liver trauma. British journal of surgery, 86, 1121-35.

Pepe, P.E. & Eckstein, M. (1998) Reappraising the prehospital care of the patient with major trauma. Emergency Medicine Clinics of North America, 16, 1-15.

O'Keefe, G.E., Jurkovich, G.J., Copass, M., & Maier, R. (1999) Ten-year trend in survival and resource utilization at a level I trauma center. Annals of surgery, 229, 409-15.

Osler, T., Baker, S.P., Long, W. (1997) A modification of the Injury Severity Score that both improves accuracy and simplifies scoring. Journal of trauma, injury, infection, and critical care, 43, 922-5.

Pepe, P.E., Eckstein, M. (1998) Reappraising the prehospital care of the patient with major trauma. Emergency medicine clinics of North America,16, 1-15.

Pittman, D., Handy, W. (1964) Patterns in criminal aggravated assault. Journal of criminal law, 55, 462-70.

Polsby, D.D. (1995) Firearm costs, firearm benefits and the limits of knowledge. Journal of criminal law and criminology, 86, 207- .

Presidential Commission on Law Enforcement and Administration of Justice. (1967) *The Challenge of Crime in a Free Society: A Report by the President's Commission on Law Enforcement and Administration of Justice.* Washington, D.C.: U.S. Government Printing Office.

Reiss, A.J. (1985) "Some failures in designing data collection that distorts results," in *Collecting Evaluation Data* (Eds.) Burstein, L., Freeman, H., & Rossi, P. (Chapter 9) New York: Sage Publications.

Reiss, A. & Roth, J. (Eds.) (1993) *Understanding and Preventing Violence*, National Academy Press, Washington DC, USA.

Rhee, P.M., Foy, H., Kaufmann, C. et al. (1998) Penetrating injuries: A population-based study. Journal of trauma, injury, infection, and critical care,45, 366-70.

Roberts, I., Campbell, F., Hollis, S., Yates, D. (1996) Reducing accident death rates in children and young adults: the contribution of hospital care. British medical journal, 313, 1239-41.

Rose, H.M (1979) "Lethal aspects of urban violence: An overview," in *Lethal Aspects of Urban Violence* (Ed.) Rose, H.M. , pp.1-16, Lexington, MA: D.C. Heath.

Rosen, P. & Anderson, G.V. (1998) Foreward – Contemporary issues in trauma. Emergency medicine clinics of North America,16, xiii-xvi.

Rosenfeld, R. (2000) "Patterns in adult homicide: 1980 – 1995," in *The Crime Drop in America*, (Eds.) Blumstein, A. & Wallman, J. (Chapter 5). Cambridge, U.K.: Cambridge University Press.

Ruchholtz, S., Zintl, B., Nast-Kolb, D. et al. (1998) Improvement in the therapy of multiply injured patients by introduction of clinical management guidelines. Injury, 29, 115-29.

Rutledge, R., Messick, J., Baker, C.C. et al. (1992) Multivariate population-based analysis of the association of county trauma centers with per capita county trauma death rates. Journal of trauma, 33, 29-37.

Sampalis, J.S., Lavoie, A., Williams, J.I. et al. (1993) Impact of on-site care, prehospital time, and level of in-hospital care on survival in severely injured patients. Journal of trauma, injury, infection, and critical care, 34, 252-261,

Sampalis, J.S., Denis, R., Frechette, P. et al. (1997) Direct transport to tertiary trauma centers versus transfer from lower level facilities: impact on mortality and morbidity among patients with major trauma. Journal of trauma, injury, infection, and critical care,43, 288-95

Sampalis, J.S., Denis, R., Lavoie, A. et al. (1999) Trauma care regionalization: a process-outcome evaluation. Journal of trauma, injury, infection, and critical care, 46, 565-79

Sheps Rural Studies Center. North Carolina Rural Health Research and Policy Analysis Program. (2000) Certified trauma centers 1994. University of North Carolina at Chapel Hill.

Sherman, L.W. & Berk, R.A. (1984) The specific deterrent effects of arrest for domestic assault. American sociological review, 261, 261-72.

