

## REFERENCES

- Garber AM, Fuchs VR, Silverman JF. Case mix, costs, and outcomes: differences between faculty and community services in a university hospital. *N Engl J Med* 1984; 310:1231-7.
- Cameron JM. The indirect costs of graduate medical education. *N Engl J Med* 1985; 312:1233-8.
- Schroeder SA, O'Leary DS. Differences in laboratory use and length of stay between university and community hospitals. *J Med Educ* 1977; 52:418-20.
- Frick AP, Martin SG, Shwartz M. Case-mix and cost differences between teaching and nonteaching hospitals. *Med Care* 1985; 23:283-95.
- Griner PF. Use of laboratory tests in a teaching hospital: long-term trends: reductions in use and relative cost. *Ann Intern Med* 1979; 90:243-8.
- Williams SV, Eisenberg JM, Kitz DS, et al. Teaching cost-effective diagnostic test use to medical students. *Med Care* 1984; 22:535-42.
- Schroeder SA, Kenders K, Cooper JK, Piemme TE. Use of laboratory tests and pharmaceuticals: variation among physicians and effect of cost audit on subsequent use. *JAMA* 1973; 225:969-73.
- Cohen DI, Jones P, Littenberg B, Neuhauser D. Does cost information availability reduce physician test usage? A randomized clinical trial with unexpected findings. *Med Care* 1982; 20:286-92.
- Martin AR, Wolf MA, Thibodeau LA, Dzau V, Braunwald E. A trial of two strategies to modify the test-ordering behavior of medical residents. *N Engl J Med* 1980; 303:1330-6.
- Grossman RM. A review of physician cost-containment strategies for laboratory testing. *Med Care* 1983; 21:783-802.
- Schroeder SA, Myers LP, McPhee SJ, et al. The failure of physician education as a cost containment strategy: report of a prospective controlled trial at a university hospital. *JAMA* 1984; 252:225-30.
- Griner PF. Innovations in ambulatory care and teaching: a house staff group practice. *J Med Educ* 1974; 49:607-9.
- Fletcher RH, Fletcher SW. The medical polyclinic: an approach to conflicting needs in a teaching hospital. *J Med Educ* 1976; 51:634-43.
- Berarducci AA, Delbanco TL, Rabkin MT. The teaching hospital and primary care: closing down the clinics. *N Engl J Med* 1975; 292:615-20.
- Pasquariello PS Jr, Ames MD, Lustig HS. Participation of house staff in group practice: experience at a tertiary care center. *J Med Educ* 1978; 53:105-10.
- Walker FB IV. A faculty and house staff group practice: report of an operational model. *J Med Educ* 1978; 53:965-72.
- Lufts HS. How do health-maintenance organizations achieve their "savings"? Rhetoric and evidence. *N Engl J Med* 1978; 298:1336-43.
- Gaus CR, Cooper BS, Hirschman CG. Contrasts in HMO and fee-for-service performance. *Soc Sec Bull* 1976; 39:3-14.
- Kosecoff J, Fink A, Brook RH, et al. General medical care and the education of internists in university hospitals: an evaluation of the teaching hospital general medicine group practice program. *Ann Intern Med* 1985; 102:250-7.
- Waggoner DM, Frengley JD, Griggs RC, Rammelkamp CH. A "firm" system for graduate training in general internal medicine. *J Med Educ* 1979; 54:556-61.
- Cohen DI, Neuhauser D. The Metro Firm Trials: an innovative approach to ongoing randomized clinical trials. In: *Assessing medical technologies*. Washington, D.C.: National Academy Press, 1985:529-34.
- Fetter RB, Shin Y, Freeman JL, Averill RF, Thompson JD. Case mix definition by diagnosis-related groups. *Med Care* 1980; 18:Suppl 2:1-53.
- Whiting-O'Keefe QE, Henke C, Simborg DW. Choosing the correct unit of analysis in medical care experiments. *Med Care* 1984; 22:1101-14.
- Cohen DI, Littenberg B, Wetzel C, Neuhauser D. Improving physician compliance with preventive medicine guidelines. *Med Care* 1982; 20:1040-5.
- Perkoff GT, Kahn L, Haas PJ. The effects of an experimental prepaid group practice on medical care utilization and cost. *Med Care* 1976; 14:432-49.
- Manning WG, Leibowitz A, Goldberg GA, Rogers WH, Newhouse JP. A controlled trial of the effect of a prepaid group practice on use of services. *N Engl J Med* 1984; 310:1505-10.