Sinauer, N., Annest, J.L., & Mercy, J.A. (1996) Unintentional, non-fatal firearm-related injuries. A preventable public health burden. Journal of the American Medical Association, 275, 1740-3.

Smith, M. D. & M.A. Zahn (Eds.). (1999). *Studying and Preventing Homicide: Issues and Challenges*. Thousand Oaks, CA: Sage.

Soderstrom C.A. (1997) Discussion of "A Modification of the Injury Severity Score that both improves accuracy and simplifies scoring." Journal of trauma, injury, infection, and critical care, 43, 922-5.

Trunkey, D.D. (2000) History and development of trauma care in the United States. Clinical orthopedics and related research, 374, 36-46.

Uniform Crime Reports (1931-1997). Crime in the United States. Washington, D.C.: U.S. Government Printing Office.

US Bureau of the Census. (1994) County and city data book 1994. Washington, D.C.: U.S. Government Printing Office.

Veenema, K.R. & Rodewald, L.E. (1995) Stabilization of rural multiple-trauma patients at level III emergency departments before transfer to a level I regional trauma center. Annals of emergency medicine, 25, 175-81.

Wintemuta, G. (2000) "Guns and gun violence," in *The Crime Drop in America*, (Eds.) Blumstein, A. & Wallman, J. (Chapter 3). Cambridge, U.K.: Cambridge University Press

Wilson, J.Q. (1985) *Thinking About Crime.* New York: Vintage Books.

Wolfgang, M. (1958) *Patterns in Criminal Homicide.* Philadelphia: University of Pennsylvania.

Zimring, F. (1968) Is gun control likely to reduce violent killings? University of Chicago law review, 35,

Zimring, F. (1972) The medium is the message: Firearm caliber as a determinant of death from assault. Journal of legal strudies,1, 97-123.

Zimring, F. & Hawkins, G. (1997) *Crime is Not the Problem; Lethal Violence in America.* NY: Oxford University Press.

Acknowledgments

We would like to thank Roland Chilton, Dee Weber, and the Social and Demographic Research Institute at the University of Massachusetts Amherst for help in providing us the datasets used in the last portion of the analysis, and Jim Lynch for his extraordinary role in helping us think through major questions in the analysis. Thanks also to Dwayne Smith, Tom Petee, Jay Corzine, Sally Simpson, Steve Messner, Michael Rand, Lee Annest, Phil Cook, Bob Bursik, Joe Sheley, Ted Chiricos and to Randall Stokes, Doug Anderton, Rob Faulkner, Stephen Gehlbach, Audrey Kieras, and several anonymous reviewers for helpful comments on drafts of this paper. Special thanks go to the North Carolina Rural Health Research and Policy Analysis Program, Sheps Rural Studies Center at the University of North Carolina at Chapel Hill, particularly Tom Ricketts and Karen Johnson-Webb, for providing us a countywide list of certified U.S. trauma centers in 1994, and to Avery Nathens and his associates at Harborview Medical Center at the University of Washington in Seattle for providing us with Bazzoli and Madura's (1993) regionalized trauma care system data and useful advice, and to Steve Messner, Robert Ballor, and NCOVR, H. John Heinz III School of Public Policy and Management, Carnegie Mellon University, for providing us with the county data referred to in endnotes 16 and 17.

ENDNOTES

[1]Absolute rates of homicide and aggravated assaults in the United States have dropped significantly since 1994. The causes of the drop – possibly including accelerated rates of incarceration, community policing, an aging population, and an improved economy -- have been vigorously disputed. Secular trends of similar magnitude can be seen in UCR data prior to 1994. Our focus is on a broader period of time and, given our dependent variable (lethality of aggravated assaults), is independent of such fluctuations.

[2]Essential here are basic developments in telecommunication services, from the simple proliferation of 911 emergency telephone dialing, radio dispatched communications between emergency service workers, to beeper services for MDs, to the use of cell phones by witnesses of accidents and assaults on isolated highways and streets. Developments in open heart, transplant surgery, emergency medicine, trauma centers and systems, and the training levels of prehospital trauma personnel are important examples of medical progress, as is the development and proliferation of such medical hardware as Computerized Tomographic Scanners (CTs) and portable defibrillators. By no means unimportant here is the simple historical proliferation of local and county hospitals throughout the nation.

[3]Nathens et al. (2000) conclude that it takes about 10 years after initial trauma system implementation before the drop on MVC mortality can be seen.

[4]Wolfgang suggested that research exploring these probable contributing factors be conducted but never attempted such a study. Considering that one of the few recommendations the President's Commission on Crime (1967) acted upon was the proposed development of a nationwide "111" emergency phone number (later to become "911"), as a consultant to the commission Wolfgang arguably played a role in actually shaping the outcome to be studied. (From conversation with Roland Chilton)

[5]Relying on what appears to be OLS regression, Doerner reports significant medical variable effects (betas) on lethality for Basic Life Support Services (B= -.53), Helicopter Landing Site (B= -.22), Computerized Tomographic Scanner (B= -.34) and %Population Health Shortage Area (B=.29). The countywide arrest data used in our concluding analysis on medical resources show an LR (lethality ratio) distribution in Florida counties from 1982 to 1986 similar to the national patterns for the period and throughout the 1960-1997 span overall. These patterns strongly point to the use of Poisson or negative binomial rather than simple ordinary least squares regression.

[6] In a separate analysis of homicides in Chicago from 1982 to 1995 (Block, Block, & the Illinois Criminal Justice Information Authority. "Homicides in Chicago, 1965-1995"), we observed similar trends for %DOA and survival time for *each* of the separate trauma categories -- automatics, knives, clubs, and beatings..

[7] Recent Vital Statistics changes in cause of death coding suggest that past homicide counts may actually have been too high (NHCS, Vital Statistics, May 2001).

[8] Two additional comparisons are worth noting. One, NIJ's Monitoring the Future project – which, like NCVS, suffers from relatively low capture of high-at-risk-for-crime populations--shows a generally increasing trend in reported assault with injury and armed robbery among high school seniors from 1980 to 1998. Over 19 years, the combined rate is correlated at .75 with UCR aggravated assaults, but at -.45 with NCVS aggravated assaults. Two, from 1986 through 1999 the parallel NCVS and UCR lethality measures are actually positively correlated at r = .26.

[9] The problem of NCS/NCVS underestimation may have been further magnified by a trend toward telephone based interviewing, changes in the nature of the proxy reporting of juvenile crime, and a severely shrinking national sample (see Biderman and Lynch, 1991, Atrostic et al., 1999), as well as an approximately four-fold increase in national imprisonment rates since the survey's inception.

[10] On the one hand, the assumption that the case fatality rate (CFR) for long gun assaults is higher than the rate for handgun assaults is reasonable and is often made in related literature (cf. Kleck, 1991). Given actual variation in assault usage, however, such as distance from target, this is ultimately an empirical matter. We explored this question using a dataset produced by the merger of a CDC Firearm Injury dataset based on a national probability sample of hospital emergency room admissions for the years 1993 to 1997 (CDC, 2000) with national UCR Supplemental Homicide data (also just from firearms) for the same years (Fox, 2000). From the CDC subset we dropped all injuries that were not coded as assault-based (eg, accidental). Assuming they would be redundant with the firearm deaths in the UCR data, all firearm assaults ending in death in the CDC subset were dropped. Each of the two datasets merged contained information on the type of gun used in the assault or homicide (airgun assaults were eliminated). In logistic regression of mortality on long gun dummies (handguns were the excluded category), we again included age of victim and year of injury as controls. The only significant effects involved age of victim which was positively related to mortality, as fully expected based from the medical literature, and the impact of shotguns which, surprisingly, showed a lower CFR than handguns The rifle dummy did not showed significantly different effects on mortality than handguns (N=66156; weighted N=213042). These somewhat counterintuive findings suggest that the upturn in lethality found for rural areas is more likely to reflect the absence of medical resources than the "intrinsic" lethality of long guns. Over the years exsanguination or, simply, "bleeding out," has likely provided a large proportion of all penetrating-wound homicides in areas -- especially rural counties -- with sparse or no medical resources.