## PROTECTION OR PERIL?

## An Analysis of Firearm-Related Deaths in the Home

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**Abstract** To study the epidemiology of deaths involving firearms kept in the home, we reviewed all the gunshot deaths that occurred in King County, Washington (population 1,270,000), from 1978 through 1983. The medical examiner's case files were supplemented by police records or interviews with investigating officers or both, to obtain specific information about the circumstances, the scene of the incident, the type of firearm involved, and the relationship of the suspect to the victim. A total of 743 firearm-related deaths occurred during this six-year period, 398 of which (54 percent) occurred in the residence where

the firearm was kept. Only 2 of these 398 deaths (0.5 percent) involved an intruder shot during attempted entry. Seven persons (1.8 percent) were killed in self-defense. For every case of self-protection homicide involving a firearm kept in the home, there were 1.3 accidental deaths, 4.6 criminal homicides, and 37 suicides involving firearms. Handguns were used in 70.5 percent of these deaths.

The advisability of keeping firearms in the home for protection must be questioned. (*N Engl J Med* 1986; 314: 1557-60.)

**T**HERE are approximately 120 million guns in private hands in the United States.<sup>1,2</sup> About half of all the homes in America contain one or more firearms.<sup>1-8</sup> Although most persons who own guns keep them primarily for hunting or sport, three quarters of gun owners keep them at least partly for protection.<sup>1-4</sup> One fifth of gun owners identify "self-defense at home" as their most important reason for having a gun.<sup>5</sup>

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Keeping firearms in the home carries associated risks.<sup>1,9</sup> These include injury or death from unintentional gunshot wounds, homicide during domestic quarrels, and the ready availability of an immediate, highly lethal means of suicide. To understand better the epidemiology of firearm-related deaths in the home, we studied all the gunshot deaths that occurred in King County, Washington, between 1978 and 1983. We were especially interested in characterizing the gunshot deaths that occurred in the residence where the firearm involved was kept.

## METHODS

King County, Washington (1980 census population 1,270,000), contains the cities of Seattle (population 494,000) and Bellevue (population 74,000), as well as a number of smaller communities.<sup>10</sup>

The county population is predominantly urban (92 percent) and white (88.4 percent), with smaller black (4.4 percent) and Asian (4.3 percent) minorities. All violent deaths in King County are investigated by the office of the medical examiner.

We systematically reviewed the medical examiner's case files to identify every firearm-related death that occurred in the county between January 1, 1978, and December 31, 1983. In addition to general demographic information, we obtained specific data regarding the manner of death, the scene of the incident, the circumstances, the relationship of the suspect to the victim, the type of firearm involved, and the blood alcohol level of the victim at the time of autopsy. When records were incomplete, corroborating information was obtained from police case files and direct interviews with the original investigating officers.

Gunshot deaths involving the intentional shooting of one person by another were considered homicides. Self-protection homicides were considered "justifiable" if they involved the killing of a felon during the commission of a crime; they were considered "self-defense" if that was the determination of the investigating police department and the King County prosecutor's office.<sup>11</sup> All homicides resulting in criminal charges and all unsolved homicides were considered criminal homicides.

The circumstances of all homicides were also noted. Homicides committed in association with another felony (e.g., robbery) were identified as "felony homicides." Homicides committed during an argument or fight were considered "altercation homicides." Those committed in the absence of either set of circumstances were termed "primary homicides."

Deaths from self-inflicted gunshot wounds were considered suicides if they were officially certified as such by one of us (D.T.R.), who is the medical examiner. Unintentional self-inflicted gunshot wounds were classified as accidental. Although the medical examiner's office considers deaths involving the unintentional shooting of one person by another as homicide, we classified these deaths as accidental for our analysis. Deaths in which there was uncertainty about the circumstances or motive were identified as "undetermined."

## RESULTS

Over the six-year interval, the medical examiner's office investigated 743 deaths from firearms (9.75 deaths per 100,000 person-years). This total represented 22.7 percent of all violent deaths occurring in King County during this period, excluding traffic deaths. Firearms were involved in 45 percent of all homicides and 49 percent of all suicides in King County — proportions lower than the national averages of 61 and 57 percent, respectively.<sup>12,13</sup> Guns accounted for less than 1 percent of accidental deaths and 5.7 percent of deaths in which the circumstances were undetermined (Table 1).

Of the 743 deaths from firearms noted during this six-year period, 473 (63.7 percent) occurred inside a

**Table 2. Relationship of Victim to Resident in Nonsuicidal Deaths Involving a Firearm Kept in the Home.**

RELATIONSHIP	No.	%	RELATIVE RISK*
Stranger	2	3	1.0
Friend or acquaintance	24	37	12.0
Nonresident relative	3	5	1.5
Resident	36	55	18.0
Relative	11	17	
Spouse	9	14	
Roommate	6	9	
Self	7	11	
Other	3	4	

\*Based on the number of homicides involving strangers.

house or dwelling, and 398 (53.6 percent) occurred in the home where the firearm involved was kept. Of these 398 firearm deaths, 333 (83.7 percent) were suicides, 50 (12.6 percent) were homicides, and 12 (3 percent) were accidental gunshot deaths. The precise manner of death was undetermined in three additional cases involving self-inflicted gunshot wounds.

In 265 of the 333 cases of suicide (80 percent), the victim was male. A blood ethanol test was positive in 86 of 245 suicide victims tested (35 percent) and showed a blood ethanol level of 100 mg per deciliter or more in 60 of the 245 (24.5 percent). Sixty-eight percent of the suicides involved handguns. In eight cases, the medical examiner's case files specifically noted that the victim had acquired the firearm within two days of committing suicide.

The victim was male in 30 of the 50 homicide deaths (60 percent). A blood ethanol test was positive in 27 of 47 homicide victims tested (57 percent) and showed a blood ethanol level of 100 mg per deciliter or more in 10 of the victims (21 percent). Handguns were involved in 34 of these deaths (68 percent).

Forty-two homicides (84 percent) occurred during altercations in the home, including seven that were later determined to have been committed in self-defense. Two additional homicides involving the shooting of burglars by residents were considered legally "justifiable."<sup>11</sup> Forty-one homicides (82 percent) resulted in criminal charges against a resident of the house or apartment in which the shooting occurred.

Four of the 12 accidental deaths involved self-inflicted gunshot wounds. All 12 victims were male. A blood ethanol test in the victims was positive in only two cases. Eleven of these accidental deaths involved handguns.

Excluding firearm-related suicides, 65 deaths occurred in the house where the firearm involved was kept (Table 2). In two of these cases, the victim was a stranger to the persons living in the house, whereas in 24 cases (37 percent), the victim was an acquaintance or friend. Thirty-six gunshot victims (55 percent) were residents of the house in which the shooting occurred, including 29 who were victims of homicide. Residents were most often shot by a relative or family member (11 cases), their spouse (9 cases), a roommate (6 cases), or themselves (7 cases) (Table 2).

**Table 1. Violent Deaths in King County, Washington, 1978–1983.\***

MANNER OF DEATH	TOTAL DEATHS	FIREARM DEATHS	
		NUMBER	% OF TOTAL
Suicide	1,049	469	45.0
Homicide†	521	256	49.0
Accidental	1,581	11	0.7
Undetermined	122	7	5.7
Total	3,273	743	22.7

\*Data on traffic deaths are not included.

†Category includes unintentional homicides.

Guns kept in King County homes were involved in the deaths of friends or acquaintances 12 times as often as in those of strangers. Even after the exclusion of firearm-related suicides, guns kept at home were involved in the death of a member of the household 18 times more often than in the death of a stranger (Table 3). For every time a gun in the home was involved in a "self-protection" homicide, we noted 1.3 accidental gunshot deaths, 4.6 criminal homicides, and 37 firearm-related suicides (Table 3).

### DISCUSSION

We found the home to be a common location for deaths related to firearms. During our study period, almost two thirds of the gunshot deaths in King County occurred inside a house or other dwelling. Over half these incidents occurred in the residence in which the firearm involved was kept. Few involved acts of self-protection.