[11] Short run dips and rises in the lethality of assault such as the rise between 1985 and 1993 seen in large U.S. cities are most likely a function of local cycles of competing weaponry and medical technology and technique, with medical resources eventually eroding the lethality of newly introduced weaponry, followed then by a round of even more lethal forms of weaponry, and so on.

[12] Zimring's work is especially instructive in its focus on the importance of weaponry -- particularly the role of firearms -- in framing general criminological analysis (eg, Zimring, 1968 and 1972), especially including cross-national comparisons of crime (*Crime is Not the Problem;*

Lethal Violence in America, Zimring and Hawkins, 1997). (Also see Cook, 1991.) Thus, the same sort of "less lethal weapons" explanation might account for the extraordinarily different lethality ratios observed in comparing the U.S. and other industrial democracies (Zimring 1972; Reiss & Rhodes 1993; Zimring & Hawkins, 1997) – with U.S. lethality ratios running consistently higher than those in other industrial democracies because of more lethal weaponry.

[13] Using arrest data has several potentially important consequences. One is that since more serious crimes such as homicide are *cleared* by arrest more frequently than less serious crimes, such as aggravated assault, in the denominator (homicide + aggravated assault) our lethality measure captures a larger proportion of known homicide than known aggravated assault, therefore yielding higher absolute lethality levels than an offenses-known based measure. (The lethality ratios based on arrest that we observed are generally 20%-50% higher than those based on offenses known to the police.) As long as the *difference* between the two measures does not vary systematically by some other key factor, such as time, for most purposes the choice does not matter. If, however, observed drops in LR are due to historical changes in the "capture ratio" of homicides to aggravated assault, an explanatory rival to the improved medical care/lowered lethality hypothesis would be provided. A marked drop in the U.S. clearance rate for homicide (from over 90% in the 1960s to just about 66% in the later 1990s) that is not be matched by a parallel drop in clearance rate for aggravated assaults, would produce an artificial deflation in the Lethality Ratio rather than a "real" one. As it turns out, the difference in question – captured in a ratio of lethality ratios (RLR) – actually does vary significantly by time, but not by much. In at least a chunk of the 1960-1999 time period examined -- from 1976 to 1993 – by using the RLR we were able to see and estimate that portion of any LR drop produced through the use of arrest rather than offenses-known data. Techniques involving the regression of the LRL on time yield estimates that the arrest-based approach introduces a statistically real but modest contribution of about 4% to the observation of the decrease in the lethality trendline. This leaves 2 important conclusions. The first is that 96% or so of the drop needs to be explained by other factors, including improvements in the nature and delivery of medical care. The second is that the drop in aggravated offense clearance is thus very nearly as ominous as the one in homicide.

[14] Chilton and Weber (1999) have compiled these police-agency level data for public download at the Institute for Social and Political Research at the University of Michigan. These data are currently limited to agencies in Metropolitan Statistical Areas. Professors Chilton and Weber were kind enough to provide the authors additional matching data for the remaining non-MSA counties during this time (1960 – 1997), with public download availability expected in 2001 or 2002. We aggregate these agency data to the county level. Although national coverage is almost complete, some of the typically smaller agencies do not report data and some of the agencies, not necessarily smaller, do not complete the full 12-month reporting schedule. UCR reported information of months covered for an agency only begins in 1974. Since then, criminologists will occasionally impute annual agency results by inflating six to eleven months' worth of agency data. We chose not to do so, dropping all "annual" agency reports *not* based on 12-month data (about 10% of the pre-drop total). Doing this does not appear to bias the results, as the 1974-1997 correlation between reporting year and "full 12 month coverage" is miniscule (r=-.013, ns). One result of working with a "full 12 month only" dataset is that our absolute crime counts are almost always a little lower than published national counts.

[15] If we had included all the medical variables considered we would still report a strong relationship between medical resources and lethality. Multicollinearity among these variables makes it impossible to differentiate the separate contributions of these variables, but it does not prevent us from discerning their joint effect.

[16] We would like to thank the Tom Petee and Jay Corzine for raising this issue and Steve Messner and his associates at NCOVR for providing us the relevant data (Messner et al, 1998).

[17] When these variables are added to the model, South has a significant positive effect on lethality in both periods, urban has a significant negative effect in Period 2, and resource deprivation has a significant positive effect in Period 2. The coefficients of the medical resource variables scarcely change, however, indicating that these "control variables" are probably picking up (a) aspects of the availability and quality of medical care that the medical resource variables -- themselves somewhat crude measures -- are insensitive to and (b) some of the effect of weaponry on lethality (for example, guns are more prevalent in the South than in other regions of the country). Most important, the omission of these variables does not create appreciable specification error, and therefore does not call into question the validity and interpretation of the regressions reported in Table 2.

[18] These data are part of a more recently initiated time-series collected by the American Hospital Association, are the only such national data and, surprisingly, are proprietary and currently available as fee-based only.

[19] This is by no means as clear-cut a finding as it might appear. We observed lethality drops for *firearm assaults in general* and were unable to adjust for specific historical trends in caliber or an increase in multiple penetrating injuries likely to have been correlated with the post-1985 increases in automatic weapons use cited by many (see Wintemute, 2000). Along with other unexamined trends from 1960 to 1999 which may actually have *suppressed* our observed lethality drops – such as lower UCR reporting rates of rural agencies with high lethality levels in the 1960s and 1970 – we suspect that an unmeasured overall increase in the *firepower* of criminally used firearms from 1985 on, if not for the entire period, acted to suppress even greater drops than those observed in firearm mortality, clearly the most important portion of the weapons mix for the purpose of estimating criminal lethality.

[20] Since, during the period 1960 to 1999, the mean age of victims of assault dropped significantly, this age drop becomes a plausible rival explanation of our observed drop in lethality. In the logistic analysis of the lethality of long gun injuries compared to handgun injuries we referred to in endnote 10, victim's age was included as a control variable. As fully expected, increasing age was significantly related to increased mortality from firearm injuries. Based on these data, we conservatively estimate the impact of age on mortality at +4% per 10 years of age. The question is: how much did the age of assault victims drop during this time? Exact estimates are difficult to produce. Using national UCR data from 1976 to 1999, the mean annual drop in victims' age in years is 0.10 (Bureau of Justice Statistics, 2000). Using NCVS data for all violent crime from 1973 to 1994, the corresponding estimate is about 0.07 (Bureau of

Justice Statistics, 1997). Using Chicago homicide data from 1965 to 1995, the mean annual drop in victims' age in years is 0.24 (Block et al, 1998). Extrapolating the latter, largest estimate to all assaults for the period 1965 to 1999 produces an estimated drop of 8.22 years of age among assault victims during the entire research period. Rounding this age drop to 10 years, and then applying the 4% increase in mortality per 10 years of age observed in the CDC/ Supplemental Homicide data implies that the maximum impact of the age drop on lethality during the period studied was 4% ((10/10) * 4%). Since the lethality drops we observed during this period ranged from approximately 60% to 75%, if our extrapolation is correct, the most the drop in the victims' age could account for in the overall lethality drop is thus about 7% (4%/60%).

[21]As a worst case example, it might be proposed that of all assaults, in 1980 family aggravated assaults comprised only one-quarter (5.9%) of the 23.8% seen in 1995. Assuming constancy in the family and non-family major injury proportions, 24.4% and 20.5%, the overall major injury rate in 1980 would have been 24.2%, as opposed to an overall rate of 23.7% in 1995, -- a overall major injury outcome in aggravated assaults "dilution" of only 2.1%. Alternatively, assuming the same 1980 family aggravated assault proportion of all aggravated assaults, but with an extremely high major injury fraction of 50% in 1980, produces an overall major injury rate in 1980 of 25.9%, as opposed to an overall rate of 23.7% in 1995, -- a "worst case "dilution" of 8.5%.

[22] Measurement problems would not be resolved by sampling only assaults with serious or even "life-threatening" injuries. Because victim or host characteristics such as age mediate the "life-threatening" properties of an injury, in any such analysis it would be important to score seriousness of *all* assault produced injuries.