Less than 2 percent of homicides nationally are considered legally justifiable.<sup>11,13</sup> Although justifiable homicides do not include homicides committed in self-defense, the combined total of both in our study was still less than one fourth the number of criminal homicides involving a gun kept in the home. A majority of these homicide victims were residents of the house or apartment in which the shooting occurred.

Over 80 percent of the homicides noted during our study occurred during arguments or altercations. Baker has observed that in cases of assault, people tend to reach for the most lethal weapon readily available.<sup>14</sup> Easy access to firearms may therefore be particularly dangerous in households prone to domestic violence.

We found the most common form of firearm-related death in the home to be suicide. Although previous authors have correlated regional suicide rates with estimates of firearm density,<sup>15,16</sup> the precise nature of the relation between gun availability and suicide is unclear.<sup>1,17</sup> The choice of a gun for suicide may involve a combination of impulse and the close proximity of a firearm. Conversely, the choice of a gun may simply reflect the seriousness of a person's intent. If suicides involving firearms are more a product of the easy availability of weapons than of the strength of intent, limiting access to firearms will decrease the rate of suicide. If the opposite is true, suicidal persons

will only work harder to acquire a gun or kill themselves by other means. For example, although the elimination of toxic coal gas from domestic gas supplies in Great Britain resulted in a decrease in successful suicide attempts,<sup>18</sup> a similar measure in Australia was associated with increasing rates of suicide by other methods.<sup>19</sup>

A recent study of 30 survivors of attempts to commit suicide with firearms suggests that many of them acted on impulse.<sup>20</sup> Whether this observation applies to nonsurvivors as well is unknown. The recent acquisition of a firearm was noted in only eight of our cases, and we do not know how long before death any suicide victim planned his or her attempt. However, given the high case-fatality rate associated with suicide attempts involving firearms, it seems likely that easy access to guns increases the probability that an impulsive suicide attempt will end in death.<sup>21</sup>

Detectable concentrations of ethanol were found in the blood of a substantial proportion of the victims tested. This suggests that ethanol may be an independent risk factor for gunshot death.<sup>22-25</sup> Although this hypothesis is compatible with the known behavioral and physiologic effect of ethanol, the strength of this association remains to be defined.<sup>25</sup>

There are many reasons that people own guns. Unfortunately, our case files rarely identified why the firearm involved had been kept in the home. We cannot determine, therefore, whether guns kept for protection were more or less hazardous than guns kept for other reasons.

We did note, however, that handguns were far more commonly involved in gunshot deaths in the home than shotguns or rifles. The single most common reason for keeping firearms given by owners of handguns, unlike owners of shoulder weapons, is "self-defense at home."<sup>1,4</sup> About 45 percent of the gun-owning households nationally own handguns.<sup>1</sup> If the proportion of homes containing handguns in King County is similar to this national average, then these weapons were 2.6 times more likely to be involved in a gunshot death in the home than were shotguns and rifles combined.

Several limitations of this type of analysis must be recognized.<sup>1,26</sup> Our observations are based on a largely urban population and may not be applicable to more rural communities. Also, various rates of suicide and homicide have been noted in other metropolitan counties.<sup>27</sup> These differences may reflect variations in social and demographic composition as well as different patterns of firearm ownership.

Mortality studies such as ours do not include cases in which burglars or intruders are wounded or frightened away by the use or display of a firearm. Cases in which would-be intruders may have purposefully avoided a house known to be armed are also not identified. We did not report the total number or extent of nonlethal firearm injuries involving guns kept in the home. A complete determination of firearm risks versus benefits would require that these figures be known.

Table 3. Classification of 398 Gunshot Deaths Involving a Firearm Kept in the Home.

CLASSIFICATION	No.	%	RELATIVE Risk*
Self-protection homicide	9	2.3	1.0
Justifiable homicide	2	0.5	
Self-defense homicide	7	1.8	
Unintentional deaths	12	3.0	1.3
Criminal homicide	41	10.3	4.6
Suicide	333	83.7	37.0
Unknown	3	0.8	0.3

\*Based on the number of self-protection homicides.

The home can be a dangerous place. We noted 43 suicides, criminal homicides, or accidental gunshot deaths involving a gun kept in the home for every case of homicide for self-protection. In the light of these findings, it may reasonably be asked whether keeping firearms in the home increases a family's protection or places it in greater danger. Given the unique status of firearms in American society and the national toll of gunshot deaths, it is imperative that we answer this question.

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### REFERENCES

1. Wright JD, Rossi P, Daly K, Weber-Burdin E. Weapons, crime, and violence in America: a literature review and research agenda. Washington, D.C.: Government Printing Office, 1981.
2. Wright JD, Rossi P. Weapons, crime, and violence in America: executive summary. Washington, D.C.: Government Printing Office, 1981.
3. Wright JD. Public opinion and gun control: a comparison of results from two recent national surveys. *Ann Am Acad Pol Soc Sci* 1981; 455:24-39.
4. An analysis of public attitudes towards handgun control. Cambridge, Mass.: Cambridge Reports, 1978.
5. Attitudes of the American electorate toward gun control. Santa Anna, Calif.: Decision Making Institute, 1978.
6. Newton GD, Zimring FE. Firearms and violence in American life: task force report on firearms. Washington, D.C.: Government Printing Office, 1969.
7. Davis JA. General social surveys, 1972-1978: cumulative codebook. Chicago: National Opinion Research Center, University of Chicago, 1978: 172.
8. Alexander GR, Massey RM, Gibbs T, Altekruze JM. Firearm-related fatalities: an epidemiologic assessment of violent death. *Am J Public Health* 1985; 75:165-8.
9. Yeager M, Alviani JD, Loving N. How well does that handgun protect you and your family? Technical report no. 2. United States Conference of Mayors, Washington, D.C., 1976.
10. Bureau of Census. 1980 census of population, Washington. Washington, D.C.: Government Printing Office, 1981.
11. Uniform crime reporting handbook. Washington, D.C.: Federal Bureau of Investigation, United States Department of Justice, 1984.
12. Centers for Disease Control. Suicide surveillance, 1970-1980. April 1985.
13. Crime in the United States 1983: Uniform Crime Reports for the United States. Washington, D.C.: Federal Bureau of Investigation, United States Department of Justice, 1984.
14. Baker SP. Without guns, do people kill people? *Am J Public Health* 1985; 75:587-8.
15. Cook PJ. The effect of gun availability on robbery and robbery murder: a cross-section study of 50 cities. In: Hearings before the Subcommittee on Crime of the Committee on the Judiciary, House of Representatives. Washington, D.C.: Government Printing Office, 1978.
16. Markush RE, Bartolucci AA. Firearms and suicide in the United States. *Am J Public Health* 1984; 74:123-7.
17. Westermeyer J. Firearms, legislation, and suicide prevention. *Am J Public Health* 1984; 74:108.
18. Brown JH. Suicide in Britain: more attempts, fewer deaths, lessons for public policy. *Arch Gen Psychiatry* 1979; 36:1119-24.
19. Burvill PW. Changing patterns of suicide in Australia, 1910-1977. *Acta Psychiatr Scand* 1980; 62:258-68.
20. Peterson LG, Peterson M, O'Shanick GJ, Swann A. Self-inflicted gunshot wounds: lethality of method versus intent. *Am J Psychiatry* 1985; 142:228-31.
21. Baker SP, O'Neill B, Karpf RS. The injury fact book. Lexington, Mass.: Lexington Books, 1984.
22. Tinklenberg JR. Alcohol and violence. In: Bourne PG, Fox R, eds. Alcoholism: progress in research and treatment. New York: Academic Press, 1973:195-210.
23. Alcohol and violent death — Erie County, New York, 1973-1983. *MMWR* 1984; 33:226-7.
24. Hedeboe J, Charles AV, Nielson J, et al. Interpersonal violence: patterns in a Danish community. *Am J Public Health* 1985; 75:651-3.
25. Goodman RA, Mercy JA, Loya F, et al. Alcohol use and interpersonal violence: alcohol detected in homicide victims. *Am J Public Health* 1986; 76:144-9.
26. Drooz RB. Handguns and hokum: a methodological problem. *JAMA* 1977; 238:43-5.
27. Reay D, Tapp J. Annual Report 1980: Division of the King County Medical Examiner, Department of Public Health. Seattle: King County, 1981.